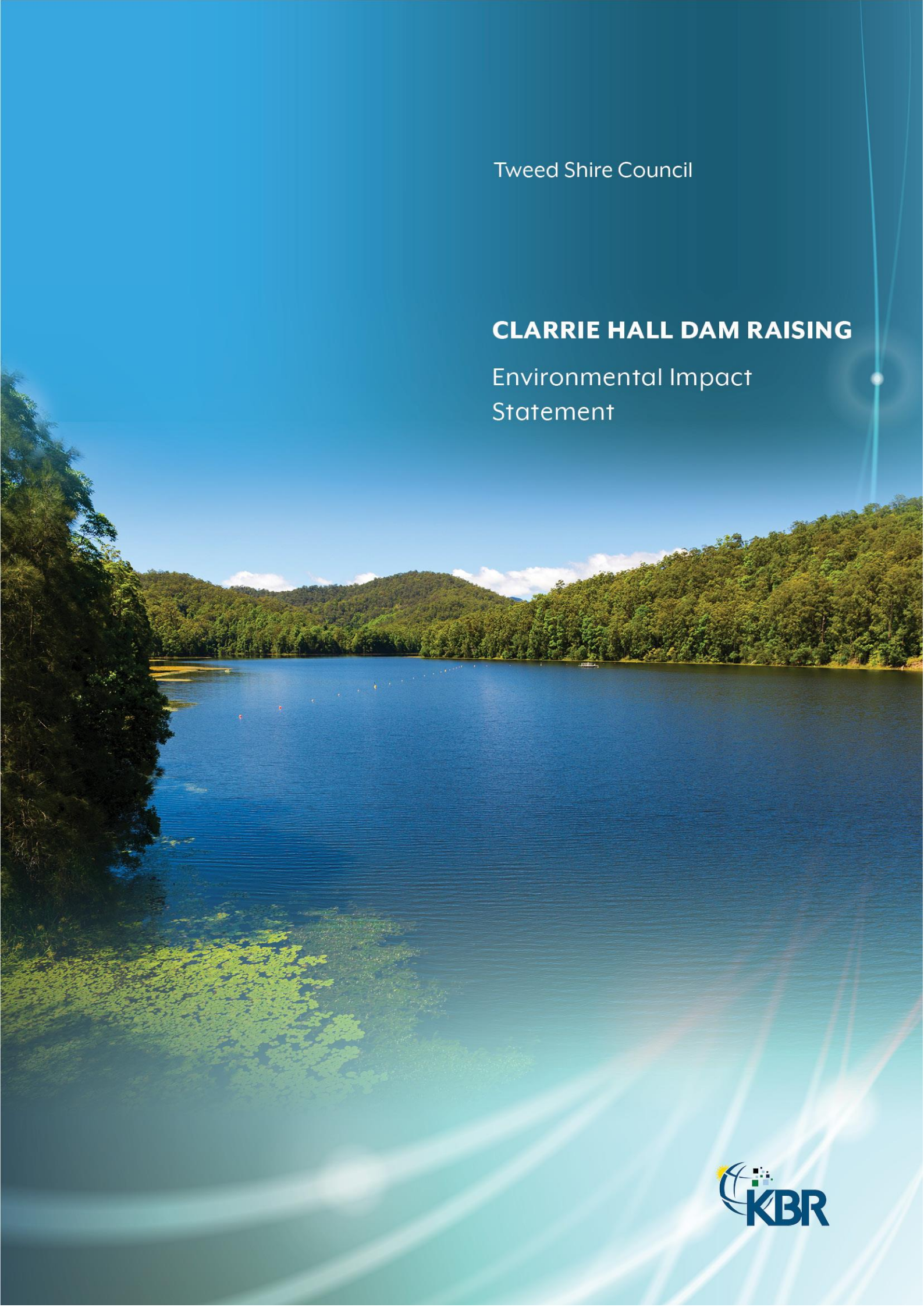
Tweed Shire Council

CLARRIE HALL DAM RAISING

Environmental Impact Statement



KBR

CLARRIE HALL DAM RAISING
Environmental Impact Statement

Prepared for:
Tweed Shire Council
Civic and Cultural Centre
Cnr Brett Street and Wharf Street
Tweed Heads NSW 2485 | Australia

Prepared by:
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16 September 2024

SEN351-TD-EV-REP-0001 Rev 0

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Limitations Statement

The sole purpose of this report and the associated services performed by Kellogg Brown & Root Pty Ltd (KBR) is to **document the Clarrie Hall Dam Raising Environmental Impact Statement** in accordance with the scope of services set out in the contract between KBR and **Tweed Shire Council** ('the Client'), including addressing the Planning Secretary's Environmental Assessment Requirements. That scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

KBR derived the data in this report primarily from **reviewing background data and information, database searches and field surveys.**

In preparing this report, KBR has relied upon and presumed accurate certain information (or absence thereof) relative to **background information** provided by government officials and authorities, the Client and others identified herein. Except as otherwise stated in the report, KBR has not attempted to verify the accuracy or completeness of any such information.

The findings, observations and conclusions expressed by KBR in this report are not, and should not be considered, an opinion concerning **the development of the Environmental Impact Statement**. No warranty or guarantee, whether express or implied, is made with respect to the data reported or to the findings, observations and conclusions expressed in this report. Further, such data, findings, observations and conclusions are based solely upon **site conditions, information, drawings supplied by the Client and other sources as identified** in existence at the time of the investigation.

This report has been prepared on behalf of and for the exclusive use of the Client and is subject to and issued in connection with the provisions of the agreement between KBR and the Client. KBR accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

Revision History

Revision	Date	Comment	Signatures			
			Originated by	Checked by	Technical Approval	Project Approval
0	16/09/2024	Issued for Use	P Billings	J.Ardas	K.Burton Kathryn Burton 2024.09.18 17:31:05 +10'00'	K Burton Kathryn Burton 2024.09.18 17:32:06 +10'00'

Declaration

Project details	
Project Name	Clarrie Hall Dam Raising
Application Number	SSI-65020460
Address of the land on which the infrastructure is to be carried out	45 Clarrie Hall Dam Road, Uki NSW 2484, within Tweed Shire
Proponent details	
Name	Tweed Shire Council
ABN	90 178 732 496
Proponent Address	Tweed Heads Administration Office Civic and Cultural Centre Corner Brett Street and Wharf Street Tweed Heads NSW 2485
Details of the person by whom this EIS was prepared	
Name	Kathryn Burton
Address	Level 13, 201 Kent Street, Sydney NSW 2000
Professional qualifications	• Master of Environmental Law • Master of Science (Environmental Toxicology) • Bachelor of Science (Environmental Biology)
Declaration by registered environmental assessment practitioner	
Name	Julian Ardas
Registration number	PIA 3760
Organisation registered with	EIANZ
Declaration	The undersigned declares that this Environmental Impact Statement: • has been prepared in accordance with the Environmental Planning and Assessment Regulation 2021 • contains all available information relevant to the environmental assessment of the development, activity or infrastructure to which the EIS relates • does not contain information that is false or misleading • addresses the Planning Secretary's environmental assessment requirements (SEARs) for the project • identifies and addresses the relevant statutory requirements for the project, including any relevant matters for consideration in environmental planning instruments • has been prepared having regard to the Department's State Significant infrastructure Guidelines – Preparing an Environmental Impact Statement • contains a simple and easy to understand summary of the project as a whole, having regard to the economic, environmental and social impacts of the project and the principles of ecologically sustainable development • contains a consolidated description of the project in a single chapter of the EIS • contains an accurate summary of the findings of any community engagement

Project details	
	• contains an accurate summary of the detailed technical assessment of the impacts of the project as a whole.
Signature	
Date	16 September 2024

Glossary

Term	Description
ABS	Australian Bureau of Statistics
Abutment	The part of the valley side where the dam is situated or will be constructed. Left and right abutments are based on an observer looking downstream.
ACHAR	Aboriginal Cultural Heritage Assessment Report
ACHMP	Aboriginal Cultural Heritage Management Plan
ACM	Asbestos containing material
ADWGs	Australian Drinking Water Guidelines
AEC	Area of potential environmental concern
AEP	Annual exceedance probability: the probability that an event of a given magnitude will occur within a period of 1 year. E.g. a 1% AEP is a 1 in 100 chance that an event of that size could occur in any one year.
AHD	Australian Height Datum: the relative height of a point in relation to Australian mean sea level
AHIMS	Australian Heritage Information Management System
AIP	NSW Aquifer Interference Policy
ALUM	Australian Land Use and Management
Amendment	A change in what the proponent is seeking approval for during the assessment. It requires changes to the project description in the EIS or modification report and amendments to the associated infrastructure application or modification request. Applications can only be amended with the agreement of the Planning Secretary.
Amendment report	A report prepared by the proponent to support amendments to an infrastructure application or modification request (see the State Significant Infrastructure Guidelines - Preparing an Amendment Report).
ANCOLD	Australian National Committee on Large Dams
ANZECC	Australian and New Zealand Environment and Conservation Council
AOBV	Area of outstanding biodiversity value
Approval authority	The approval authority for an SSI application or SSI modification request. This will be the Minister.
APZ	Asset Protection Zone
AQBMP	Aquatic Biodiversity Management Plan
AQIA	Air Quality Impact Assessment
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AR&R	Australian Rainfall and Runoff
ASC	Australian Soil Classification
ASS	Acid Sulfate Soil
BAL	Basic Left Turn

Term	Description
BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Method Calculator
BAR	Basic Right Turn
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BCD	Biodiversity Conservation Directorate
BDAR	Biodiversity Development Assessment Report
BFPL	Bushfire prone land
BFRMP	Bushfire Risk Management Plan
BMP	Biodiversity Management Plan
BoM	Bureau of Meteorology
BOS	Biodiversity Offsets Scheme
BSAL	Biophysical strategic agricultural land
BTEXN	Benzene, Toluene, Ethylene, Xylene and Napthalene
CBP	Concrete Batching Plant
CCAP	Climate Change Adaptation Plan
CCRA	Climate Change Risk Assessment
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
Chl-a	Chlorophyll (type A)
CEP	Community Engagement Plan
CIC	Critical Industry Class
CIV	Capital Investment Value
Council	Tweed Shire Council
CO_2-e	The number of metric tonnes of CO_2 emissions with the same global warning potential as one metric tonne of another greenhouse gas
CSIRO	Commonwealth Scientific Industrial Research Organisation
CWG	Community Working Group
CWP	Cold Water Pollution
Cumulative impacts	The combined impacts of the project on a matter with other relevant future projects (see the Department's Cumulative Impact Assessment Guidelines for State Significant Projects).
dB	Decibels
Declaration	A REAP may declare the EIS, for a State significant project are in accordance with the EP&A Regulation and the Registered Environmental Assessment Practitioner Guidelines before they are submitted to the Department.
DCCEEW C'wealth	Australian Government Department of Climate Change, Energy, the Environment and Water
DCCEEW NSW	NSW Government Department of Climate Change, Energy, the Environment and Water

Term	Description
DPHI	Department of Planning, Housing and Infrastructure (formerly Department of Planning and Environment (DPE))
Determination	A decision by an approval authority for an SSI application to either approve the application subject to modifications or conditions or refuse the application.
DO	Dissolved oxygen
DSC	Dam Safety Committee
DSEP	Dam Safety Emergency Plan
EC	Electrical conductivity
ECLs	East Coast lows
EEC	Endangered Ecological Community
EMP	Emergency Management Plan
EMU	Extraction management unit
ENM	Extracted Natural Material
ENSO	El Niño/La Niña Southern Oscillation
Environmental assessment reports	Reports required to be submitted to the Department by a proponent seeking approval for an SSI application or modification request. These reports include scoping reports, EISs, submissions reports, amendment reports, preferred infrastructure reports and modification reports.
Environmental impact statement (EIS)	An environmental impact statement prepared by the proponent to support an SSI application.
Environmental planning instrument (EPI)	Means an environmental planning instrument (including a SEPP or Local Environmental Plan) made under part 3 of the EP&A Act.
EPA	Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979.
EP&A Regulation	Environmental Planning and Assessment Regulation 2000.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically Sustainable Development
FAQs	Frequently Asked Questions
FCC	Flood consequence category
FDCV	Fixed dispersion cone valve
FFA	Flood Frequency Analysis
FFDI	Forest Fire Danger Index
FM Act	*Fisheries Management Act 1994*
FNCRWS	Far North Coast Regional Water Strategy
FSL	Full Supply Level
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas

Term	Description
GL	Gigalitres
GREP	*Government Resource Efficiency Policy 2014* (NSW)
Grout curtain	A barrier that protects the foundation of a dam from seepage by reducing the hydraulic conductivity of the rock mass and reducing uplift pore pressure.
ha	Hectare
HAA	Historical Archaeological Assessment
HHMP	Historic Heritage Management Plan
HTW	High threat weed
HV	High-voltage
ICNG	Interim Construction Noise Guideline
IPCC	Intergovernmental Panel on Climate Change
Infrastructure Sustainability (IS) Rating	The Infrastructure Sustainability Rating is administered by the Infrastructure Sustainability Council and is a third party verified sustainability rating tool used on infrastructure projects.
KFH	Key Fish Habitat
kt	Kilotonnes
KTP	Key Threatening Processes
LALC	Local Aboriginal Land Council
L_{Amax}	Maximum sound level, the highest time-weighted sound level measured during a period
$L_{Aeq,15minute}$	The A-weighted energy average noise level, which is the continuous sound pressure level measured over a over a 15-minute period
LEPs	Local Environmental Plans
LGA	Local Government Area
LLI	Low Level Inlet
LSC	Land and soil capability or land suitability classes
LSEA	Land, Soils and Erosion Assessment
LTAAEL	Long-term average annual extraction limit
LV	Low-voltage
m	Metres
Matter	An element of the environment that may be affected by an SSI (e.g., air, amenity, biodiversity, economic, social).
mbgl	Metres below ground level
mbtoc	Metres below top of bore casing
MCA	Multi-Criteria Analysis
MIC	Maximum interval of change
Minister	The Minister for Planning and Public Spaces.
Mitigation	Actions or measures to reduce the impacts of the project.
ML	Megalitres

Term	Description
ML/d	Megalitre per day
MLO	Multiple level offtake
MNES	Matters of National Environmental Significance
Modification report	A report prepared by the proponent to support a modification request (see the State Significant Infrastructure Guidelines - Preparing a Modification Report).
Modification request	A request seeking to modify an SSI approval under section 5.25 of the EP&A Act.
NARCLiM	NSW and ACT Government Regional Climate Modelling climate change projections
NGER	National Greenhouse and Energy Reporting
NGER Act	*National Greenhouse and Energy Reporting Act 2007* (Commonwealth)
NML	Noise Management Level
NPC	Net Profit Cost
NPW Act	*National Parks and Wildlife Act 1974*
NPWS	National Parks and Wildlife Services
NPfI	*Noise Policy for Industry*
NT Act	*Native Title Act 1993* (Commonwealth)
NVIA	Noise and Vibration Impact Assessment
OEMP	*Operational Environment Management Plan*
Ogee	A form of overflow spillway where the cross section of the crest, downstream slope and bucket have an "S" curve shape.
OOH	Outside of the ICNG standard construction hours
PAD	Potential archaeological deposit
PBP 2019	*Planning for Bushfire Protection 2019* (NSW Rural Fire Service 2019).
PCT	Plant Community Type
Planning Secretary	The Secretary of the Department.
Planning Systems SEPP	*State Environmental Planning Policy (Planning Systems) 2021* (NSW)
PMF	Probable Maximum Flood (a flood of 1 in 10,000,000 year magnitude)
PM_{10}	Particles with a diameter of 10 microns or less
$PM_{2.5}$	Particles with a diameter of 2.5 microns or less (fine particulate matter)
PMST	Protected Matters Search Tool
POEO Act	*Protection of the Environment Operations Act 1997*
PO_4	Phosphate
Preferred infrastructure report	A report prepared by an SSI proponent at the request of the Planning Secretary that outlines any proposed changes to the SSI to minimise its environmental impact or to deal with any other issue raised during the assessment of the application concerned (see the State Significant Infrastructure Guidelines - Preparing a Preferred Infrastructure Report).
PRG	Project Reference Group
Proponent	The proponent seeking approval for an SSI application or modification request.
Proposal	A proposed project that is not yet the subject of a lodged SSI application.

Term	Description
PSI	Preliminary Site Investigation
Putrescible	Waste that rots or decays rapidly, often producing odour, e.g. food
RAP	Registered Aboriginal Party
RBL	Rating background level
Refinement	A change that fits within the limits set by the project description and does not change what the proponent is seeking approval for or require an amendment to the infrastructure application for the project.
Registered environmental assessment practitioner (REAP)	A person who is registered or certified under a professional scheme that is specified as a registered environmental assessment practitioner scheme in the Accredited Registered Environmental Assessment Practitioner (REAP) Schemes published on the NSW Planning Portal.
REPs	Regional Environmental Plans
RFS	Rural Fire Service
RL	Reduced Level: relative height of a point above a common assumed datum, which is Australian Height Datum
RMP	Rehabilitation Management Plan
RP	Reporting point
SAII	Serious and Irreversible Impact (defined by section 9.1 of the BAM (DPIE 2020a)
SAM	Southern Annular Mode
Scoping	The process of identifying the matters that require further assessment in an EIS.
Scoping report	A report prepared by the proponent to inform the setting of SEARs for an SSI project (see the State Significant Infrastructure Guidelines - Preparing a Scoping Report).
SDCC	Sunny day consequence category: failure not associated with flood, e.g. eathquake
SDS	Safety data sheets
SEARs	The Planning Secretary's environmental assessment requirements for the preparation of an EIS for an SSI project.
SEPP	State Environmental Planning Policy.
SES	State Emergency Service
SIA	Social Impact Assessment
SILO	Queensland Government Scientific Information for Land Owners
SIMP	Social Impact Management Plan
SLC	Soil Loss Class
SMP	Safety Management Plan
SPC	Soil Profile Class
Spoil	Excavated wastes, such as soil and rock
SSAL	State Significant Agricultural Land
SSP	Shared socioeconomic pathways: scenarios of future development options used for climate change projections
State significant infrastructure (SSI)	Infrastructure that is declared to be State significant development under section 5.12 of the EP&A Act.

Term	Description
Submission	A written response from an individual or organisation, which is submitted to the Department during the public exhibition of an EIS, amendment report, preferred infrastructure report or modification report for SSI.
Submissions report	A report prepared by the proponent to respond to the issues raised in submissions (see the State Significant Infrastructure Guidelines - Preparing a Submissions Report).
SWA	Surface Water Assessment
SWMP	Surface Water Management Plan
TAPM	The Air Pollution Model
TBDC	Threatened Biodiversity Data Collection
TIA	Traffic Impact Assessment
The Blue Book	*Managing Urban Stormwater: Soils and Construction* (Landcom 2004)
The Minister	The Minister of the Department of Planning, Housing and Infrastructure
TMP	Traffic Management Plan
TP	Total phosphorus
TN	Total nitrogen
Transport and Infrastructure SEPP	*State Environment Planning Policy (Transport and Infrastructure) 2021* (NSW)
TSP	Total suspended particles
Tweed LEP	*Tweed Shire Local Environmental Plan 2014*
UN SDGs	United Nations Sustainable Development Goals
UNFCCC	United Nations Framework Convention on Climate Change
µS/cm	Microsiemens per centimetre
VENM	Virgin Extracted Natural Material
WAL	Water Access Licence
WHS	*Work Health and Safety*
WHS Act	*Work Health and Safety Act 2011*
WM Act	*Water Management Act 2000*
WMP	Water Management Plan or Waste Management Plan
WQOs	Water Quality Outcomes
WSPs	Water Sharing Plans
WTP	Water Treatment Plant

EXECUTIVE SUMMARY



Executive Summary

Acknowledgement of Country

KBR acknowledges the Traditional Custodians of country throughout Australia and their continuing connection to land, culture and community. We pay our respects to Elders past, present and future.

INTRODUCTION

There is a requirement to augment the Tweed Shire district water supply by 2028. This is because of an increasing demand for water as a result of projected population growth, and the increasing uncertainty of water supply yield due to climate change.

Tweed Shire Council (Council) proposes to raise the wall (embankment) of Clarrie Hall Dam by 8.5 m to a height of 70 m Australian Height Datum (AHD) (RL 70 m), thereby increasing the capacity of the dam from 16,000 megalitres (ML) to approximately 42,300 ML (the Proposal).

The purpose of the Proposal is to ensure water security for the Tweed Shire region until at least 2065.

The Proposal is classified as state significant infrastructure (SSI-65020460) and is subject to approval by the NSW Minister for Planning and Public Spaces under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act).

On 27 February 2019, Council was advised that the Proposal is a 'Controlled Action' (2018/8339) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the requirements of this Act were incorporated into the Secretary of the Department of Planning, Housing and Infrastructure's Environmental Assessment Requirements (SEARs).

This environmental impact statement (EIS) supports an application for approval of the Proposal in accordance with Division 5.2 of the EP&A Act. It addresses the SEARs issued on 31 May 2024.

Overview of the Proposal

The Proposal includes the following main activities and elements:

- raising the dam wall by 8.5 m
- a new spillway channel constructed higher in the left abutment with a flip bucket at the downstream end
- re-establishment of the quarry used to construct the existing dam for the purpose of sourcing rock material to raise the dam wall
- construction of associated haul roads to transport quarry material for the proposed raising of the dam wall
- establishment of a construction area for plant, equipment, storage, material handling and offices
- establishment of stockpile sites associated with construction
- construction of work compounds and site offices
- establishment of materials storage and handling facilities
- construction of workers' accommodation
- construction of a concrete batching plant

- realignment of Clarrie Hall Dam Road higher in the right abutment
- raising of the existing intake tower and bridge
- decommissioning of existing recreational facilities at the dam wall area
- construction of new dam operational facilities including signage, car parking, security fences, lighting, monitoring equipment and a boat ramp
- removing and/ or reconstructing impacted recreational infrastructure and facilities at Crams Farm
- upgrading the Kyogle Road and Clarrie Hall Dam Road intersection
- replacing McCabes Bridge and realignment of Commissioners Creek Road
- relocating existing power and telecommunications utilities
- construction of new recreation facilities including an amenities block, public shelters, viewing areas, interpretation signage, paths, car parks, and landscaping near the dam wall area.

The operational footprint for the upgraded dam would increase the area of inundation to below the RL 70 m contour, which is the waterline at full supply level (FSL).

Need for the Proposal

The former Department of Planning and Environment (DPE) – now the Department of Planning, Housing and Infrastructure (DPHI) – released the Far North Coast Regional Water Strategy (FNCRWS) (DPE 2023a), which provides a 20-year Far North Coast region-specific strategy to improve the security and certainty of water resources. The raising of Clarrie Hall Dam is discussed in the FNCRWS, which states it would assist Council to achieve some of the objectives of the FNCRWS.

Proposal objectives

Due to increasing demand for water as a result of projected population growth, and the increasing uncertainty of water supply yield associated with climate change, there is a requirement to augment the Tweed Shire district water supply by 2028. Peak demand is expected to exceed secure yield by 2028, when factoring in ongoing implementation of demand management and revisions of the secure yield of the Tweed district water supply based on an increase of one degree Celsius by the year 2030 (NSW Urban Water Services 2016). Updated secure yield modelling using the latest climate predictions was undertaken in 2021 to assess the strategic need and climate change risk to the present and proposed water supply system (NSW Urban Water Services 2021). The updated secure yield modelling shows that a raised Clarrie Hall Dam, as proposed, would be able to provide a secure water supply to the Tweed until at least 2065, and probably beyond.

Six water supply augmentation options were assessed, after 9 options were first considered in 2009–2010 (MWH 2009). Environmental, social and economic analysis of the 6 water supply options consistently indicated that raising Clarrie Hall Dam was the most advantageous to Council and the community (see section 2.4 for a discussion on alternatives).

Clarrie Hall Dam is operated in accordance with the Tweed River Area Unregulated and Alluvial Water Sources Water Sharing Plan (WSP) 2023 (DCCEEW 2023a). The Proposal has been designed to meet the WSP objectives.

The water supply objective of Council, stated in section 2.1.1 of the Tweed Shire Council Delivery Program 2022–2026 and Operational Plan 2023–2024 is:

> "To provide secure, high quality and reliable drinking water which meets health and environmental requirements."

The Proposal is consistent with Council's Community Strategic Plan, Delivery Program and Operational Plan.

The raising of Clarrie Hall Dam is discussed in the FNCRWS, which states it would assist Council to achieve some of the objectives of the FNCRWS.

Proposal location

The location of the Proposal is the existing Clarrie Hall Dam, which is situated on Doon Doon Creek, a tributary of the Tweed River. Doon Doon is approximately 15 km south-west of Murwillumbah and 4 km south-west of Uki in the Tweed Shire local government area (LGA), as shown in Figure 1.

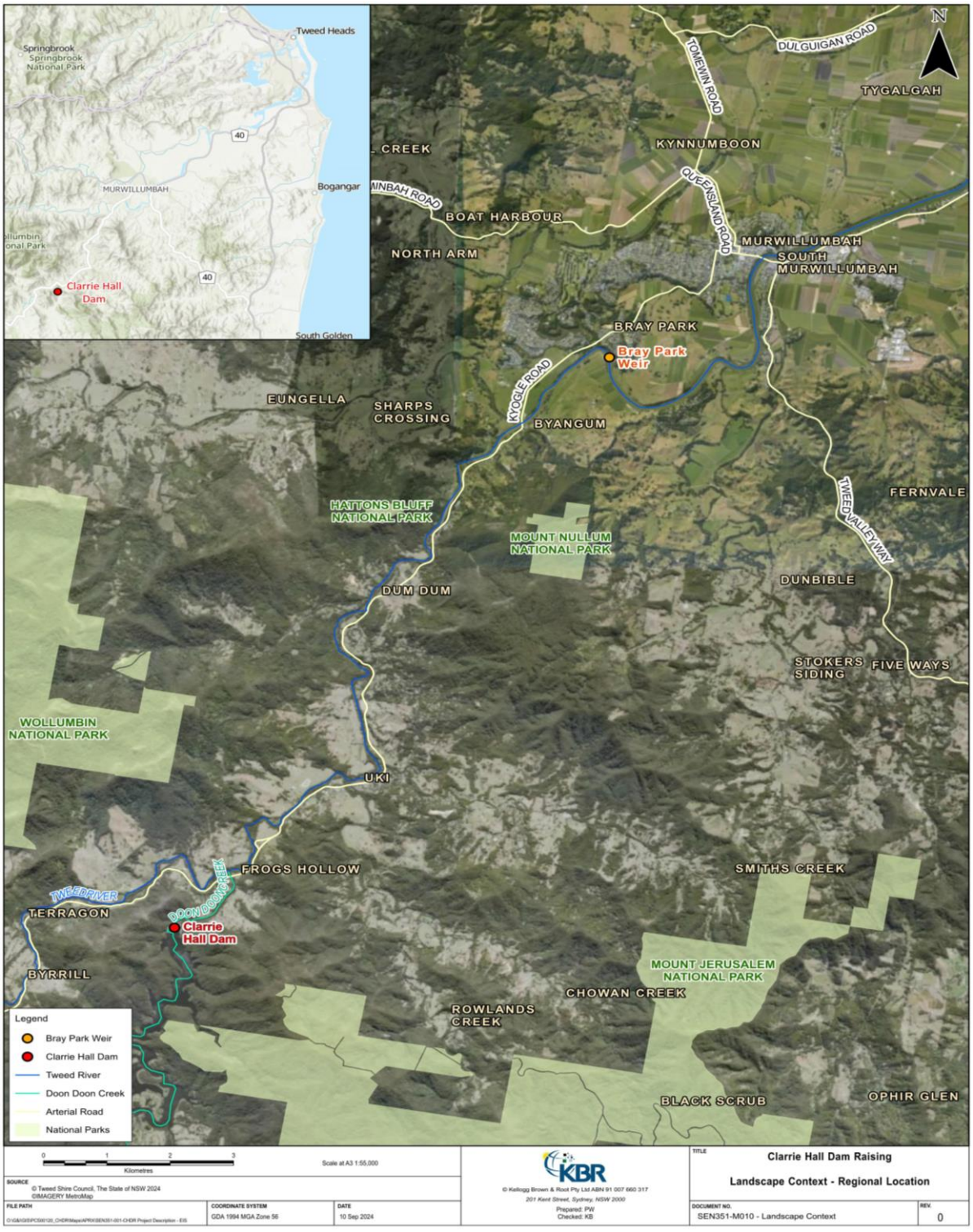


Figure 1 Regional context of the Proposal

Proposal design

The Tweed District water supply is currently a run-of-river supply augmented by releases from Clarrie Hall Dam. Water spills over into Doon Doon Creek via the spillway the majority of the time. To meet environmental flow requirements defined in the WSP, in periods of low flow in the Tweed River, water is released to Doon Doon Creek via a shuttered intake in the intake tower into a pipe/outlet tunnel that runs under the dam wall to a valve chamber (outlet works) where there are a number of valves through which the water goes through before it discharges into Doon Doon Creek to the Tweed River. Raw water is drawn from upstream of Bray Park Weir, effectively a saltwater barrage, in the Tweed River.

In 2018, a detailed concept design was prepared by NSW Public Works Advisory (PWA). The options assessment and detailed concept design for the raised dam and its components were based on hydrological studies, geotechnical investigations and seismic and structural assessments. The preferred option for the dam raising incorporates increasing the height of the existing concrete faced rockfill embankment and constructing a new concrete lined spillway higher up in the west abutment. The existing intake tower and access bridge would also be raised.

The optimum size of the proposed raised Clarrie Hall Dam is 42,300 ML, based on raising the dam wall height by 8.5 m to a height of RL 70 m AHD. The raised dam would, as a result, provide adequate water supply to the Tweed Shire until at least 2065. Raising the wall height further was not considered feasible due to topographical constraints in the catchment.

The detailed concept design includes:

- constructing access roads to construction areas and establishing the construction site
- re-establishing the quarry used to construct the existing dam
- removing and storing parapet walls for reuse
- increasing the base width of the valley-side abutment and raising the crest of the concrete faced rockfill embankment to RL 70 m
- constructing a new concrete lined spillway higher on the west abutment
- extending the upstream concrete face to the new crest height
- raising the intake tower and access bridge
- constructing a new section of the Clarrie Hall Dam Road to provide access to the east abutment of the dam wall
- establishing new recreation and operational facilities including an amenities block, public shelters, viewing areas, interpretation signage, paths, car parks, landscaping, security fences, lighting, monitoring equipment and a boat ramp.

In addition, construction activities for ancillary works would include:

- upgrading the Kyogle Road and Clarrie Hall Dam Road intersection
- replacing McCabes Bridge and realigning Commissioners Creek Road
- removing and/or reconstructing impacted infrastructure and facilities at Crams Farm
- relocating Telstra assets
- realigning powerline easements along Doon Doon Road and Commissioners Creek Road.

An overview of the Proposal is shown in Figures 2 to 4.

Further work has been completed that identified options for locating workers' accommodation, the concrete batching plant and site offices during construction. These locations are shown in Figure 2.

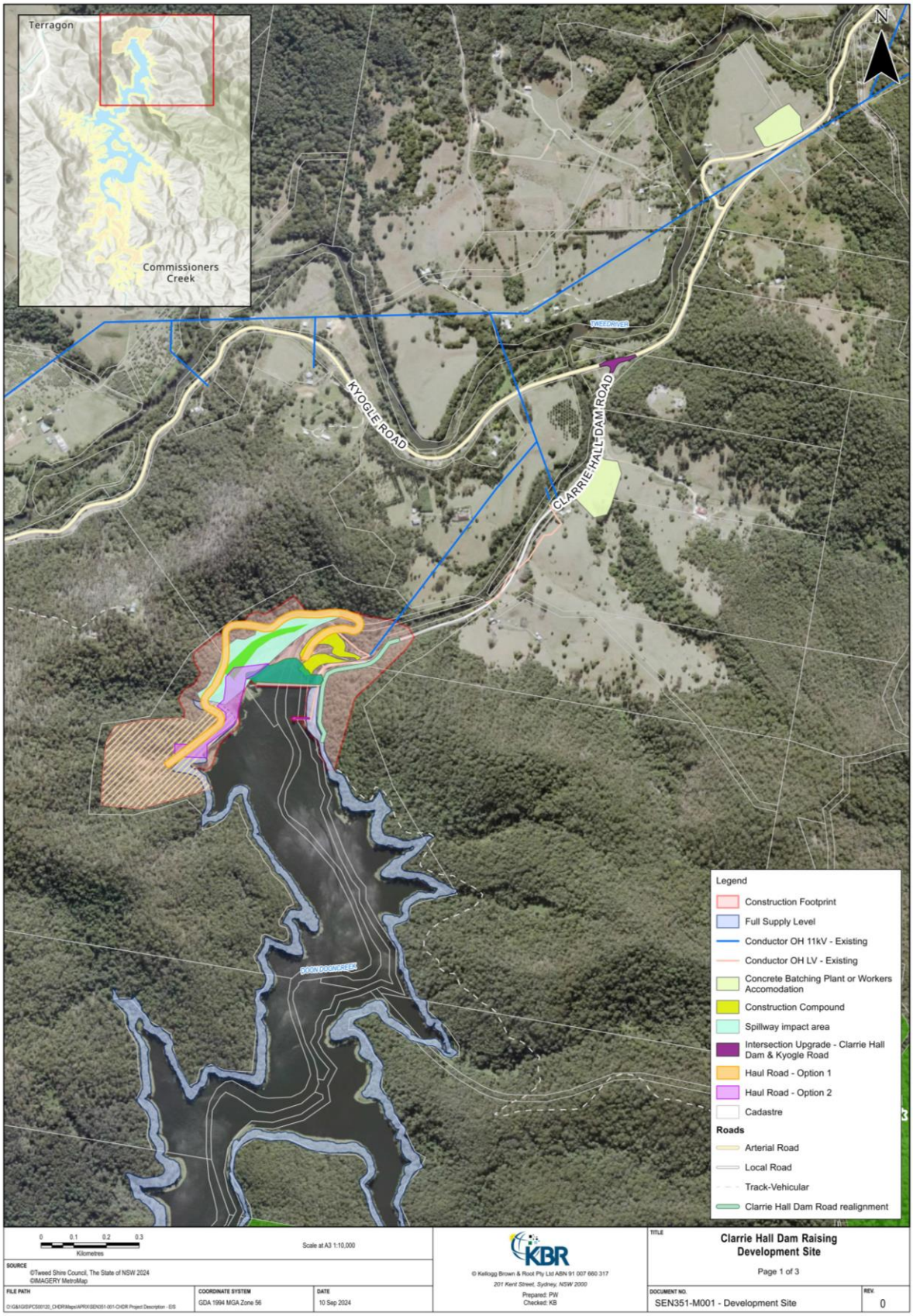


Figure 2 Proposal overview – northern section

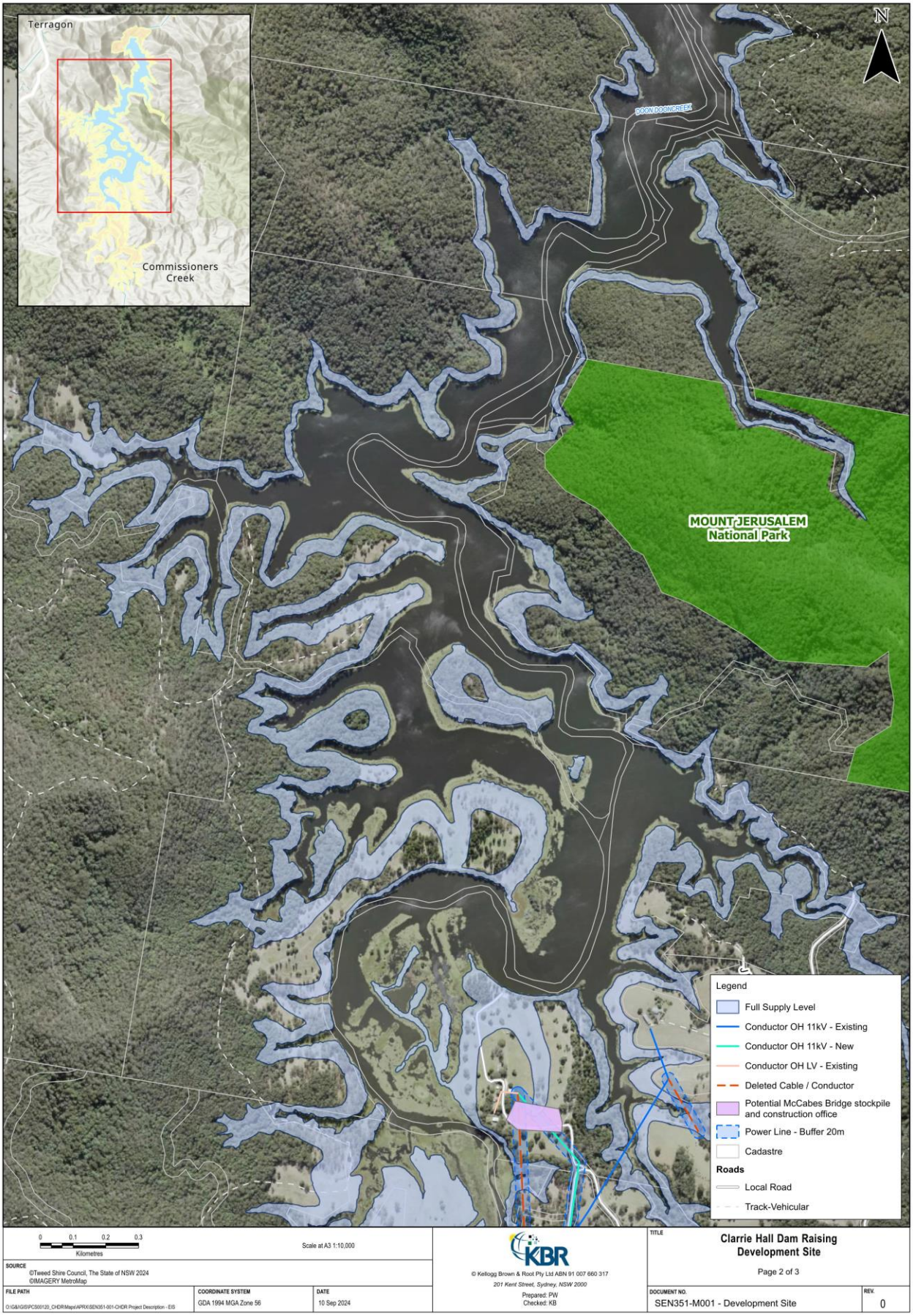


Figure 3 Proposal overview – central section

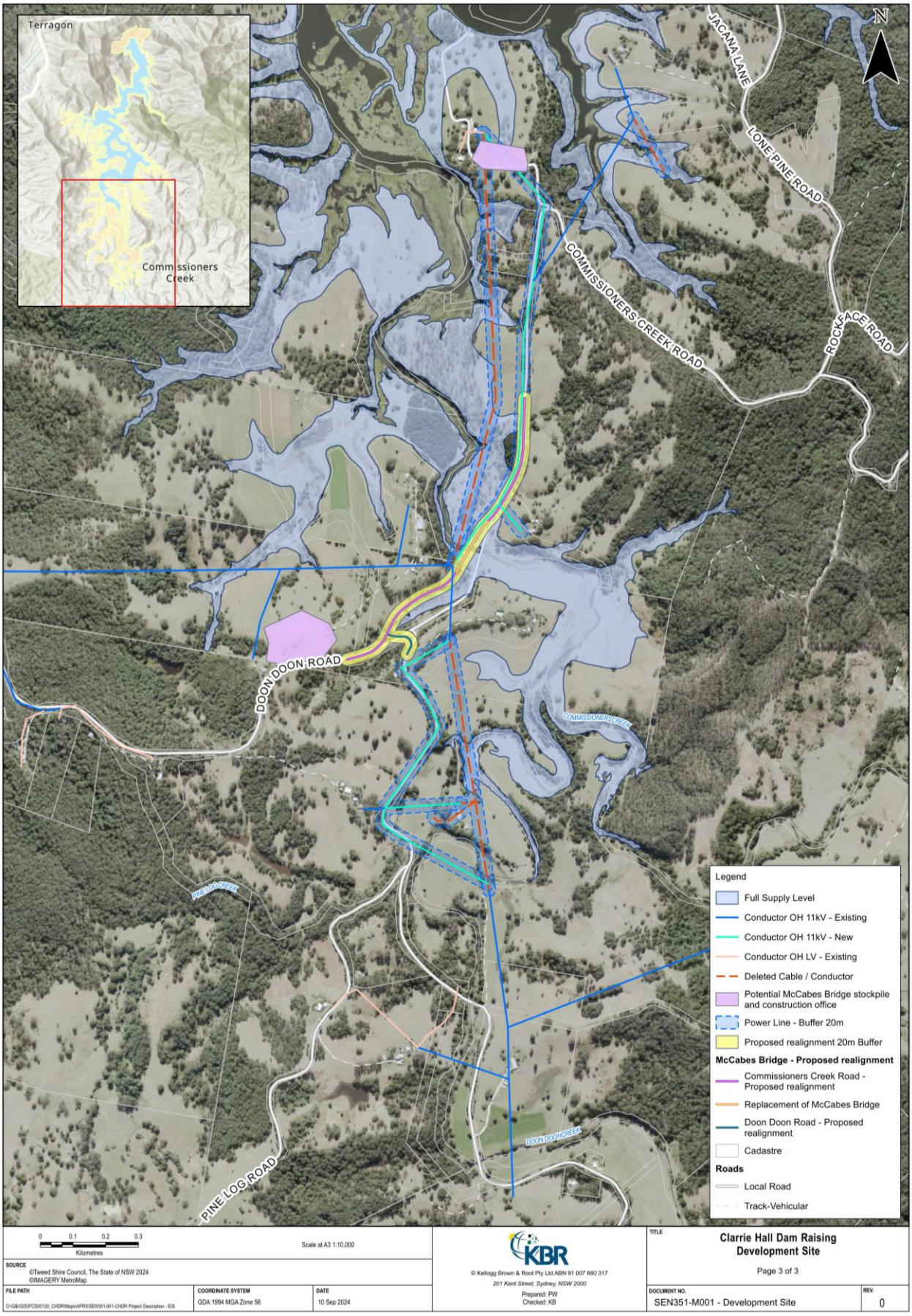


Figure 4 Proposal overview – southern section

Proposal construction

Should the Proposal be approved, construction is expected to commence in 2026 after detailed design is completed. Construction would take approximately 18 months and involve work 7 days a week. The proposed stages and sequencing of construction are provided in section 3.5 of the EIS.

Disturbance areas

The disturbance areas include the main construction area, ancillary works areas, FSL and areas where changes in upstream and downstream hydrology could potentially occur, including the area between the FSL and PMF.

The extent of the Proposal disturbance area includes all areas where direct impacts may occur due to construction and/or operation. These areas are the:

- construction activities disturbance area, comprising:
  - the raised dam wall, spillway, road realignments/upgrades, quarry, stockpile sites and construction compounds, intake tower and bridge and recreational areas
  - concrete batching plant
  - workers' accommodation
  - upgrading the Kyogle Road and Clarrie Hall Dam Road intersection
  - replacement of McCabes Bridge and realignment of Commissioners Creek Road
  - removing and/or reconstructing impacted infrastructure and facilities at Crams Farm
  - utilities relocations
  - new recreation and operational facilities including an amenities block, public shelters, viewing areas, interpretation signage, paths, car parks, landscaping, security fences, lighting, monitoring equipment and boat ramp at the dam wall area
- operational disturbance areas including the:
  - raised inundation area (RL 70 m contour), which is the waterline boundary at FSL
  - area between FSL and PMF
  - downstream areas, where there could be changes in flow.

The activities and disturbance area footprints of the Proposal provided the basis for assessing the extent of direct environmental impacts.

The area where direct impacts may occur during construction and/or operation of the Proposal is approximately 250.6 ha. Approximately 49.6 ha would be impacted for construction and 209 ha for operation. During operation, approximately 248 ha may also be temporarily impacted in the area between the proposed FSL and the PMF which could be temporarily inundated due to flood events including the 5% annual exceedance probability (AEP), 1% AEP, 0.5% AEP, 0.2% AEP and PMF.

Key benefits

The proposed raising of Clarrie Hall Dam has been developed to ensure water security for the Tweed Shire region until at least 2065. As evidenced by recent droughts and secure yield modelling, the existing water supply system does not provide a secure water supply beyond 2028; therefore, augmentation of the Tweed Shire water supply by 2028 is required.

The Proposal would result in the following key benefits:

- improved water security for the Tweed Shire region as water demand grows with projected population growth
- improved resilience to climate change for the Tweed Shire region as drought periods are expected to occur more often and for longer periods of time
- local procurement and business opportunities during construction of the Proposal, including opportunities for Aboriginal participation in construction
- opportunities for Aboriginal participation during operation, including ongoing involvement in catchment management planning and community education.

The Proposal was developed following several iterations of detailed options analysis for water supply augmentation options, design, environmental assessment and stakeholder engagement. Where reasonable and practicable, the Proposal aims to avoid and minimise biophysical, social, cultural and economic impacts.

Key uncertainties

The EIS has been prepared based on the detailed concept design completed by PWA (Appendix B). Key uncertainties around the design or construction methodologies that may be subject to further refinement include the locations of construction compounds, location of the concrete batching plant, location of the workers' accommodation, design of the spillway, source of embankment material, alignment of plant community types for biodiversity offsetting, modelling to determine the dam consequence category, sequence of construction, locations for vegetation removal in the FSL, and layouts of construction compounds. Further details are provided in Table 7-2.

Alternative options

In 2009, Council commissioned an options study to augment the Tweed District water supply (MWH 2009). This was updated in 2024.

The options study (MWH 2009) considered 9 options, as summarised in Table 1.

Table 1 Options considered in 2009

Option no.	Option summary	Reason not pursued
1	Raising the existing Clarrie Hall Dam	N/A
2	New dam on Byrrill Creek	There was potential for considerable escalation of costs due to the long lead time envisaged before construction could commence.
3	New dam on Oxley River, near Tyalgum (Rocky Cutting site)	There was potential for considerable escalation of costs due to the long lead time envisaged before construction could commence. There was significant habitat for threatened flora and fauna species near the proposed site, and there would be the social impacts due to the proximity to Tyalgum. There was also the potential for flooding parts of the village and rural properties. These issues would contribute to planning approval difficulties.
4	Pipeline link to Rous Water, at Ocean Shores	This option did not meet the secure yield required (5,250 ML/year) and established technologies and feasibility criteria. It would only be able to provide approximately 1,825 ML/year.
5	Pipeline link to the South East Queensland Water Grid, near the Tugun desalination facility)	This option had many political and legislative difficulties due to interstate transfer of resources. These impacts would not likely be diminished during periods of prolonged drought, when alternative supplies are needed most.

Option no.	Option summary	Reason not pursued
6	Desalination	This option was too expensive and involved significant environmental impacts associated with disposal of brine waste.
7	Groundwater supply	This option did not meet the secure yield required (5,250 ML/year) and established technologies and feasibility criteria. It would only be able to provide approximately 1,470 ML/year.
8	Indirect potable reuse	This option was expensive and not socially acceptable. These issues would contribute to planning approval difficulties.
9	Direct potable reuse	This option did not meet the secure yield required (5,250 ML/year) and established technologies and feasibility criteria. It was also expensive and not socially acceptable. These issues would contribute to planning approval difficulties.

Council, through further studies and consultation with the community, shortlisted 3 options for further consideration. Those options were:

- Raising Clarrie Hall Dam
- Byrrill Creek Dam construction
- Pipeline to the SEQ Water Grid.

The following options were reconsidered by Council in 2014:

- Raising Clarrie Hall Dam
- Small Byrrill Creek Dam construction
- Large Byrrill Creek Dam construction
- Staged Byrrill Creek Dam construction
- Pipeline to the SEQ Water Grid
- Pipeline link to City of Gold Coast.

The consideration noted that the Byrrill Creek Dam options had been prohibited by the Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2010. The consideration also included updated costings (PWA 2015), advice from Seqwater on the costs of connection to the SEQ Water Grid, and revised secure yield and demand projections. A cost risk assessment of the raised Clarrie Hall Dam option was updated by PWA in 2018 and again in 2023. Biodiversity offset costs were not included in the options assessments, and for the preferred option, offsets costs would be estimated as part of the biodiversity assessment.

Consideration of these water supply augmentation options, including analysis of environmental, social and economic factors, indicated that raising Clarrie Hall Dam was the most advantageous option to Council and the community. In December 2015, Council resolved to adopt the raising of Clarrie Hall Dam as the preferred option for future water security and proceed with the planning approval and land acquisitions phase for the Proposal.

In 2024, Council engaged Stantec to review the rankings of the water supply augmentation options previously identified to confirm or otherwise that raising Clarrie Hall Dam was the most appropriate option to augment the water supply. This options review was documented in the Review of Strategic Water Supply Options Report (Stantec 2024).

The review methodology included the following tasks to determine the preferred option for water supply augmentation:

- a simplified financial assessment using net present cost (NPC) to ensure all options were comparable on a financial basis
- a multi-criteria assessment (MCA).

The assessments considered the following 3 options:

- Raise Clarrie Hall Dam
- Desalination Plant
- Link to SEQ Water.

The MCA determined that Option 1 – Raising Clarrie Hall Dam was the preferred option as it has the lowest NPC value and offers the best technical and deliverability outcomes.

ENGAGEMENT

Engagement has been conducted in accordance with the NSW Governments guidelines published as *Undertaking Engagement Guidelines for State Significant Projects* (DPE 2022c), which require engagement to be undertaken as early as possible including as part of site selection and scoping.

A Communication and Engagement Plan (CEP) was developed by Council in 2015 following a resolution of Council to adopt Clarrie Hall Dam as the preferred option for future water security and to proceed with the land acquisition and planning approval. The CEP was updated in 2017, 2019 and 2023.

To guide recent engagement activities and approach, the CEP was updated by KBR in 2023, in consultation with Council, to address the SEARs and guidelines.

Council has informed and consulted with the community and stakeholders since 2009 on the need for long-term water security solutions for the Tweed Shire, and specifically on this Proposal in relation to the need, design, and potential impacts. This has included engagement with landholders, local residents, members of the local Aboriginal community, government agencies, business and industry, and community groups.

The Community and Stakeholder Participation Report – Raising of Clarrie Hall Dam (Appendix D) provides a summary of community consultation undertaken between 2009 and 2022 and details of more recent consultation since November 2023.

The issues raised during the consultation activities and responses to consider and address these in the Proposal design, construction and operation are provided in section 5.3.

IMPACTS OF THE PROPOSAL

Hydrology

Hydraulic modelling

Three models were developed by EMM, by updating the Tweed River Valley Source model (Source model) to reflect the updates in the Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2023, which was released during the EIS preparation period. The updates were conducted in consultation with DCCEEW.

The Source model was also updated by EMM to accommodate the climate and hydrological data required to assess the Proposal. Further information on the models is provided in Appendix G1.

The existing surface water environment was characterised to allow the assessment of potential impacts through the following 3 models:

- a streamflow regime model of the Tweed Valley waterways, used to investigate potential changes to dam release volumes, the timing of releases, and the effects of climate change on flow regimes (Appendix G1 Annexure A)
- a limnology model, used to investigate the expected changes to water quality within the reservoir (Appendix G1 Annexure B)
- a hydraulic model of Doon Doon Creek and the Tweed River, used to investigate cold water transmission downstream from the dam, stream power, depth and velocity of water in waterways (Appendix G1 Annexure C).

Surface water assessment

A surface water assessment was undertaken to determine the potential impacts to surface water as a result of the Proposal.

Within Doon Doon Creek, the assessment of flow regimes concluded the following:

- The Proposal may increase the frequency of minimum releases from the dam, and subsequently increase the frequency of minimum flow depth over riffles within Doon Doon Creek from 38% of the time to 47% of the time. There may also be an increase in depth of up to 0.1 m for about 20% of the time, when the riffle depth is around 0.5–0.6 m.
- The flow velocity in Doon Doon Creek riffles is expected to be below 1.5 m/s for 90% of the time but could increase to around 3 m/s during high flows. The velocity and depth data influence the calculation of bed shear stress, which in the assessed Doon Doon Creek riffle is expected to be below 100 N/m^2 close to 100% of the time. The Proposal is not predicted to substantially alter these thresholds or frequencies. Under these conditions, gravel sized rocks (i.e. 10 mm and larger) are not expected to be particularly mobile with either the current or future flow regime.
- The minimum release of 4 ML/day, which is current practice, is expected to cause bed shear of 10 N/m^2, sufficient to mobilise particles 1 mm diameter and smaller.
- From these results, the morphology of rocky Doon Doon Creek riffles is not expected to be affected by changes in the shear stress regime.
- Depth of water in pools within Doon Doon Creek may vary by ± 0.1 m due to alterations of the flow regime as a result of the Proposal. Average flow velocities are expected to remain below 1 m/s almost 100% of the time. Bed shear stress within pools is expected to remain low and to not be materially affected by the Proposal.

Within the Tweed River, the assessment of flow regimes concluded the following:

- Riffle water levels, velocities and bed shear stress in the Tweed River are not expected to be materially affected by the Proposal.
- Pool water levels, velocities and bed shear stress in the Tweed River are not expected to be materially affected by the Proposal.

Potential surface water effects associated with construction activities were identified and a risk assessment conducted. Each potential impact could be reduced by the application of proposed mitigation measures. However, mobilisation of fill material placed in Doon Doon Creek to provide access to the spillway construction area and downstream face of the dam wall remained a residual risk. Erosion modelling and pad design has not been undertaken as part of the EIS but would be completed prior to construction.

Potential surface water effects associated with the ongoing operation of the raised Clarrie Hall Dam were identified and risk assessed. Each potential impact could be reduced by the application of proposed mitigation measures. However, algae and associated water quality effects in Doon Doon Creek and the Tweed River remained a residual risk. Limnology modelling indicated that an increase in primary production, meaning rate of algae growth, is likely following dam wall raising. The modelling illustrated that releases of PO_4 (phosphate) from sediment in the enlarged hypolimnion of the raised dam would result in an increase to concentrations of total phosphorus, PO_4 and consequently Chl-a. Compounding this risk is the prediction that cyanophytes (blue-green algae), which are currently dominant during the summer months, may become more dominant throughout the year as a result of climate change impacts (in particular the direct and indirect impacts of increased air temperature).

Previously installed mixing devices in Clarrie Hall Dam have been somewhat effective in redistributing temperature gradients and have weakened, but not eliminated, thermal stratification. The overall performance of the mixers, however, has proven unsatisfactory. Hunter H2O (2018) concluded from the monitoring data that mechanical mixers cannot maintain:

- complete thermally destratified conditions
- stable and sufficient dissolved oxygen concentrations throughout the water column
- low and stable iron and manganese concentrations
- low and stable cyanobacterial populations.

Given the increased depth of the raised dam and the predicted increase in internal loading of nutrients from the hypolimnion under anoxic conditions, it is considered unlikely that a destratification system with the specifications of the previous system would effectively mitigate the water quality risks that have been identified.

Implementation of a destratification system is therefore not a part of the Proposal however, is discussed further below.

Historical monitoring of algae within Doon Doon Creek, the reservoir and the Tweed River has usually not detected blue-green algae within the Tweed River downstream from the reservoir even when the dam is full and spilling. When detections occur in the Tweed River, cell counts are typically one or more orders of magnitude lower than in the reservoir. There is no strong correlation between algal counts in the reservoir and algal counts in the Tweed River, and as such it is likely that increased algal counts in the reservoir due to raising would not result directly in a commensurate increase in algal counts in the river.

The risk of cold water pollution is expected to decrease following dam raising. The larger reservoir surface area is expected to receive greater input of wind energy, leading to a deeper thermocline, warmer water at depth, and less cold water pollution released from the dam to the degree that effects at the Doon Doon Creek – Tweed River junction are expected to meet NSW Office of Water (NOW) recommendations for cold water management (NOW 2011).

Limnology modelling indicated that after the dam raising, climate change (to 2065) may have the following effects on the reservoir waterbody:

- an increase in water temperature by 1–2°C
- no meaningful change to suspended solids, dissolved oxygen, nitrogen compounds, or phosphorus compounds
- ±10% cyanophyte algal cell counts (i.e. unchanged, with an uncertainty range)
- –50% chlorophyte algal cell counts (i.e. counteracting the increase expected from dam wall raising).

The large reduction in chlorophyte cell counts is associated with the change in water temperature, with a reduced period in the year with optimal water temperatures.

Changes in water temperatures would favour cyanophyte (blue-green) algae, and it is possible that these species could become more common through the cooler parts of the year when they would typically die off.

Dam water quality monitoring is proposed. If the simulated algae increases are realised, Council would apply the best available science and value for money approaches available at the time to reduce algae concentrations to acceptable levels, or otherwise mitigate algae effects. The Proposal would not preclude or prevent the adoption of physical mitigation measures (e.g. a bubbler or destratification system) being considered and implemented if this is ultimately warranted.

Flooding

A TUFLOW hydraulic model of the dam and its surroundings was created for the purpose of assessing flood impacts due to the Proposal. The inflows into the hydraulic model were obtained from a RORB hydrological model created by WRM (2017), which was updated to incorporate Australian Rainfall and Runoff (AR&R) (Ball et al. 2019).

Hydraulic simulations for the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF design events were modelled to assess the likely impacts of the Proposal, as well as climate change conditions for each of the design events.

Hydraulic modelling was undertaken using the TUFLOW version 2020-10-AD-iSP. In order to assess and determine the likely flood impacts of the proposed raised dam condition, 2 scenarios were modelled – for the 'existing case' and the 'proposed case', as summarised in Table 2.

Table 2 Summary of modelled scenarios

Scenario	Summary
Existing case	Represents the dam in its existing condition, with the spillway level at 61.5 m AHD and the wall of the dam at 70.4 m AHD.
Proposed case	Represents the wall of the dam at 77 m AHD and the spillway raised by 8.5 m to 70.0 m AHD. The scenario also includes the proposed upgrade to McCabes Bridge.

The flood impact assessment concluded the following:

- Peak flows for all design events are reduced downstream of the dam for all design events in the proposed case as a result of the upgraded spillway and raised dam embankment. As a result, peak water levels were simulated to be lower by up to 250 mm for all design events. Changes in flood extents are noted to be minimal downstream of the dam, with sporadic reductions in flood extents. Flood velocities in the downstream reaches are lower by 0.1 m/s.
- Upstream of the dam, flood water levels increased in the dam's main storage area by up to 7.6 m. The flood level increase is due to the raising of the dam's spillway by 8.5 m, which results in higher water levels, although the increases in water level are less than the increase in spillway level. The severity of the flood level rise reduces further upstream of the dam. Although higher flood levels are simulated upstream of the dam, the increased flood impacts are confined to the main waterway corridors and are not considered to require any mitigation measures. The increased flood extents encroach onto some properties situated within the vicinity of the additional storage area. However, no buildings are noted to be impacted by the increased flood extents and levels. Flood velocities in the upstream reaches are noted to be lower than in the existing case, while closer to the dam wall, flood velocities are noted to have increased by up to 1.0 m/s.

- Flood hazard increased by one level as per the classification system provided in the Flood hazard Flood risk management guideline FB03 (NSW DPE 2023d) upstream of the dam and decreased at sporadic locations downstream of the dam.
- The PMF with climate change (SSP3-7.0) scenario resulted in the dam overtopping while all other design events were contained within the dam. The application of climate change scenarios to flood design events would be reviewed during detailed design and is discussed further below.
- The dam takes approximately 120 hours for the water level to recede back towards FSL in a stable state in the proposed case.
- The outcomes of the flood assessment show that due to the proposed dam upgrade, there is a small increase in flood risk upstream of the dam, which is mainly confined within waterway corridors. The climate change modelling has shown that while water levels are increased, only the PMF with climate change scenario overtops the proposed dam.

The climate change scenario applied the updates to the climate change factors proposed in the *Draft update to the Climate Change Considerations chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation* (Department of Climate Change, Energy, the Environment and Water 2024a) which is scheduled for release towards the end of 2024.

The updated climate change guidelines present temperature projections based on shared socioeconomic pathways (SSPs) that cover a broad range of potential future development options identified as very low (SSP1-1.9), low (SSP1-2.6), medium (SSP2-4.5), high (SSP3-7.0) and very high (SSP5-8.5) emissions pathways.

AR&R 2019 recommends the application of representative concentration pathway (RCP) 4.5, which aligns with the medium development option (SSP2-4.5) in the updated climate change guidelines. For the purpose of the study the more conservative, high development (SSP3-7.0) pathway for the long-term projection (2081-2100) was applied. Climate change factors were calculated and applied to the Intensity-Frequency-Duration (IFDs) data.

The 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF design events with climate change (SSP3-7.0) were simulated within the TUFLOW model to determine the impacts of climate change. The flood level differences maps (proposed case minus existing case) are presented in Appendix F (Appendix D). The differences in flood levels were similar to the current climate change scenario – that is, flood levels were reduced downstream of the dam as a result of the dam upgrades.

Water levels for the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP design events with climate change were mainly contained within the dam. The PMF with climate change scenario simulated a water level of 78.23 m AHD, which resulted in the dam overtopping the proposed wall of 77.0 m AHD by 1.23 m. Further modelling would be completed during detailed design when the 'Climate Change Considerations chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation' (Department of Climate Change, Energy, the Environment and Water, 2024a) is released, so that the spillway design passes the PMF with climate change without dam overtopping.

Groundwater assessment

A Groundwater Impact Assessment was prepared for the Proposal. Potential groundwater impacts relate to:

- groundwater quality impacts from quarrying and Proposal construction – spills of hazardous materials/chemicals and/or the generation of liquid waste can potentially contaminate groundwater. Similarly, the use of blasting substances may result in residual substances occurring at the face of blasted material, blasting substances leaching from stockpiled material during rain events and/or the introduction of blast material into the groundwater system where blasting occurs. Potential groundwater contamination incidences, if they even occur, are expected to be minor and localised to within the construction area.

- groundwater pressure/level increases in the Clarence-Moreton Basin groundwater system upward hydraulic gradient of the dam, owing to increased recharge from a higher FSL – this could occur underlying the FSL inundation area and where there are fractures and rock openings that permitted groundwater entry. Potential rises in groundwater levels are not expected to migrate beyond the FSL inundation area as the potentially highly transmissive alluvium is very localised and minor in extent, and the fractured and porous rock units have low transmissivity based on inferred airlift yields.

There are no third-party landholder bores in the immediate vicinity of the Proposal, including the operational and construction areas. The 2 closest bores to the FSL inundation area (GW065390 and GW065508) are both deemed to be abandoned. There are no high priority WSP listed GDEs in the study area. With the exception of the River Oak, impacts to potential GDEs due to the Proposal are not anticipated. This is because of an absence of potential GDEs (both terrestrial and aquatic), presumably owing to the regional high rainfall volumes, the typical depths to groundwater, and the predominance of groundwater occurrence in fracture networks.

The risk ranking for all potential groundwater impacts is low. A Water Management Plan would be developed for the Proposal.

Terrestrial biodiversity

A Biodiversity Development Assessment Report (BDAR) was prepared in accordance with the Biodiversity Assessment Method (BAM) (DPIE 2020a).

Biodiversity surveys within the Proposal area as well as surrounding areas commenced in 2016 and continued until early 2024.

Three plant community types (PCTs) were recorded within the Proposal area, one of which constitutes the *Biodiversity Conservation Act 2016*-listed lowland rainforest in NSW North Coast and Sydney Basin bioregion endangered ecological community and the EPBC Act-listed lowland rainforest of subtropical Australia critically endangered ecological community.

The direct impact of the Proposal on biodiversity values constitutes the loss of 246 ha of native vegetation, inclusive of 8.77 ha of a threatened ecological community (TEC) and 13.00 ha of planted native vegetation, and the habitat values that this vegetation provides to some threatened species. Specifically, the Proposal would result in the loss of:

- 12 Corokia (*Corokia whiteana*) individuals, listed as endangered under the BC Act and EPBC Act
- 50 Rusty Rose Walnut (*Endiandra hayesii*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 457 Green-leaved Rose Walnut (*Endiandra muelleri subsp. bracteata*) individuals, listed as endangered under the BC Act
- 4 Red Boppel Nut (*Hicksbeachia pinnatifolia*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 15 Fine-leaved Tuckeroo (*Lepiderema pulchella*) individuals, listed as vulnerable under the BC Act
- 12 Rough-shelled Bush Nut (*Macadamia tetraphylla*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 709 Scrub Turpentine (*Rhodamnia rubescens*) individuals, listed as critically endangered under the BC and EPBC Act
- 105 Red Lilly Pilly (*Syzygium hodgkinsoniae*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 16 Durroby (*Szygium moorei*) individuals, listed as vulnerable under the BC Act and EPBC Act

- 2.21 ha of habitat for Thorny Pea (*Desmodium acanthocladum*), listed as vulnerable under the BC Act and EPBC Act
- 0.50 ha of habitat for Basket Fern (*Drynaria rigidula*), listed as endangered under the BC Act
- 1.03 ha of habitat for Narrow-leaf Finger Fern (*Grammitis stenophylla*), listed as endangered under the BC Act
- 78.96 ha of habitat for Slender Marsdenia (*Marsdenia longiloba*), listed as endangered under the BC Act and vulnerable under the EPBC Act
- 95.53 ha of habitat for Native Guava (*Rhodomyrtus psidioides*), listed as critically endangered under the BC and EPBC Act.

The Proposal would also lead to the loss and degradation of some threatened fauna species habitats, including hollow bearing trees, rocky areas, and creeks.

A total area of 246 ha of native vegetation and planted native vegetation would be directly impacted due to construction and operation of the Proposal.

Areas of each vegetation zone that would be directly impacted by the Proposal are shown in Table 3.

Table 3Areas of vegetation zones directly impacted

Plant community type ID	Plant community type name	Vegetation zones	Extent in Proposal area (ha)
827	Flooded Gum –Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	827_High	72.13
		827_Mod	31.27
		827_Burnt	19.04
		827_Low	25.50
		827_Planted	5.08
		827_Pasture	64.06
		827_Derived_sedgeland	4.58
		Total area of PCT	**221.66**
1073	Pink Bloodwood – Tallowwood moist open forest of the far northern ranges of the NSW North Coast bioregion	1073_High	2.67
		Total area of PCT	**2.67**
1302	White Booyong – Fig subtropical rainforest of the NSW North Coast Bioregion	1302_High	5.78
		1302_Mod	2.99
		Total area of PCT	**8.77**
N/A	Eucalyptus plantation	N/A	7.34
N/A	Hoop Pine plantation	N/A	4.64
N/A	Planted native vegetation	N/A	1.02
		Total area of planted native vegetation	**13.00**
Total native vegetation			**246.11**

A substantial amount (68.64 ha) of the impacted vegetation constitutes pasture or sedgeland in low condition, where the vegetation integrity offset in these areas is below the condition thresholds that require offsets as per section 9.2.1 of BAM (DPIE 2020a), and so would not require ecosystem offsets. A further 13.00 ha of planted native vegetation would also not require offsets. The remaining native vegetation in the disturbance footprint would generate an ecosystem credit offset requirement as described in Appendix H (section 8.3). Impacts to habitat for species-credit species would also generate a species credit offset requirement as described in Appendix H (section 8.3).

The 246.11 ha of vegetation that would be directly lost also comprises habitat for native fauna. The threatened fauna habitat to be lost as a result of construction and operation of the Proposal includes:

- 165.61 ha of habitat for White-eared Monarch (*Carterornis leucotis*), listed as vulnerable under the BC Act
- 19.99 ha of habitat and one nest tree for White-bellied Sea-Eagle (*Haliaeetus leucogaster*), listed as vulnerable under the BC Act
- 14.49 ha of habitat for Albert's Lyrebird (*Menura alberti*), listed as vulnerable under the BC Act
- 32.16 ha of habitat for Pouched Frog (*Assa darlingtoni*), listed as vulnerable under the BC Act and the EPBC Act
- 6.09 ha of habitat for Giant Barred Frog (*Mixophyes iteratus*), listed as vulnerable under the BC Act and EPBC Act
- 0.16 ha of habitat for Loveridge's Frog (*Philoria loveridgei*), listed as endangered under the BC Act
- 136.92 ha of habitat for the Southern Myotis (*Myotis macropus*), listed as vulnerable under the BC Act
- 160.87 ha of habitat for Koala (*Phascolarctos cinereus*), listed as endangered under the BC Act and EPBC Act
- 0.10 ha of habitat for Southern Pink Underwing Moth (*Phyllodes imperialis smithersi*), listed as endangered under the BC Act and EPBC Act
- 2.20 ha of habitat for Mitchell's Rainforest Snail (*Thersites mitchellae*), listed as endangered under the BC Act and critically endangered under the EPBC Act
- 52.65 ha of habitat for Masked Owl (*Tyto novaehollandiae*), listed as vulnerable under the BC Act
- 52.65 ha of habitat for Sooty Owl (*Tyto tenebricosa*), listed as vulnerable under the BC Act
- 46 hollow bearing trees.

The following indirect impacts on native vegetation, threatened ecological communities and threatened species habitats that may occur due to the Proposal include:

- edge effects
- introduction and spread of weed species, resulting in degradation of retained native vegetation and habitat
- introduction and spread of imported red fire ants
- temporary increase in noise, dust, vibration and artificial lighting levels associated with construction
- temporary inundation of retained native vegetation and habitats during extreme flood events
- temporary erosion and sedimentation impacts to the dam and downstream receivers associated with construction
- minor increase in groundwater recharge in southern areas of the dam.

The assessment of prescribed impacts concluded:

- there is potential for an increased incidence of vehicle strikes upon fauna
- there is potential for Impacts due to changes in hydrology.

Impacts due to the raised FSL

Threatened flora submerged during the dam filling has been assumed to be a direct loss. It is anticipated that filling of the dam would occur slowly so that all fauna species would be able to move upslope, avoiding loss of individuals.

To assess upstream flooding impacts, the BDAR did not use the PMF, as it is highly unlikely to occur. The 0.2% AEP or once in 500-years event was used to assess impacts as follows:

- an area of 166.55 ha (any areas overlapping with construction areas or ancillary impact areas of the Proposal were removed)
- the maximum water level of approximately 73.8 m at 24 hours (3 m above FSL)
- a reduction to 2 m above FSL after 32 hours
- a reduction to 1 m above FSL after 42 hours.

Based upon the current lack of any observable flood impacts at the current FSL, it is anticipated that once the dam raising is complete, plant communities, fauna habitats and threatened flora already established above FSL would remain intact, with no discernible flooding impacts. This is due to any flooding being an infrequent occurrence with relatively short inundation periods.

Fauna is likely to be able to move upslope away from the flood waters, given the relatively steep gradient and good connectivity of habitat.

Fauna most vulnerable to flooding impact are anticipated to be the least mobile species and those preferring lower-lying habitat adjacent to watercourses. The critically endangered Mitchell's Rainforest Snail therefore has the potential to be impacted by flooding. However, it is anticipated that the snail is able to persist in this environment and may seek refugia during periods of heavy rainfall, moving upslope and also climbing trees to escape flood events.

Downstream hydrological impacts

Doon Doon Creek is impacted by water regulation and also by historic clearance of vegetation, impacts from agriculture weed invasion and adjacent road building and earthworks.

The vegetation immediately adjacent to Doon Creek and impacted by high flow events include River Oak (*Casuarina cunninghamiana*) and to a lesser extent Water Gum (*Tristaniopsis laurina*). Exotic species are prevalent with Cockspur Coral Tree (*Erythrina crista-galli*), Wild Tobacco Bush (*Solanum mauritianum*) and Camphor Laurel (*Cinnamomum camphora*) among the most notable. Herbaceous exotic species are also prevalent as groundcover.

Changes to the downstream flow regime, as described in section 6.1, indicate that the magnitude of geomorphological effect is likely to be relatively small. Therefore, impacts would be minimal.

The reduction in the maximum peak flow during flood events as a result of the Proposal may lead to Doon Doon Creek being slightly less disturbed by extreme events, allowing persistence of some trees and other vegetation during extreme events, which would otherwise be removed by the water velocity under the current situation. This change is not anticipated to be of a significant magnitude to result in change of vegetation community and would relate only to the vegetation within the watercourse itself and immediately adjacent bankside vegetation.

Serious and irreversible impacts

Additional assessments were conducted for threatened species that are considered at risk of a serious and irreversible impact (SAII) in accordance with section 9.1 of the BAM (DPIE 2020a). An impact is to be regarded as SAII if it is likely to contribute significantly to the risk of a threatened species (including endangered populations) or an ecological community becoming extinct in accordance with the 4 principles outlined in clause 6.7 of the NSW BC Regulation. Actions to avoid and minimise impacts to these species have been discussed in the BDAR, while mitigation and management measures are outlined in section 6.2.4.

Section 9.1.1 of the BAM (DPIE 2020a) also requires additional impact assessment for threatened ecological communities that are also listed as candidate entities for SAII.

PCT 1302 aligns with two TECs:

- lowland rainforest on floodplain in the New South Wales North Coast bioregion EEC (BC Act)
- lowland rainforest of subtropical Australia CEEC (EPBC Act).

Neither TEC is included in the current list of entities at risk of SAII, and therefore no SAII assessment has been conducted for these TECs.

The BDAR also included assessment of impacts under the EPBC Act for the purpose of assessment by the Commonwealth DCCEEW. Significant impact assessments concluded that the Proposal has potential to cause significant impacts to the following fauna species: Pouched Frog, Glossy Black-Cockatoo, Giant Barred Frog, Koala, Grey-headed Flying-fox, Mitchell's Rainforest Snail, and the following flora species: Scrub Turpentine, Corokia, Slender Marsdenia, Native Guava and Red Lilly Pilly. A significant impact is also likely for the EPBC Act-listed lowland rainforest of subtropical Australia CEEC. As such, the Proposal has been declared a controlled action. As the Proposal is being assessed in accordance with the bilateral agreement between the Commonwealth and NSW governments, impacts to matters of national environmental significance would be compensated through the implementation of the Biodiversity Offset Strategy.

The BDAR proposes mitigation measures to address the management of the uncertain, temporary, indirect and prescribed impacts of the Proposal on native flora and fauna.

To compensate for the residual impacts of the Proposal, 4,994 ecosystems credits are required to compensate for impacts on native PCTs and ecosystem credit species. In addition to ecosystem credits, the Proposal also requires a total of 35,133 species credits. Tweed Shire Council would compensate for these residual impacts through the implementation of a biodiversity offset strategy.

Aquatic ecology

An aquatic ecology assessment was undertaken. A range of biotic and abiotic components associated with the Proposal were assessed including aquatic habitat and presence/absence, and the distribution and abundance of aquatic fauna that may be present within the broader study area. Aquatic surveys were undertaken in accordance with the *Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the EPBC Act* (Department of Sustainability, Environment, Water, Population and Communities 2011).

The assessment of aquatic ecology found the Proposal does not pose a significant impact to aquatic ecological values. A summary is provided below in the context of construction and operation of the Proposal.

Assessments of significance

Southern purple-spotted gudgeon

An assessment of significance was completed in accordance with the *Fisheries Management Act 1994* (FM Act) for the southern purple-spotted gudgeon.

The southern purple-spotted gudgeon is extremely rare in inland NSW and has no public records in the Northern Rivers catchment. Despite the presence of suitable habitat and adherence to survey guidelines, this species was not detected in Clarrie Hall Dam or associated waterways. Additionally, exotic species known to impact or compete with the southern purple-spotted gudgeon have been recorded in these areas. It is unlikely that Clarrie Hall Dam or associated waterways support populations of southern purple-spotted gudgeon.

The assessment of significance found that construction and operation of the Proposal are unlikely to significantly impact the southern purple-spotted gudgeon.

Platypus

The platypus is not currently listed as threatened under the EPBC Act. However, it has been nominated for listing as critically endangered. An assessment was therefore conducted under *Matters of National Environmental Significance –Significant impact guidelines 1.1* (DEWHA 2013) to determine if a significant impact was likely (see Appendix H of Appendix I).

The assessment found that construction and operation of the Proposal are unlikely to significantly impact on the platypus given that changes to flows resulting from the Proposal are modelled to be minimal and that cold water pollution is modelled to improve marginally with the raised dam in place.

Construction

The construction of the dam wall would result in the direct loss of key fish habitat, including areas affected by the construction of ancillary infrastructure. It is estimated that 260 m² of key fish habitat would be lost during construction, along with an additional 23,200 m² due to the increased capacity of Clarrie Hall Dam. This results in a total loss of 23,460 m² of Type 1 Class 1 key fish habitat due to the Proposal. However, this potentially expands the habitat for aquatic biota, including the platypus.

Construction activities may degrade water quality within and downstream of the dam, and increased water levels may temporarily decrease water quality as inundated vegetation decomposes. Unlisted aquatic biota may be affected, but listed species under the EPBC Act and/or FM Act are unlikely to be present within Clarrie Hall Dam or downstream in Doon Doon Creek or the Tweed River. Overall, the construction is not expected to significantly impact listed species and impacts on non-listed species can be minimised through management measures listed in section 6.3.4. The Proposal would not introduce new impacts on fish passage.

Indirect impacts from raising Clarrie Hall Dam may include erosion and sedimentation smothering non-listed aquatic biota due to earthworks, overflows from site water treatment systems entering Clarrie Hall Dam or Doon Doon Creek, and changes to surface hydrology affecting water flow and pooling, potentially impacting aquatic biota emergence and/or persistence. Spilled contaminants could enter waterways or groundwater, affecting aquatic biota and riparian vegetation, while dust from blasting may decrease water quality, impacting aquatic flora and fauna. However, with the implementation of appropriate mitigation measures before and during construction, impacts on aquatic biota and habitat are expected to be minimal.

Operation

The raising of Clarrie Hall Dam would result in the direct loss of aquatic and riparian habitat due to the increased inundation area. Offsets are required for the direct loss of key fish habitat as a result of the Proposal. Fish passage offset requirements are discussed below and in section 6.3.4.

The aquatic ecology assessment included determining the impacts of the depth of water in pools within Doon Doon Creek, which may vary by ± 0.1 m due to alterations to the flow regime as a result of the Proposal. Average flow velocities are expected to remain below 1 m/s almost 100% of the time.

Downstream impacts resulting from operation of the Proposal are considered to be nil to negligible and are limited to the following:

- a possible 10 cm increase in depth in riffle habitat within Doon Doon Creek, due to a predicted increased frequency of minimum releases from the raised dam
- no material changes in depth within riffle habitat in the Tweed River
- no material changes in depth within pool habitat in the Tweed River
- cold water pollution that would decrease in magnitude by 2 degrees Celsius (i.e. a temperature increase) and increase in frequency by 10%
- nil to negligible impacts to platypus
- no impacts to the southern purple-spotted gudgeon as a result of the Proposal
- nil to negligible impacts to groundwater-dependent ecosystems.

Direct impacts on aquatic biota are likely to be minimal; however, changes to flows and water levels (~10 cm) in Doon Doon Creek due to more frequent minimum releases from the dam, may negatively impact non-listed aquatic fauna, flora and the platypus. Alterations to the thermal profile in these waterways (modelled to increase by 2 degrees Celsius) could also adversely affect non-listed fauna, flora and the platypus. Additionally, overtopping of Clarrie Hall Dam during high flow events may lead to the loss and mortality of native fish washed over the outlet, which is also the case for the current Clarrie Hall Dam.

Fish passage

The raising of the Clarrie Hall Dam triggers section 218 (Fishways to be provided in construction of dams and weirs) of the FM Act, which requires Council to notify the Minister of any proposal to construct, alter or modify a dam, weir or reservoir on a waterway. Council notified DPI-Fisheries on 28 October 2021 regarding the Proposal and DPI-Fisheries responded on 14 July 2023, recommending the application of section 218, which requires that the provision of suitable fish passage be transferred to the construction of suitable fish passage at Bray Park Weir under section 4.8 (Fish Passage Trade-offs) of the NSW Policy and guidelines for fish habitat conservation and management (DPI 2013a).

Australian bass

Reduced flows downstream into Doon Doon Creek may have indirect impacts, including an increase in existing fish mortality events. Flows from Clarrie Hall Dam are thought to induce Australian bass to migrate up Doon Doon Creek. However, the dam's presence restricts the species to the lower 1.5 km of Doon Doon Creek, with the dam wall forming an impassable barrier. When flows from Clarrie Hall Dam cease, Australian bass may become trapped in pool refugia in high densities and must endure decreasing water quality over time.

The temperature assessment for Doon Doon Creek and Tweed River conducted as part of the hydrology assessment (section 6.1) states that moderate flow releases from Clarrie Hall Dam of more than 5 days are supportive of upstream Australian bass migrations. Currently, overtopping of the spillway occurs in 86% of years (section 6.1). With the raised dam wall, the frequency of these types of flows is predicted to increase to 87% of years. If Australian bass are in fact cued to migrate upstream when these flows are released, the frequency of upstream migrations is likely to increase only marginally. As such, it is considered that the raising of the dam wall would not create new negative impacts to Australian bass.

There may be the potential to minimise large flows through management of water releases from Clarrie Hall Dam; however, this option would not entirely stop Australian bass entering Doon Doon Creek given the nomadic behaviour of the species.

Ultimately, even if access to Doon Doon Creek were blocked, it would not be possible to exclude Australian bass from the waterway. It is considered unlikely that mortality events can be completely avoided while the species is present within the catchment.

The aquatic ecology assessment found that the Proposal does not pose a significant impact to aquatic ecological values associated with the Proposal.

Protected and sensitive lands

An assessment of impacts to protected and sensitive lands was undertaken to include consideration of areas managed by National Parks and Wildlife Service under the *National Parks and Wildlife Act 1974*, key fish habitat, critical habitat, waterfront land, matters of national environmental significance (MNES), matters protected by the *Native Title Act 1993*, areas of outstanding biodiversity value (AOBVs) and biodiversity stewardship sites.

The assessment concluded the following regarding construction of the Proposal:

- Due to the distance to Nightcap National Park and Wollumbin National Park, impacts from the Proposal on these protected areas are not anticipated during construction or operation.
- Construction impacts are not anticipated to impact Mount Jerusalem National Park, adjacent to the Proposal, as water levels would not increase until the dam wall is raised. The dam wall construction area is about 1.6 km to the north of Mount Jerusalem National Park, and the works associated with McCabes Bridge and Commissioners Creek Road are approximately 1.8 km away.
- Direct loss of key fish habitat would occur as a result of the Proposal. These losses are associated with the construction of the Proposal.
- Other construction activities that may indirectly impact on key fish habitat include water quality impacts, loss of riparian habitat, possibility of contamination, changes to surface hydrology and dust impacts.
- The construction Proposal has potential to cause significant impacts to EPBC Act listed species and a critically endangered ecological community. This would be mitigated by a biodiversity offset strategy.
- There are no active native title applications or determinations that encompass the Proposal area.

The assessment concluded the following regarding operation of the Proposal:

- Once the proposed Clarrie Hall Dam is operational and at FSL, the dam would impact Mount Jerusalem National Park. However, approximately 1.91 ha of Mount Jerusalem National Park has been revoked and is currently pending transfer to Council once subdivision, land title registration and the transfer of compensatory land is finalised. Once the transfer has been completed, no impacts to Mount Jerusalem National Park are anticipated.
- The Proposal would negatively impact key fish habitat. There would be minor alterations to flows downstream of Clarrie Hall Dam due to the increased dam capacity. There may also be changes to the thermal profile within Doon Doon Creek and the Tweed River. Direct impacts on aquatic fauna are considered likely to be minimal.
- The Proposal has potential to cause significant impacts to EPBC Act-listed species and a critically endangered ecological community due to inundation. This would be mitigated by a biodiversity offset strategy.

The main impacts associated with the Proposal during construction are confined to the dam wall area, McCabes Bridge and Commissioners Creek Road, and ancillary facilities. Once the dam is operational, the FSL is not expected to impact on protected and sensitive lands associated with Mount Jerusalem National Park.

Residual impacts due to operation of the Proposal would be mitigated by land transfer agreements and a biodiversity offset strategy.

Aboriginal heritage

An Aboriginal Cultural Heritage Assessment Report (ACHAR) was undertaken for the Proposal, and included consultation with Aboriginal parties, cultural mapping, field survey and test excavations.

The ACHAR has been undertaken in accordance with the requirements of the following NSW Government guidelines:

- Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH 2011)
- Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW 2010b).

Consultation

Aboriginal consultation for the Proposal has in various forms extended over 14 years, having been initiated by Council in 2009, followed by Navin Officer Heritage Consultants (NOHC) in July 2017, continued by Eco Logical Australia (ELA) between 2020 and 2021 and most recently by EMM since mid-2023. Over this period, a core group of local Bundjalung traditional owners and the Tweed-Byron Local Aboriginal Land Council (LALC) have been involved. These activities highlighted several issues associated with the Proposal, including a general concern over potential impacts, the need to consider cultural and intangible values, and the further exploration of several rockshelters on the edge of the inundation area.

As a result of the length of the project, the consultation process was restarted in accordance with Heritage NSW guidelines in mid-2023. This included the re-registration of several of the local Aboriginal communities previously involved, and additional individuals to identify registered Aboriginal parties (RAPs).

Additional tasks to further explore the issues previously raised by NOHC (2018) and ELA (2021) were undertaken by EMM, and feedback on these issues has been generally positive. This includes undertaking a Proposal-specific cultural values mapping study and further consideration of key rockshelter sites. Overall sentiment for the Proposal remains mixed, with an acknowledgment of the need for water security but continued concerns over impacts to cultural heritage.

A summary of Aboriginal consultation activities – as per the Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW 2010) – undertaken for the Proposal since early 2023 is included in Table 4.

Table 4 Summary of Aboriginal consultation activities undertaken since early 2023

Stage	Description	Date initiated	Date completed
1	Government agency pre-notification	18 May 2023	
	Advertisement in the *Tweed Valley Weekly*	1 June 2023	
	Notification and registration of potential Aboriginal stakeholders	31 May 2023	14 June 2023
	Advising Heritage NSW and Tweed Byron LALC of RAPs	4 July 2023	
2/3	Presentation of information about the proposed project and additional tasks	18 July 2023	14 August 2023
	Invitation to a Cultural values mapping workshop	31 July 2023	
	Fieldwork – rockshelter management site visit	14–15 August 2023	
	Fieldwork – cultural values mapping	25 September 2023	26 September 2023

Stage	Description	Date initiated	Date completed
	Fieldwork – additional survey	17 January 2024	18 January 2024
4	Review of the draft ACHAR report	17 June 2024	19 July 2024

Each of the activities undertaken for the ACHAR identified various areas and locales of archaeological and/or cultural value. Due to the initiation of the Proposal in various forms since 2017, the investigations of the project area have extended across multiple assessments including an assessment by NOHC (2018), which undertook significant field survey of the project area; and an assessment by ELA (2021), which undertook subsurface investigations of a smaller number of potential deposits identified by NOHC (2018).

Through ongoing Proposal refinement and liaison with the RAPs, 2 significant sites have been avoided by the Proposal, including CHD-ST1 (#04-1-0285) and one of the overhangs within CHD-RS1 (#04-1-0286). A further 4 sites would be avoided by the Proposal or would be fully inundated.

Overall, the Proposal would potentially result in adverse impacts to 11 identified Aboriginal sites, objects and/or places, as well as various amounts of buried stone or artefactual. These consist of one rockshelter, one culturally modified tree and 7 discrete stone artefact scatters and/or deposits. A low-density broader background scatter of stone artefacts extending across the project area would also be adversely affected.

Recommendations are proposed for inclusion in the project approval to guide post-approval requirements for Aboriginal heritage. These include the development of an Aboriginal Cultural Heritage Management Plan to provide a framework for such activities, as well as direction on its content including additional archaeological investigation and recovery of significant cultural materials, the development of an Interpretation Strategy and Plan to provide acknowledgement and other visual/educational opportunities for the Aboriginal and broader local community.

Historic heritage

A Historical Archaeological Assessment (HAA) was undertaken for the Proposal to identify areas of heritage significance within the Proposal area and determine potential impacts that may arise from the undertaking of the Proposal.

Much of the Proposal area has seen little change since the earliest phases of historical activity, and modern development disturbances have been limited to areas that have been inundated following construction of Clarrie Hall Dam. Past historical activity in the Proposal area has not been intensive and areas of high archaeological potential are limited to specific sites of post-1920 dairy farming activities and the former Doon Doon Sawmill Company. Both of these potential resources fall in the most prominent and well-documented historical land holding in the Proposal area – Crams Farm. Nil to low potential has been identified for the remainder of the Proposal area, as a very limited possibility exists that ephemeral archaeological evidence may be present that could not be identified from documentary research or physical inspection of the landscape.

The HAA determined the following:

- Assessment of the site histories for the potential archaeological resources has determined that they are unlikely to be of research value or meet other thresholds for significance, and these areas therefore hold low archaeological sensitivity.
- The location of the former sawmill has also been found to fall in the current FSL, rendering it inaccessible and subject to existing inundation impacts. As a result, archaeological ‘relics’ are unlikely to be present in the Proposal area.
- Archaeological resources that are likely to be present in Crams Farm Reserve would not be impacted by the proposed enlargement of the FSL to 70 m AHD or the PMF to 77 m AHD. As a result, the raising of Clarrie

Hall Dam is considered to pose no direct or indirect impacts to potentially significant archaeological resources as defined by the relics provision of the *Heritage Act 1977*.

- Very few historical properties or structures, past or existing, have been identified overall. However, two locally significant historical buildings have been identified in Crams Farm Reserve, being:
  - The Bails and Dairy, which:
    - has been assessed to be locally significant under NSW heritage assessment Criterion a) (historical significance), as it is characteristic of the development of Crams Farm and the broader, early development of dairy farms at Lower Doon Doon.
    - is also a highly contributory element of the historical setting of Crams Farm Reserve that includes Doon Doon Hall and mature tree plantings
  - Doon Doon Hall, which:
    - has been assessed as locally significant under criterion a) (historical significance) and criterion d) (social/cultural significance)
    - is among the oldest Federation era community halls in the Tweed LGA, has occupied 3 separate sites in 2 Tweed communities and has served the Doon Doon community for almost 100 years as the sole historical public building in the local area.
- Although the green space of Crams Farm Reserve would be reduced by the raising of Clarrie Hall Dam, no direct impacts are posed to the Bails and Dairy building by the proposed works, new FSL or PMF.
- Indirect impacts would also be limited to reduction in the surrounding lawn green space and former area of Crams Farm. The immediate, contributory setting provided by mature trees and additional structures in Crams Farm Reserve would not be altered or impacted as a result of the proposed works.
- Doon Doon Hall would not be impacted by the raised dam.
- Proposed changes are considered unlikely to adversely affect the significance of the Bails and Dairy or Doon Doon Hall. The historical narrative of the farm and the setting of the public reserve are both currently enhanced, not reduced, by the waterway formed by the dam and this would remain the case if the buildings were brought into closer proximity to the waterline.
- An assessment of the potential indirect impacts to Wollumbin National Park, located 3 km to the north and listed on the World and National heritage list, indicates that there would be no direct impacts. Indirect impacts would be limited to a potential change in the outlook from some areas of the Wollumbin National Park, but these changes are likely to be minimal due to the intervening distance, topography and vegetation.
- An assessment of the potential indirect impacts to the state and locally listed Mount Jerusalem National Park, which abuts the Proposal, would be minimal. The measures proposed in the Biodiversity Development Assessment Report are suitable to manage the potential indirect impacts.

Social, land use and property

A Social Impact Assessment (SIA) was undertaken to assess the potential social impacts associated with the Proposal. The development of the SIA included development of an initial demographic profile and social baseline, development of a stakeholder engagement plan, stakeholder engagement and a social impact risk assessment. The SIA identified impacts that may occur to different groups within the community during construction and/or operation of the Proposal, include the following:

- The Proposal would result in positive and negative social impacts during construction and operation.

- Most of the impacts would be realised through the construction phase of the Proposal. The risk of impacts depends on the proximity of stakeholders to the construction site and access roads, and how stakeholders utilise recreational facilities at the dam and Crams Farm.
- The SIA demonstrated that the Proposal would have various impacts on stakeholders, including changes to accessibility, amenity and community. These impacts are most relevant for stakeholders who are located near the construction site and access roads and who access the sites of Clarrie Hall Dam and Crams Farm.
- Stakeholder engagement demonstrated public support for an effective and immediate start to the Proposal. Stakeholders also highlighted a key relationship between the local community and the natural environment. They communicated a strong connection with the recreational areas at Crams Farm and Clarrie Hall Dam.
- Mitigation measures included in the SIA reduce the risk of impacts from the Proposal to acceptable levels.
- The region is currently experiencing strong population growth, which is forecast to continue. Population growth is leading to increases in both rental and property prices. As such, the SIA supports Council's Proposal to provide a secure water resource that can support a growing population.

Soils and contamination

Soils

A Land, Soils and Erosion Assessment (LSEA) was prepared to determine the potential impacts to soil quality and quantity, erosion hazard, agriculture and geomorphology associated with the Proposal. The LSEA also included geotechnical considerations related to sourcing, importation and management of fill and quarried materials, landform stability and the potential for landslides.

An assessment of existing soil conditions and detailed soil survey for the Proposal concluded:

- The Frogs Hollow (fh) and Kunghur (ku) soil landscapes are dominant in the study area. They are modelled as host to Dermosol and Kurosol soil orders respectively.
- The erosion hazards discussed for all soil landscapes present are commonly high to extreme when surface cover is low (including cultivation) or when overland flows become concentrated. The modelled land and soil capability (LSC) and inherent soil fertility indicate that the more valuable land for agricultural productivity would be associated with the Kurosols of the Kunghur and Kunghur variant a soil landscape (LSC Class 4) and Dermosols of the Terania and Oxley soil landscape (LSC Class 3).
- Soil profiles were described at 5 locations, with single soil samples taken at a further 4 locations during the survey. Soil profiles across the study area were grouped into 3 soil profile classes (SPCs), based primarily on classification under the Australian soil classification, with the site consisting predominantly of non-cracking clay Dermosols and acidic, texture contrast Kurosols with minor areas of poorly developed alluvial Rudosols, generally consistent with regional soil mapping.
- The study area soils are relatively stable from an assessment of soil chemistry, with no sodicity and typically balanced Ca:Mg ratios, indicating that the potential for soil dispersion is low. This is inconsistent with the potential for erosion and dispersion identified in the soil landscape soil materials, which should be considered. Erosion risk is increased in the sandier, less developed profiles (SPC03), as their reduced cohesion means they are likely to be susceptible to movement and erosion. No apparent soil salinity limitations are present in the study area based on the soil samples submitted for laboratory analysis.
- The primary chemical limitation identified, consistent with some of the soil landscape soil materials, is the acidic soil pH and potential for aluminium toxicity, which could be a constraint to revegetation and should be considered in the selection of species utilised in rehabilitation activities.

- Soil stripping and management are likely to be highly constrained by topographic constraints of the Proposal footprint. The presence of shallow, constrained soils across the site necessitates the implementation of soil management measures to minimise impacts and ensure the preservation of soil quality and quantity suitable for use in rehabilitation.

An assessment of erosion hazards, as per section 4.4.1 of Landcom (2004), determined the following:

- The erosion potential of soils that would be disturbed, expressed as K-factor, is moderate. Assessment of rainfall erosivity indicates erosion hazard would be high for areas where slopes exceed 5%. The study area has a high erosion hazard based on the mean slope typical of the local topography.
- Soil loss classes (SLCs) were calculated to map erosion risk for Proposal-specific slopes and soil characteristics. Assessing changes in the SLCs with associated change in slope gives an indication of potential erosion hazard across different SPCs. Generalising across the SPCs, high erosion hazard occurred at slopes exceeding 8% (based on a flow length of 80 m).
- It would be necessary to implement suitable erosion and sediment control measures, as recommended, to minimise erosion and manage any sedimentation that does occur.
- Recommended mitigation measures to further minimise erosion potential include development and implementation of an Erosion and Sediment Control Plan with progressive plans, (as part of the overarching Soil and Water Management Plan), limiting flow lengths on disturbed areas with steep gradients (typically 17% or greater), and implementing temporary groundcover options in the event of significant or prolonged rainfall.

An assessment of Proposal impacts to agricultural land was undertaken based on desktop assessment of available agricultural land use and productivity at a regional level, primarily based on the Tweed Shire LGA within the North Coast Natural Resource Management region of NSW. The assessment determined the following:

- Much of the study area is too steep and isolated for viable agricultural production. Given the utilisation of the dam for local drinking water supply, Council has endeavoured to remove all agricultural practices, such as excluding stock, from proximity of the dam to protect the dam catchment from degradation and minimise water quality impacts associated with sedimentation and agricultural runoff.
- Indicative dollar per hectare ($/ha) values were developed based on available regional land use and productivity data. Extrapolating from the indicative annual commodity values, the FSL area, if fully developed, would encompass some 73.6 ha of grazing land, valued at approximately $25,097 in annual productivity value based on calculated agricultural values for the Tweed Shire LGA.
- Given agricultural activities ceased to prevent impacts to drinking water quality, the estimated agricultural impacts are likely to be further reduced compared to those calculated values.
- No mitigation measures are required to further minimise impacts to agriculture.

A geomorphic analysis was conducted on the catchment of the Clarrie Hall Dam and downstream receiving watercourse of Doon Doon Creek. The assessment determined the following:

- The overall risk to Doon Doon Creek is assessed to be low due to only localised evidence of mass failure and bank erosion, which is often subsequent to bed erosion, within areas downstream on Doon Doon Creek. Further, based on the expected changes in the operation of the dam, hydrologic and hydraulic modelling indicates only minor changes in flow regime and associated hydraulic conditions would occur as a result of the Proposal, which are not expected to materially influence sediment mobilisation and transport within the existing watercourses.

- No mitigation measures are required to further minimise impacts to geomorphology. However, consideration should be given to activities associated with the rehabilitation of riparian areas that include the removal of weeds, enhancement of native vegetation, and the replacement of natural debris that would need removal during construction.

Geotechnical considerations within the LSEA were based on geotechnical surveys. The assessment concluded that:

- The geological setting of the dam comprises a uniform sequence of hard rhyolite with minor welded tuff for the foundational bedrock. Geotechnical surveys have identified different zones within the subterranean embankment profile, ranging from semi-permeable moderately weathered rhyolite to downstream mesh and face zones of unweathered rhyolite. Geotechnical investigations completed to date have concluded that:
  - weathering of rock material is a key constraint to sourcing construction material
  - underlying the existing dam is slightly weathered and fresh rock described as strong to very strong
  - excavation of the new spillway would not produce viable construction material for the raising of the dam wall; however, it is expected that sufficient construction material is present in the existing rockfill quarry
  - quarry stability needs to be informed by an extraction plan and design. This extraction plan and design would be informed by existing and additional testing data to propose a layout that achieves stable batters and confirms the material required can be extracted within the proposed footprint. Using site and external analogues for rhyolite quarry extraction activities, batters of 1V to 1.5H and 5 m wide benches at least every 10 m vertically, conceptually work and can be stable long-term.
- Management of cut and fill materials has been considered by KBR (2023) including a number of areas identified where material can be stockpiled through construction. Material reuse between various construction elements would depend on the quality of materials encountered. The major construction components of the dam wall, spillway and access road have been quantified. From these components, and rehabilitation requirements of the quarry, it is likely that the Proposal would have an excess of material remaining following construction and rehabilitation. Remaining material would be reused where possible within external nearby construction projects or disposed offsite to a licensed landfill or other approved disposal site.
- With regard to landslide risk, studies have shown a correlation between geological factors, rainfall intensity and duration, and the probability of shallow slides. The stability of natural slopes is influenced by factors such as soil depth and moisture, rock type, bedding planes, discontinuities, and weathering. Based on past landslide incidents, identified soil hazards, and length/slope factors, areas of elevated risk were identified for the Proposal; however, it is difficult to predict the occurrence of such events across the Proposal. Areas of elevated risk also do not preclude events in other areas of the study area from occurring. It should be considered that the potential for landslides is across the study area, as regional mapping supports. The consequence of such an event is considered low due to the absence of receptors within and adjacent to the increased FSL. The volume of soil entering the dam due to a landslip occurring is unlikely to significantly influence the total volume of the dam.
- Embankment stability analysis is not required for a conventional concrete face rockfill dam like Clarrie Hall Dam. The existing embankment slopes, constructed using fresh to slightly weathered free draining rockfill, were selected based on precedent and prior research. For the proposed raised embankment, a similar approach has been considered, utilising fresh to slightly weathered free draining rockfill and matching the slope ratio of the existing wall. Other Proposal elements requiring construction are unlikely to present an elevated landform stability risk due to these aspects being of a typical form and function.

Overall, potential land and soils related impacts during construction and operation of the Proposal are considered minor and can be adequately managed through the implementation of recommended mitigation measures. Key issues to be addressed for which mitigation measures have been developed include construction issues associated with landform stability, erosion and sediment control, and operational risks associated with the potential for landslides.

Contamination

A Preliminary Site Investigation (PSI) was undertaken to assess potential contaminants, exposure mechanisms, pathways and potentially affected media associated with the undertaking of the Proposal. Areas of potential contamination were identified by reviewing historical information, the environmental setting and the site inspection. The PSI concluded that:

- The data reviewed and site inspection observations indicated a low potential for the presence of significant widespread contamination in disturbance areas within the proposed footprint. The PSI data indicated the following:
  - The observed agricultural activities across the PMF and surrounds appeared non-intensive; thus, frequent and widespread application of pesticides/herbicides and/or fill material causing widespread contamination is considered unlikely.
  - Based on the review of the available data, there is a potential that construction works may encounter asbestos-containing material in building structures. Asbestos must be managed in accordance with prevailing legislative requirements and management measures.
  - The Doon Doon cattle dip is adjacent to the Kyogle Road and Clarrie Hall Dam Road intersection. Should this dip site be subject to disturbance during construction works, an intrusive investigation and remediation and/or management would be required.
  - Two potentially contaminated sites at 269 & 571 Doon Doon Road both contained a diesel above ground storage tank and evidence of surface spills. These areas are not located within the proposed construction disturbance footprint or within the FSL or PMF. Based on evaluation of source-pathway-receptor linkages, the risk was assessed to be low.
  - Chemical storage areas were identified at a number of properties. However, all areas were not located within the proposed construction disturbance footprint or within the FSL or PMF. Based on evaluation of source-pathway-receptor linkages, the risk was assessed to be low.
  - Household/building waste observed in the potential stockpile area at 511 Doon Doon Road is located further north of the proposed stockpile area. However, it is recommended that this location be assessed through a targeted intrusive investigation and/or be remediated prior to stockpile activities associated with construction works.
- The key management measures for the construction and/or ongoing operation of the Proposal include the development of appropriate project documentation (e.g. Construction Environmental Management Plan, Contaminated Land Management Plan, Construction Soil and Water Management Plan, Asbestos Management Plan, Operational Environment Management Plan (OEMP)) to manage contamination identified during the construction and operation of the project.
- Temporary construction laydown areas would be required to store materials, spoil and equipment, as well as provide space for other ancillary facilities such as site offices. The laydown areas would be used to stockpile material from excavation activities. Stockpiling would be ongoing for the duration of the excavation works. Stockpiling activities would be managed by adopting appropriate erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom 2004) (The Blue Book). Operational impacts associated with the Proposal are not considered to present a significant risk;

however, these impacts would be outlined in the OEMP to ensure appropriate management actions are documented in the event of an incidence of environmental harm occurring.

Waste

An assessment of waste streams that would be generated by the Proposal was undertaken. Approximate quantities of waste streams were determined and classified in accordance with NSW EPA *Waste Classification Guidelines* 2014. Opportunities for reuse of materials and recycling were also identified to align with NSW *Waste and Sustainable Materials Strategy 2041 Stage 1: 2021-2027*. Locations of waste storage and material stockpiles were suggested throughout the construction footprint in consideration of safety and ease of access.

The waste streams assessment concluded the following:

- Section 48 of the *Protection of the Environment Operations Act 1997* (POEO Act) requires an environment protection licence (EPL) for scheduled activities to be undertaken at a premise, as listed in Part 1 Schedule 1 of the Act. The premises-based scheduled activity is listed under clauses 16(1) and 16(2) of Schedule 1 of the Act, being crushing, grinding or separating.
- Unlicenced waste (waste that is not controlled by an EPL) can be disposed of at a licenced waste facility; however, the waste would be subject to levy liabilities under the Part 2 of the Protection of the Environment Operations (Waste) Regulation 2014.
- Waste from construction of the Proposal would be classified in accordance with NSW EPA *Waste Classification Guidelines* (2014) and the NSW EPA waste hierarchy to prioritise avoidance and reduction of waste over disposal of waste.
- The following waste streams are expected to be generated by construction of the Proposal:
  - special waste: asbestos-containing materials present in the intake tower and other buildings
  - liquid waste: liquid wastes such as process water for concrete works, grey water and sewage at construction compounds
  - hazardous waste: waste from the operation and maintenance of construction vehicles and machinery including adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses and tyres
  - general solid waste (non-putrescible): excavated wastes (spoil) such as soil and rock including excavated natural material (ENM) virgin excavated natural material (VENM); demolition wastes – mainly concrete and rubble and other smaller volumes of metals, bricks, timber (untreated and treated), and electrical cables; vegetation (green) wastes; general construction waste such as timber formwork, scrap metal, steel, concrete asphalt, concrete slurry from scarifying, packaging material; general wastes from the site office/construction compound such as paper, cardboard, plastics, glass and printer cartridges
  - general solid waste (putrescible): putrescible food waste from workers at site offices and accommodation.
- Operational waste from the Proposal would be managed in the same manner as existing operational waste due to negligible change in waste amounts and types.

Climate change

Climate change risk assessment

A Climate Change Risk Assessment (CCRA) was undertaken for the Proposal in consideration of the near future (2030) and far future (2070). The future climate was characterised using a range of data sources, and notably the projection data from the NARCliM 1.0 and NARCliM 1.5 projects. Climate was characterised using variables relating to temperature, rainfall, droughts and fire danger, along with qualitative information on storms.

The CCRA included a climate risk and adaptation workshop to consider effects of the future changes in climate in relation to potential impacts on Proposal assets or functions, including areas such as physical structures, transport and worker safety. In total, 31 potential impacts were identified and discussed. Where appropriate, planned and additional measures were then considered, including:

- design:
  - designing dam components in accordance with Australian Standards, which account for temperature variability and extreme rainfall events
  - site landscaping to maintain an Asset Protection Zone
- operation:
  - selective water extraction, with the drawing of water from an optimum depth to provide maximum water quality
  - ongoing monitoring of water quality
  - adherence to optimal environmental outflows
  - consideration of supply augmentation if a shortfall in water supply is determined
  - rehabilitation of vegetated areas to increase bank stability, improve natural filtration, secure sediment in situ and stabilise excavated soil
- plans and schedules:
  - compliance with licence and the Water Sharing Plan
  - adherence to annual maintenance schedules, and adjustment of schedules if needed
  - incorporation of an emergency response procedure and flood forecasting into operating procedures, to mitigate the risk of flooding during extreme rainfall events
  - implementation of a Bushfire Emergency Management and Operations Plan.

Most climate risks were determined to have 'low' residual risk once the additional measures were applied.

Greenhouse gases

A greenhouse gas (GHG) assessment was undertaken for the Proposal to calculate scope 1, 2 and 3 GHG emissions for the 18-month period of construction for the Proposal, and on an annual basis over the Proposal's operational lifetime (assumed to be 100 years in the GHG assessment). The assessment concluded the following:

- Construction of the Proposal would emit around 21,000 tonnes of CO^2-e, with scope 1 emissions representing around 86% of the total. The main contributors to construction emissions would be diesel combustion and vegetation removal (i.e. lost carbon sink).
- For the operation of the Proposal, in the nominal opening year of 2028, there would be an increase in all-scope GHG emissions of around 4,700 t CO_2-e/year. By far the largest component would be the reservoir (and hence scope 1 emissions), which represented 98% of the total. Over the operational lifetime of the Proposal, the impact of the Proposal would decrease, again due almost entirely to a reduction in emissions from the reservoir. The reservoir contribution was projected to decrease from around 4,700 tonnes CO_2-e/year at opening to around 360 tonnes CO_2- e/year by 2128.
- During construction, the total (all scope) GHG emission for the Proposal would represent a very small percentage of emissions in NSW and Australia in 2028, at around 0.02% and 0.005% respectively. The

operation of Proposal would also represent a very small contributor to GHG emissions in NSW and Australia in 2029, at around 0.006% and 0.001% respectively. The contribution would remain small further into the future.

- The construction works would be designed to minimise GHG emissions including, for example, by sourcing construction materials locally and reusing cleared materials.
- Operational GHG emissions are dominated by the reservoir, including the decomposition of organic matter. Partial clearing of vegetation within the new FSL would be implemented as a mitigation measure. The locations of trees that would be removed would be decided during detailed design.

Sustainability

A sustainability assessment was undertaken for the Proposal to assess the Proposal against the current guidelines, targets and strategies for improving government efficiency in the use of water, energy and transport. Additionally, the assessment provided a recommendation for an Ecologically Sustainable Design (ESD) rating system for the Proposal to be assessed under.

The sustainability assessment considered the 4 following sustainability frameworks for assessing ESD performance of the Proposal:

- Hydropower Sustainability Standard (accredited)
- IS v2.1 (accredited)
- IS Essentials (accredited)
- sustainability self-assessment (equivalent program of ESD performance).

The assessment recommended that the Proposal proceeds with a sustainability assessment equivalent to an IS v2.1 rating to embed sustainability and address the SEARs. This meets the 'or equivalent program of ESD performance' requirement of the SEARs. It is recommended that the sustainability self-assessment aligns with the equivalent of an IS v2.1 score of 42.6 (Silver). This assessment cannot be completed until detailed design has commenced; however, a materiality assessment was undertaken to highlight the credits most material to the Proposal (Pla-2, Res-1, Res-2, Rso-2, Rso-4, Rso-5, Eco-1, Sta-1, Sta-2 and Her-1).

Other recommendations of the assessment included:

- A Sustainability Manager should be engaged, if the Proposal is approved, during detailed design and construction to ensure sustainability objectives are embedded. This approach would allow sustainability opportunities to be embedded into the design of the Proposal and considered from the beginning of the Proposal.
- The requirement to undertake a sustainability self-assessment should be included in design and delivery contracts. The contracts should also include requirements for review and auditing needed to verify contract compliance.
- Sustainability objectives should be developed for the Proposal and be stated publicly. It is also recommended that achievements against the objectives be reported publicly at least annually.

Noise and vibration

A Noise and Vibration Impact Assessment (NVIA) was prepared for the construction and operation of the Proposal. The assessment considered the potential for noise and vibration impacts of the Proposal and has been prepared in accordance with the methodology outlined in the Noise Policy for Industry (NPfI), Interim Construction Noise Guideline (ICNG) and other relevant guidelines and standards.

Noise

Noise-sensitive receivers were identified and assessed. Noise goals for operation and construction of the Proposal have been established based on applying the most stringent minimum criteria for background noise level and the methodology provided in the NPfI. The assessment found the following:

- Construction noise levels were assessed for standard construction hours and outside of standard construction hours periods during noise-enhancing meteorological conditions.
- For Scenario 1 (i.e. workers' accommodation located along Tarcoola Lane and concrete batching plant located along Clarrie Hall Dam Road), construction noise levels under noise-enhancing weather conditions are predicted to satisfy the relevant construction noise management levels (NMLs) at 31 of the 45 assessment locations during ICNG standard construction hours. However, noise levels above NMLs are predicted at 14 assessment locations in total, with 9 assessment locations in the northern section (associated with the Clarrie Hall Dam wall raising construction works) and 5 assessment locations in the southern section (associated with the McCabes Bridge replacement and road realignment works).
- During daytime, out of hours, construction noise levels under noise-enhancing weather conditions are predicted to satisfy NMLs at 29 of the 45 assessment locations. However, noise levels above NMLs are predicted at 16 assessment locations in total, with 10 assessment locations in the northern section (attributed to the Clarrie Hall Dam wall raising construction works) and 6 assessment locations in the southern section (attributed to the McCabes Bridge replacement and road realignment works).
- During the evening and night-time periods, construction noise levels under noise-enhancing weather conditions are predicted to satisfy NMLs at 22 of the 45 assessment locations. However, noise levels above NMLs are predicted at 23 assessment locations in total, with 17 assessment locations in the northern section (attributed to the Clarrie Hall Dam wall raising construction works) and 6 assessment locations in the southern section (attributed to the McCabes Bridge replacement and road realignment works).
- For Scenario 2 (i.e. workers' accommodation located along Clarrie Hall Dam Road and concrete batching plant located along Tarcoola Lane), construction noise levels under noise-enhancing weather conditions are predicted to satisfy the relevant NMLs at 36 of the 45 assessment locations during ICNG standard construction hours. However, noise levels above NMLs are predicted at 9 assessment locations in total, with 4 assessment locations in the northern section (attributed to the Clarrie Hall Dam wall raising construction works) and 5 assessment locations in the southern section (attributed to the McCabes Bridge replacement and road realignment works).
- During daytime, out of hours, constructions noise levels under noise-enhancing weather conditions are predicted to satisfy NMLs at 33 of the 45 assessment locations. However, noise levels above NMLs are predicted at 12 assessment locations in total, with 6 assessment locations in the northern section (attributed to the Clarrie Hall Dam wall raising construction works) and 6 assessment locations in the southern section (attributed to the McCabes Bridge replacement and road realignment works).
- During the evening and night-time periods, constructions noise levels under noise-enhancing weather conditions are predicted to satisfy NMLs at 28 of the 45 assessment locations. However, noise levels above NMLs predicted at 17 assessment locations in total, with 11 assessment locations in the northern section (attributed to the Clarrie Hall Dam wall raising construction works) and 6 assessment locations in the southern section (attributed to the McCabes Bridge replacement and road realignment works).
- Given the construction noise findings, the ICNG requires adoption of all feasible and reasonable measures to reduce noise at assessment locations. Construction noise generated by the Proposal would be actively managed, and feasible and reasonable measures would be adopted in accordance with NSW Environment Protection Authority (EPA) policy. Measures include that the proponent must notify the affected residents

of construction works and the potential for noise exceedances, and measures would discuss options for mitigating impacts should they occur.

Maximum construction noise levels were assessed for during the night-time period under noise-enhancing meteorological conditions at the 41 residential assessment locations.

- For Scenario 1, maximum $L_{Aeq,15minute}$ construction noise levels under noise-enhancing weather conditions are predicted to satisfy the $L_{Aeq,15minute}$ sleep disturbance screening criteria at 25 of the 41 residential assessment locations.
- Maximum L_{Amax} construction noise levels under noise-enhancing weather conditions are predicted to satisfy the L_{Amax} sleep disturbance screening criteria at 39 of the 41 residential assessment locations. However, noise levels above the L_{Amax} sleep disturbance screening criteria are predicted at 2 assessment locations in total, with one assessment location (R22) in the northern section (attributed to the Clarrie Hall Dam wall raising construction works) and one assessment location (R36) in the southern section (attributed to the McCabes Bridge replacement and road realignment works).
- For Scenario 2, maximum $L_{Aeq,15minute}$ construction noise levels under noise-enhancing weather conditions are predicted to satisfy the LAeq,15minute sleep disturbance screening criteria at 31 of the 41 residential assessment locations.
- Maximum L_{Amax} construction noise levels under noise-enhancing weather conditions are predicted to satisfy the L_{Amax} sleep disturbance screening criteria at 40 of the 41 residential assessment locations. However, noise levels above the L_{Amax} sleep disturbance screening criteria are predicted at one assessment location (R36), which can be attributed to the McCabes Bridge replacement and road realignment works.

Operational noise levels associated with the daily operation and maintenance of Clarrie Hall Dam are not expected to change due to the Proposal. As such, noise impacts from the operation of the Proposal, including operational noise and sleep disturbance, are not expected to change.

The Proposal would result in additional road traffic movements during the construction period. Road traffic noise increases are predicted to occur on Kyogle Road, Clarrie Hall Dam Road and Doon Doon Road. It is of note that the road traffic noise results are based on heavy vehicle movements during the peak construction scenario; hence, the assessment of road traffic noise is the worst case. Further, the application of the NSW Road Noise Policy criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts related to construction activities.

Operational road traffic volumes are expected to be less than 2% of the existing road traffic experienced on the abovementioned roads. As such, adverse noise impacts from operational road traffic noise are considered unlikely.

Blast overpressure and ground vibration levels from the Proposal are predicted to satisfy relevant EPA guidelines if managed appropriately. Notwithstanding, blast overpressure and vibration would be actively managed and monitored in accordance with current best practice.

Vibration

The NVIA considered potential vibration impacts from the Proposal. Given that, generally, there are significant distances between the construction work areas and the nearest residences or sensitive sites, vibration impacts from the construction of the Proposal are predicted to meet the relevant criteria. Further, given that no significant vibration generating components are included in the operational design of the Proposal, and that there are significant distances between the infrastructure and the nearest residences or sensitive sites, vibration impacts from the operation of the Proposal are also considered unlikely. Notwithstanding, recommendations have been provided regarding work practices to be considered to minimise construction noise and vibration.

A range of project-specific and standard noise and vibration mitigation and consultation measures have been provided in the NVIA. These measures, if integrated with Proposal construction and operational environmental management plans, and implemented as intended, would moderate the impact of the Proposal on local receivers.

Health and safety

Dam safety

The Proposal design was assessed against the applicable dam safety guidelines and regulation as shown below. The assessment determined that:

- The concept design as outlined in the Clarrie Hall Dam Raising Concept Design Report (Appendix B) not only satisfies Dams Safety NSW (previously NSW Dams Safety Committee) requirements but is also in accordance with all relevant ANCOLD guidelines, Australian Standards and best practice, including:
  - ANCOLD Guidelines on Concrete Faced Rockfill Dams
  - NSW Dams Safety Committee, DSC3A: Consequence categories for dams
  - NSW Dams Safety Committee, DSC3B: Acceptable flood capacity for dams
  - NSW Dams Safety Committee, DSC3C: Acceptable earthquake capacity for dams.
- Throughout the detailed design process, there would be ongoing consultation and assessment with Dams Safety NSW and others as relevant to ensure that the design continues to meet legislative and other requirements.
- The dam consequence categories for flood and sunny days for the Proposal design would be determined during the detailed design stage in consultation with Dams Safety NSW.
- The acceptable flood capacity of the Proposal is the PMF event, which was used as a basis for key design requirements.
- The Maximum Design Earthquake of the Proposal is the 0.01% AEP (10,000 year) event, which was used as a basis for key design requirements.
- For the health and safety of construction personnel, the works would be undertaken in accordance with the *Work Health and Safety Act 2011* (WHS Act) and Work Health and Safety Regulation 2017. Safety management plans should be prepared for all high-risk works, including clearing and grading, rock stripping, quarrying, blasting, concrete batching plants works and others.
- The works would involve storage and handling of dangerous goods. Where storage, handling or processing of Schedule 11 hazardous chemicals exceed the quantities specified in Schedule 11 of the Work Health and Safety Regulation 2017, SafeWork NSW would be notified, and an emergency plan would be developed, and a copy of it would be provided to Fire and Rescue NSW.

Bushfire

A strategic bushfire study was prepared to identify the extent to which the proposed development conforms with or deviates from the relevant provisions of the NSW Rural Fire Service's guide, *Planning for Bushfire Protection 2019* ('PBP 2019') (NSW Rural Fire Service 2019). Construction activities for the Proposal were assessed under Chapter 8 (Other Development) of the PBP 2019. The proposed design of the non-habitable components of the project infrastructure demonstrates how the bushfire protection measures satisfy the aims and objectives of the PBP 2019. The proposed temporary workers accommodation facility options are considered as habitable development under PBP 2019, as they would result in an increased residential density. The performance of the temporary workers accommodation facilities has been assessed against the principles

and criteria of Chapter 5 (Residential and Rural Residential Subdivision) acknowledging Chapter 8.2.1 of the PBP 2019.

The entire Proposal area lies within bushfire-prone land (or within a buffer area) and has had an active fire history. The Proposal is located (in general) on the lower slopes within the landscape. Vegetation is predominantly wet sclerophyll forest, grassland and forested wetlands formations.

The strategic bushfire study recommended the following:

- Bushfire protection measures for the Proposal include provisions relating to asset protection zones (APZs), landscaping, construction, access, water supply and utilities, and emergency management arrangements:
  - A standard 15 m APZ has been recommended for all non-habitable Class 5–8 and Class 10 structures associated with construction and operation of the dam to mitigate intense radiant heat and avoid the direct flame zone. This would achieve the maximum bushfire attack level BAL40 and offer a minimum defendable space for firefighting operations.
  - APZs for each proposed accommodation facility option would achieve a radiant heat level 29 kW/m^2 or less and the bushfire attack level BAL29.
    - The proposed workers accommodation facility (WFA1) on Kyogle Road achieved the smallest APZ setback distances due to minor slopes and (primarily) grassland vegetation surrounding the location (APZ setbacks 10–20 m).
    - The proposed accommodation facility on Clarrie Hall Dan Road (WFA2) has increased slopes and is impacted by the close proximity of Forest vegetation (APZ setbacks 10–20 m).
- Standard access and water supply recommendations have been provided and would satisfy the performance criteria of the PBP 2019. The study notably identified that the proposed accommodation facility on Clarrie Hall Dam Road is located on a 'no through road', increasing the risk to life and safety for the workforce if evacuation is required and for attending firefighting personnel. Therefore, a higher reliance on the emergency management and evacuation planning would be necessary.
- Emergency management planning is required prior to construction and must address the construction and operation stages. It is recommended that an emergency management plan (EMP) be prepared in accordance with the NSW Rural Fire Service (RFS) guide to developing a bushfire emergency management and evacuation plan titled *Development Planning* (2014) and implemented for the lifetime of the project. The EMP should detail the mitigation measures associated with the construction and operation of the Proposal, and relevant recommendations made in this report. A separate and site-specific EMP should be developed for the temporary workers accommodation, with a focus on situational awareness and evacuation.
- Early consultation with the NSW RFS is recommended. Engagement and liaison with local RFS brigades (1st attending brigades – Uki and Kunghur) should also occur before the emergency management and evacuation planning.

Air quality

An Air Quality Impact Assessment (AQIA) was prepared for the Proposal to determine the air quality and dust deposition impacts during the construction and operation phase. The AQIA documented the existing air quality and meteorological environment, applicable impact assessment criteria, air pollutant emission calculations, dispersion modelling of calculated emissions and assessment of predicted impacts relative to the criteria. The AQIA determined the following:

- Particulate matter emissions from the main construction activities associated with the Proposal were estimated and modelled. Analysis of existing meteorological and ambient air quality data was conducted to determine a representative year for modelling. The 2021 calendar year was selected based on this analysis.
- Dispersion modelling was completed for a worst-case construction phase scenario of the Proposal using the TAPM and CALMET/CALPUFF model system. Two options for concrete batching plants (CBPs) were considered.
- The results of the modelling show that the predicted concentrations and deposition rates for cumulative TSP, PM_{10}, $PM_{2.5}$ and dust deposition during the Proposal's construction phase did not exceed the applicable impact assessment criteria at any assessment locations and for both CBP options.
- Several dust mitigation measures are proposed during the construction of the Proposal. These include water injection in drill holes, watering of exposed areas and stockpiles at the CBP, and watering of unpaved roads within rock movement areas. These measures were taken into consideration in the emissions estimation and modelling of the construction phase scenario.
- Air quality impacts and dust deposition from the operation of the Proposal were considered negligible, as there would be minimal change to operation conditions related to air quality and dust generation.

Transport and traffic

A Traffic Impact Assessment (TIA) has been undertaken for the Proposal. The key construction and operational traffic impacts this assessment identified are as follows:

- All key intersections operate at Level of Service A (i.e. good) in peak hours for all options proposed and all scenarios.
- A basic left turn (BAL) and basic right turn (BAR) treatment would be required for all intersections, except for Kyogle Road/Clarrie Hall Dam Road under Option 1 (concrete batch plant located along Clarrie Hall Dam Road), where a shortened auxiliary left turn treatment and BAR treatment would be required.
- Due to the narrowness of the roads, a review of intersections would be conducted during detailed design to ensure construction vehicles can safely turn at Kyogle Road/Tarcoola Lane, Kyogle Road/Clarrie Hall Dam Road and Kyogle Road/Doon Doon Road.
- Vegetation at Kyogle Road/Clarrie Hall Dam Road and Kyogle Road/Doon Doon Road would require clearing to ensure clear sight lines for turning traffic.
- Impacts to public transport, pedestrian and cyclist movements would be negligible. Detailed traffic management requirements would be specified in the Proposal's Construction Traffic Management Plan to manage and mitigate potential traffic safety conflicts with road users including school buses along the haulage route.

MANAGEMENT FRAMEWORK/MITIGATION MEASURES

Management and mitigation measures have been included for the management of potential impacts (see Appendix E).

JUSTIFICATION/SYNTHESIS

The proposal to raise Clarrie Hall Dam has been developed to ensure water security for the Tweed Shire region until at least 2065. As evidenced by recent droughts and secure yield modelling, the existing water supply system does not provide a secure water supply beyond 2028; therefore, augmentation of the Tweed Shire water supply by 2028 is required. The Proposal would result in the following key benefits:

- improved water security for the Tweed Shire region as water demand grows with projected population growth
- improved resilience to climate change for the Tweed Shire region as drought periods are expected to occur more often and for longer periods of time
- local procurement and business opportunities during construction of the Proposal, including opportunities for Aboriginal participation in construction.
- Opportunities for Aboriginal participation during operation, including ongoing involvement in catchment management planning and community education.

The Proposal was developed following several iterations of detailed options analysis of water supply augmentation options, design, environmental assessment and stakeholder engagement. Where reasonable and practicable, the Proposal has aimed to avoid and minimise biophysical, social, cultural and economic impacts.

Where impacts are unavoidable, mitigation measures and safeguards have been identified or developed to reduce the likelihood, consequences and magnitude of any residual impacts. Whilst most of the impacts associated with the Proposal can be mitigated, there are impacts to water, biodiversity and heritage that would require alternative management approaches and offsets. These alternative approaches and offsets are detailed in sections 6.1, 6.2, 6.3 and 6.5 of this EIS and have been informed by consultation with the relevant government agencies and Aboriginal participants.

If the Proposal were not to proceed, the existing Clarrie Hall Dam would continue to operate with ongoing risk to water security within the Tweed Shire region. Alternative options to water supply augmentation would be required at significant cost and delay to Council and ratepayers. Additionally, identified impacts of these alternative options have the potential to become greater than the impacts identified in the EIS. Furthermore, should a worst-case dry climate scenario eventuate, the Tweed Shire region would not have adequate water supply to satisfy the water needs of a growing population during a prolonged period of drought(s).

The Proposal should be approved, as:

- it aligns with:
  - NSW Water Strategy (DPE 2021)
  - North Coast Regional Plan 2041 (DPE 2022a)
  - Far North Coast Regional Water Strategy (DPE 2023a)
  - Community Strategic Plan 2022–2032 (TSC 2022a)
  - Delivery Program 2022–2026 and Operational Plan 2023–2024 (TSC 2024a)
  - Tweed Local Strategic Planning Statement (TSC 2020a)
  - Integrated Water Cycle Management Strategy 2014 (Hydrosphere 2014)
  - Water Supply Strategic Business Plan (TSC 2019d)

- it addresses climate change and would provide a drought resilient option to improve water security for the region
- the Tweed Shire region would be provided with adequate water supply until at least 2065, ensuring there would be little need to augment the water supply until 2065
- planning for and implementation of emergency water supply options would not have to be undertaken by Council when the dam water level is at 97% or 100%, saving time and resources
- local economic impacts during construction would benefit local businesses and provide both direct and indirect jobs over the duration of the construction period
- impacts could be appropriately managed, and viable offset options would be developed in consultation with the Biodiversity Conservation Trust and DPI-Fisheries to ensure positive conservation outcomes could be achieved within the region.

In considering the impacts and benefits of the Proposal, it is considered that the long-term benefits of improved water security and climate resilience outweigh the mitigated environmental impacts and costs. The raising of Clarrie Hall Dam would meet the identified Proposal objectives and would satisfy the critical need to ensure the Tweed Shire region has adequate water supply until at least 2065.

Contents

Section		Page
DECLARATION		**IV**
GLOSSARY		**VI**
EXECUTIVE SUMMARY		**XIII**
Introduction		xiii
Engagement		xxiii
Impacts of the proposal		xxiii
Management framework/Mitigation measures		l
Justification/Synthesis		li
1	**INTRODUCTION**	**1**
1.1	Clarrie Hall Dam	1
1.2	Project overview	3
1.3	Objectives of the Project	6
1.4	Purpose and structure of this Environmental Impact Statement	6
2	**STRATEGIC CONTEXT**	**8**
2.1	Strategic need for the Project	8
2.2	Strategic plans and policies	9
2.3	Key features of the site	14
2.4	Feasible alternatives	20
2.5	Cumulative impacts	26
2.6	Existing agreements	26
3	**PROJECT DESCRIPTION**	**27**
3.1	Project overview	28
3.2	Dam raising infrastructure	33
3.3	Ancillary infrastructure	39
3.4	Project areas	46
3.5	Construction	51
3.6	Project operation and water delivery	84
4	**STATUTORY CONTEXT**	**92**
4.1	Statutory background	93
4.2	Relevant legislation	93
5	**ENGAGEMENT**	**100**
5.1	Engagement process	101
5.2	Engagement activities	105

5.3	Community Views	122
5.4	Future engagement	140
6	**ASSESSMENT OF IMPACTS**	**141**
6.1	Hydrology, flooding and water quality	141
6.2	Terrestrial biodiversity	219
6.3	Aquatic ecology	249
6.4	Protected and sensitive lands	266
6.5	Aboriginal heritage	279
6.6	Historic heritage	297
6.7	Social, land use and property	313
6.8	Soils and contamination	342
6.9	Waste	372
6.10	Climate change	398
6.11	Sustainability	420
6.12	Noise and vibration	447
6.13	Health and safety	466
6.14	Transport and Traffic	504
6.15	Cumulative impacts	516
7	**EIS SYNTHESIS**	**521**
7.1	Description of the Project for which approval is sought	521
7.2	Project Objectives and need	523
7.3	Avoidance of impacts	526
7.4	Unavoidable impacts	527
7.5	Ecologically sustainable development	533
7.6	Compliance and monitoring performance	534
7.7	Outcomes and conclusion	534
8	**REFERENCES**	**536**

APPENDIX A: SEARS COMPLIANCE TABLE

APPENDIX B: CONCEPT DESIGN REPORT

APPENDIX C: STATUTORY COMPLIANCE TABLE

APPENDIX D: STAKEHOLDER ENGAGEMENT TECHNICAL REPORT

APPENDIX E: MITIGATION MEASURES TABLE

APPENDIX F: FLOODING ASSESSMENT

APPENDIX G: HYDROLOGY ASSESSMENT

APPENDIX H: BDAR

APPENDIX I: AQUATIC ECOLOGY ASSESSMENT

APPENDIX J: ACHAR

APPENDIX K: HISTORIC ARCHAEOLOGICAL ASSESSMENT

APPENDIX L: SOCIAL IMPACT ASSESSMENT

APPENDIX M: LAND, SOILS AND EROSION ASSESSMENT

APPENDIX N: PRELIMINARY SITE INVESTIGATION

APPENDIX O: CLIMATE CHANGE RISK ASSESSMENT

APPENDIX P: NOISE AND VIBRATION ASSESSMENT

APPENDIX Q: AIR QUALITY ASSESSMENT

APPENDIX R: BUSHFIRE RISK ASSESSMENT

APPENDIX S: TRANSPORT AND TRAFFIC ASSESSMENT

List of Tables

Table 2-1	Relevant SEARs – strategic context	8
Table 2-2	Local planning context	13
Table 2-3	Option consideration	21
Table 2-4	Options description and MCA outcomes	25
Table 3-1	SEARs requiring project description information	27
Table 3-2	Proposal summary	29
Table 3-3	Lot and deposited plan information for the proposed construction disturbance area	47
Table 3-4	Property information for the proposed operational disturbance area	49
Table 3-5	Proposed stages, approximate timing and sequencing of construction	51
Table 3-6	Alternative construction sequence	53
Table 3-7	Estimates of off-highway truck data	62
Table 3-8	Estimated quantities of key constituents of structural concrete	66
Table 3-9	Bulk sand suppliers	66
Table 3-10	Local concrete batching plants and ready-mix suppliers	66
Table 3-11	Cement manufacturing centres	67
Table 3-12	Concrete volumes and mix constituent estimates	69
Table 3-13	Summary of key material properties	72
Table 3-14	Valve information	86
Table 3-15	Environmental flows from Clarrie Hall Dam	88
Table 4-1	SEARs for statutory and strategic context	92
Table 4-2	Overview of the statutory background of the Proposal	93
Table 4-3	Identification of statutory requirements	94
Table 4-4	Relevant and mandatory matters for consideration	98
Table 4-5	Other approvals required under NSW legislation	99
Table 5-1	Relevant SEARs - engagement	100
Table 5-2	Objectives for the engagement and the resulting actions	103
Table 5-3	Stakeholder groups and their potential interest in the Proposal	104
Table 5-4	Timeline of consultation with the local community	108
Table 5-5	Methods used to communicate and engage with the public	113
Table 5-6	Timeline of consultation with the Aboriginal Community	116
Table 5-7	Government agency consultation	120
Table 5-8	Summary of engagement during 2021	123
Table 5-9	Summary of issues raised during consultation	125
Table 5-10	Summary of feedback received through various engagement methods	128
Table 5-11	Responses to feedback received via Your Say Tweed, Facebook and Email	130
Table 5-12	Issues raised during the community information sessions and responses	135
Table 6-1	SEARs relevant to hydrology, flooding and water quality	141
Table 6-2	Summary of modelled scenarios	146
Table 6-3	Bridges identified within the hydraulic model	147
Table 6-4	Minimum releases from Clarrie Hall Dam	153
Table 6-5	Restriction triggers for Tweed District Water Supply Scheme	154
Table 6-6	Water supply systems in the Tweed LGA	162
Table 6-7	WAL summary for the Mid Tweed River and Doon Doon Creek water sources	163
Table 6-8	Australian Bass migration flow cues, Tweed River	165
Table 6-9	Flood levels (m AHD) upstream of Clarrie Hall Dam – existing case	176
Table 6-10	Flood velocities (m/s) upstream of Clarrie Hall Dam – existing case	176
Table 6-11	Flood levels (m AHD) downstream of Clarrie Hall Dam – existing case	176

Table 6-12 Flood velocities (m/s) downstream of Clarrie Hall Dam – existing case 177
Table 6-13 Landholder bores 180
Table 6-14 Estimate of water required during construction 189
Table 6-15 Overview of model results with the current climate 193
Table 6-16 Current flow regime and climate compared to modelled future flow and climate 194
Table 6-17 Physical and chemical water quality impacts in the reservoir for current and future (2065) climate 195
Table 6-18 Peak flows at the spillway and corresponding water level in the dam for all design events 199
Table 6-19 Flood levels (mAHD) upstream of Clarrie Hall Dam – proposed case 200
Table 6-20 Differences in flood levels (m) upstream of Clarrie Hall Dam – proposed case minus existing case 200
Table 6-21 Flood velocities (m/s) upstream (US) of Clarrie Hall Dam – proposed case 201
Table 6-22 Differences in flood velocities (m/s) US of Clarrie Hall Dam – proposed case minus existing case 201
Table 6-23 Flood levels (m AHD) downstream of Clarrie Hall Dam – proposed case 202
Table 6-24 Differences in flood levels (m) downstream of Clarie Hall Dam – proposed case minus existing case 202
Table 6-25 Flood velocities (m/s) downstream of Clarrie Hall Dam – proposed case 203
Table 6-26 Differences in flood velocities (m/s) downstream of Clarrie Hall Dam – proposed case minus existing case 203
Table 6-27 Peak flows Immediately downstream of the Clarrie Hall Dam and at Bray Park Weir 203
Table 6-28 Hazard classifications 204
Table 6-29 Hydrology mitigation measures 213
Table 6-30 Relevant SEARs – terrestrial biodiversity 219
Table 6-31 Vegetation surveys completed 222
Table 6-32 Summary of methodology for assessment of threatened species 223
Table 6-33 Targeted flora survey effort summary 224
Table 6-34 Fauna survey techniques used at each survey site 226
Table 6-35 Survey sites per stratification unit 226
Table 6-36 Fauna species surveyed 227
Table 6-37 PCTs in the Proposal area 231
Table 6-38 Vegetation zones within the disturbance footprint 232
Table 6-39 areas of vegetation zones directly impacted 238
Table 6-40 Candidate SAII species 241
Table 6-41 Native vegetation that does not require offsets 242
Table 6-42 Outcomes of assessments of significance 243
Table 6-43 Regional priority weeds and biosecurity duty 244
Table 6-44 Terrestrial biodiversity mitigation measures 246
Table 6-45 Relevant SEARs – aquatic ecology 249
Table 6-46 Aquatic ecology mitigation measures 264
Table 6-47 Relevant SEARs – protected and sensitive lands 266
Table 6-48 Consideration of construction impacts on Mount Jerusalem National Park 274
Table 6-49 Consideration of operational impacts on Mount Jerusalem National Park 275
Table 6-50 Protected and sensitive land mitigation measures 278
Table 6-51 Relevant SEARs - Aboriginal heritage 279
Table 6-52 Summary of Aboriginal consultation activities undertaken since early 2023 281
Table 6-53 Criteria for assessing cultural significance 288
Table 6-54 Summary of potential impacts to Aboriginal objects and/or sites by the Proposal 292
Table 6-55 Aboriginal heritage mitigation measures 295
Table 6-56 Relevant SEARs – historic heritage 297
Table 6-57 Historical and natural heritage listed items 299
Table 6-58 Summary of historical buildings 299

Table 6-59 Summary of archaeological potential in the Proposal area 308
Table 6-60 Historic heritage mitigation measures 312
Table 6-61 Relevant SEARs – social, land use and property 313
Table 6-62 SIA guideline principles 313
Table 6-63 Methodology for social impact assessment 314
Table 6-64 Stakeholder engagement 315
Table 6-65 Stakeholders interviewed to date 319
Table 6-66 Tweed Shire and New South Wales housing types 2021 329
Table 6-67 Summary of positive social impacts and their residual risk ratings after applying mitigation measures 333
Table 6-68 Summary of negative social impacts, mitigation measures and their residual risk ratings after applying mitigation measures 334
Table 6-69 Relevant SEARs – soils and contamination 342
Table 6-70 Soil landscapes relevant to the Proposal 348
Table 6-71 Overview of potential contamination sources 357
Table 6-72 Rehabilitation risks and controls 363
Table 6-73 Soils and contamination mitigation measures 366
Table 6-74 Relevant SEARs – waste 372
Table 6-75 Waste-related premise-based scheduled activities of the POEO Act 373
Table 6-76 Waste classification and proposed waste management 378
Table 6-77 General solid waste (non-putrescible) types, sources, impacts and approximate amounts 382
Table 6-78 Waste mitigation measures 391
Table 6-79 Relevant SEARs – climate change 398
Table 6-80 CCRA methodology 401
Table 6-81 Temperature statistics for Murwillumbah (Bray Park) (1995-2009) 403
Table 6-82 Rainfall statistics for Murwilumbah (Bray Park) (1990–2009) 404
Table 6-83 FFDI at locations in the North Coast region (OEH2014a) 405
Table 6-84 Summary and interpretation of climate projections 407
Table 6-85 Initial risk profile for the Proposal 410
Table 6-86 Climate change impacts with extreme or high risk 410
Table 6-87 Climate change impacts with residual risk above 'low' 411
Table 6-88 GHG emission sources for the Proposal 413
Table 6-89 GHG emissions – Proposal construction 415
Table 6-90 GHG emissions - Proposal operation (first year) 416
Table 6-91 Climate change risk mitigation measures 419
Table 6-92 GHG emissions mitigation measures 419
Table 6-93 Relevant SEARs -- sustainability 420
Table 6-94 Relevant ESD-related NSW and Commonwealth legislation 423
Table 6-95 National sustainability guidelines 424
Table 6-96 NSW sustainability guidelines 424
Table 6-97 Government Resource Efficiency Policy objectives and their relevance to the Proposal 425
Table 6-98 Infrastructure sustainability themes and categories 428
Table 6-99 Legislation, policies and guidelines related to IS v2.1 categories and credits 433
Table 6-100 Government Resource Efficiency Policy aims mapped to IS v2.1 credits 434
Table 6-101 Number of credits required for each capex band (as of November 2023) 435
Table 6-102 Applicability of ESD assessment tools 436
Table 6-103 IS v2.1 materiality scores 437
Table 6-104 Summary of the results from the ESD assessment 439
Table 6-105 IS v2.1 credits and levels that meet the requirements of the SEARs 440
Table 6-106 Recommended equivalent IS v2.1 credits to undertake in a sustainability assessment 442

Table 6-107 Relevant SEARs – noise and vibration 447
Table 6-108 Meteorological parameters adopted for the noise modelling 449
Table 6-109 Construction NMLs for residential locations 451
Table 6-110 Sleep disturbance screening criteria at residences[1] 460
Table 6-111 Predicted blast overpressure and vibration levels 461
Table 6-112 Project intrusiveness noise levels 462
Table 6-113 Project amenity noise criteria 463
Table 6-114 Project noise trigger levels 463
Table 6-115 Construction mitigation measures 464
Table 6-116 Relevant SEARs – health and safety 466
Table 6-117 Impact assessment criteria for airborne particular matter 470
Table 6-118 Key data from Clarrie Hall Dam Annual Safety Standards Report 2024 474
Table 6-119 Frequency of inspections of local water utility dams 475
Table 6-120 Flooding alert levels 475
Table 6-121 Dam instrumentation for monitoring 476
Table 6-122 Statistics for PM_{10} and $PM_{2.5}$ concentrations – Department of Environment, Science and Innovation (DESI) – North Maclean, 2021 to 2022 477
Table 6-123 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions 490
Table 6-124 Asset protection zones – construction and operational areas 492
Table 6-125 Dam safety, health and safety, bushfire risk and air quality mitigation measures 498
Table 6-126 Relevant SEARs – transport and traffic 504
Table 6-127 Option 1 construction traffic volumes 509
Table 6-128 Option 2 construction traffic volumes 509
Table 6-129 Traffic volumes at each of the intersections 510
Table 6-130 Construction phase mitigation measures 513
Table 6-131 SEARs for cumulative impact assessment 516
Table 7-1 SEARs for synthesis and justification of the proposal 521
Table 7-2 Uncertainties in concept design or construction methodologies 522
Table 7-3 Evaluation of the Proposal's alignment with ESD principles 533

List of figures

Figure 1-1 Regional context of the Proposal 2
Figure 1-2 Proposed development footprint 5
Figure 2-1 Actions to plan and conduct the EIS for the proposed raising of Clarrie Hall Dam, in the Regional Water Strategy Far North Coast Implementation Plan 12
Figure 2-2 Land tenure (north) 15
Figure 2-3 Land tenure (south) 16
Figure 2-4 Land tenure (south, detailed) 17
Figure 2-5 Panoramic view of the spillway, dam wall and intake tower 18
Figure 2-6 Clarrie Hall Dam intake tower 19
Figure 2-7 Crams Farm recreation area 20
Figure 3-1 Proposal overview – northern section 30
Figure 3-2 Proposal overview – central section 31
Figure 3-3 Proposal overview – southern section 32
Figure 3-4 Embankment construction area 34
Figure 3-5 Concept design for the raised dam wall and new spillway 35
Figure 3-6 Concept design for the raised dam wall 36
Figure 3-7 Concept design for the proposed new spillway 37
Figure 3-8 Concept design for the proposed new intake tower 38
Figure 3-9 Quarry site 40
Figure 3-10 Kyogle Road and Clarrie Hall Dam Road intersection area 41
Figure 3-11 Construction disturbance footprint of the McCabes Bridge and Commissioners Creek Road realignment 42
Figure 3-12 Proposed locations of construction compounds, site offices, concrete batching plant, workers' accommodation and realignment of utilities at the southern end of the Proposal area 45
Figure 3-13 Probable maximum flood area for the proposed dam upgrade 50
Figure 3-14 Extract of proposed quarry cross-section 57
Figure 3-15 Existing quarry 3D image 58
Figure 3-16 Alternative to the major haul route utilising a material staging promontory 60
Figure 3-17 Concept Design key material quantities for the dam raising 65
Figure 3-18 Overview of raised embankment material zones 73
Figure 3-19 Spillway and intake tower craneage 76
Figure 3-20 Spillway construction area 78
Figure 3-21 Electricity supply (11 kV) in the vicinity of Clarrie Hall Dam 82
Figure 3-22 Electricity supply (11 kV) in the vicinity of McCabes Bridge work zone 83
Figure 4-1 Land zoning of the Proposal area 97
Figure 5-1 Project information signage displayed at the dam wall 115
Figure 5-2 Project information signage displayed at Crams Farm 116
Figure 5-3 Responses to question asking about support of the Proposal 123
Figure 5-4 Reasons for supporting the Proposal 124
Figure 5-5 Reasons for not supporting the Proposal 124
Figure 5-6 Reasons for interest in the Proposal 125
Figure 6-1 TUFLOW model schematisation 148
Figure 6-2 Groundwater study area 151
Figure 6-3 Pool and riffle in Doon Doon Creek downstream of Clarrie Hall Dam 155
Figure 6-4 Pool and riffle in the Tweed River between Uki and Doon Doon Creek 155
Figure 6-5 Clarrie Hall Dam monthly rainfall totals 156

Figure 6-6 Historical rainfall trend at Murwillumbah, and regional flood and drought markers 157
Figure 6-7 ACESS1-3 seasonal rainfall projections (2065) 158
Figure 6-8 Flow duration curve at Doon Doon Creek downstream of Clarrie Hall Dam, current climate 159
Figure 6-9 Stream depth curve for Tweed River at downstream Palmers Road crossing (201015) 159
Figure 6-10 Stream depth curve for Tweed River At Uki (201900) 160
Figure 6-11 Approximate Clarrie Hall Dam depth–volume relationship and release elevations 161
Figure 6-12 Spillway discharges (modelled) 161
Figure 6-13 Shire-wide historical demand and 2020 demand forecasts 163
Figure 6-14 Locations of Tweed Shire Council water quality monitoring sites 166
Figure 6-15 Modelled cold water pollution travel distances with 0 ML/d and 25 ML/d inflow at the Tweed River, releases of 16°C water into 25°C water for the 2018 scenario 168
Figure 6-16 Distance before water released at 16°C warms to 23°C 169
Figure 6-17 Existing flood conditions – maximum flood outline 5% AEP 170
Figure 6-18 Existing flood conditions – maximum flood outline 1% AEP 171
Figure 6-19 Existing flood conditions – maximum flood outline 0.5% AEP 172
Figure 6-20 Existing flood conditions – maximum flood outline 0.2% AEP 173
Figure 6-21 Existing flood conditions – maximum flood outline PMF event 174
Figure 6-22 Location of reporting points (RPs) 175
Figure 6-23 Geological outcrops of the study area 178
Figure 6-24 Locations of landholder bores in the Proposal area 181
Figure 6-25 High potential groundwater-dependent ecosystems 183
Figure 6-26 Geological fault location 185
Figure 6-27 Clarrie Hall Dam stored water volume, current climate (palaeo-stochastic climate data) 192
Figure 6-28 Potential changes to spillway discharges (palaeo-stochastic climate data) 193
Figure 6-29 Number of years per decade with flows supportive of Australian Bass migration (palaeo-stochastic climate data) 195
Figure 6-30 AIDR flood hazard vulnerability curves 205
Figure 6-31 Proposal – maximum flood outline 5% AEP 206
Figure 6-32 Proposal – maximum flood outline 1% AEP 207
Figure 6-33 Proposal – maximum flood outline 0.5% AEP 208
Figure 6-34 Proposal – maximum flood outline 0.2% AEP 209
Figure 6-35 Proposal – maximum flood outline PMF 210
Figure 6-36 Proposed case stage hydrographs for all design events (48-hour duration) over a longe simulation period (150 hours) 211
Figure 6-37 Flora survey sites 225
Figure 6-38 Fauna survey sites 229
Figure 6-39 PCTs and other vegetation types in the Proposal area 234
Figure 6-40 Locations of survey sites for the aquatic ecology surveys 251
Figure 6-41 Catchment and sub-catchments relevant to the Proposal 255
Figure 6-42 Key fish habitat distribution within the Proposal area 256
Figure 6-43 Protected lands managed under the NPW Act 268
Figure 6-44 Revoked portion of Mount Jerusalem National Park 269
Figure 6-45 Key fish habitat within the Proposal area 271
Figure 6-46 Flooding and key fish habitat 277
Figure 6-47 Previously documented Aboriginal objects and sites within the Proposal Area 284
Figure 6-48 Potential cultural heritage impacts by the Proposal 294
Figure 6-49 Locations of natural heritage sites 300
Figure 6-50 Bullock team hauling logs over the creek crossing at Uki in the early 20th century 302
Figure 6-51 Parish map of Nullum, County of Rous in 1921 302

Figure 6-52 Members of the Cram family and friends c. 1950 at the rear of the Cram house. Charlie Cram is seated in the wheelchair and Grace Cram wears the white apron .304
Figure 6-53 Terragon Hall prior to its transferral to Doon Doon in 1927.....305
Figure 6-54 The giant screed machine applying a 300 mm concrete face to the inner compacted rock fill dam wall.....306
Figure 6-55 Crams Farm west view 307
Figure 6-56 McCabes Bridge 308
Figure 6-57 Social locality – Tweed Shire.....326
Figure 6-58 Population heat map of Tweed Shire showing key communities around Clarrie Hall Dam.....328
Figure 6-59 Year-to-year population forecast within the Tweed Shire 325
Figure 6-60 Percentage of tenancy type within the Tweed Shire, Uki, Murwillumbah and New South Wales, 2021 330
Figure 6-61 Mean monthly temperature and rainfall for Clarrie Hall Dam.....345
Figure 6-62 Map depicting surface geology of the study region.....347
Figure 6-63 Map depicting soil landscapes in the study region 349
Figure 6-64 Soil investigation locations 354
Figure 6-65 Potential contamination sources in the study region 356
Figure 6-66 NSW EPA waste hierarchy 374
Figure 6-67 Potential waste storage and material stockpile locations (north) 389
Figure 6-68 Potential waste storage and material stockpile locations (south) 390
Figure 6-69 Historical temperature data for Murwillumbah (Bray Park).....402
Figure 6-70 Historical rainfall data for Murwillumbah (Bray Park).....404
Figure 6-71 Overview of GHG emission scopes.....412
Figure 6-72 Annual GHG emissions from the reservoir over the lifetime of the Proposal 417
Figure 6-73 Components of annual GHG emissions over the lifetime of the Proposal 418
Figure 6-74 IS delivery timeline Source: ISv2.1 Infrastructure Sustainability Technical Manual.427
Figure 6-75 IS rating process Source: ISv2.1 Infrastructure Sustainability Technical Manual.....432
Figure 6-76 Materiality assessment and material topics for the Proposal 437
Figure 6-77 Noise sensitive receivers and assessment locations.....450
Figure 6-78 Noise contours – northern area, day (Scenario 1) 454
Figure 6-79 Noise contours – northern area, evening/ night (Scenario 1) 455
Figure 6-80 Noise contours – northern area, day (Scenario 2) 456
Figure 6-81 Noise contours – northern area, evening/night (Scenario 2) 457
Figure 6-82 Noise contours – southern area, day (Scenario 1 & 2).....458
Figure 6-83 Noise contours – southern area, evening/night (Scenario 1 & 2).....459
Figure 6-84 Air quality assessment locations.....469
Figure 6-85 Clarrie Hall Dam reduction in peak outflow in comparison to peak inflow 473
Figure 6-86 CALMET calculated diurnal variation in atmospheric stability ('no observations' mode).....478
Figure 6-87 Bushfire prone land in the Proposal area.....480
Figure 6-88 Asset protection zone for WFA1 493
Figure 6-89 Asset protection zone for WFA2 494
Figure 6-90 Road network 506
Figure 6-91 Transport routes schematic, showing the key project-related roads and intersections assessed for option 1 (left) and option 2 (right) 508



CHAPTER 1

Introduction

1 Introduction

1.1 CLARRIE HALL DAM

Tweed Shire Council (Council) is proposing to raise Clarrie Hall Dam by 8.5 metres. Clarrie Hall Dam is located on Doon Doon Creek, a fifth-order stream forming a tributary of the Tweed River. The dam is located in Doon Doon, approximately 15 km south-west of Murwillumbah and 4 km south-west of Uki in the Tweed Shire Local Government Area (LGA).

Clarrie Hall Dam was constructed in 1983 by the NSW Department of Public Works and is owned and operated by Council for the primary purpose of providing a drinking water supply to the Tweed Shire region. The dam has a catchment area of approximately 60 square kilometres (km^2) and a storage capacity of 16,000 megalitres (ML).

The Tweed District water supply is currently a run-of-river supply augmented by releases from Clarrie Hall Dam down Doon Doon Creek via a shuttered intake in the intake tower into a pipe/outlet tunnel that runs under the dam wall to a valve chamber (outlet works) where there are a number of valves through which the water goes through before it discharges into Doon Doon Creek to the Tweed River. Raw water is drawn from upstream of Bray Park Weir, effectively a saltwater barrage, in the Tweed River. In periods of low flow in the river, flows are augmented by releases from Clarrie Hall Dam to ensure availability of water for the Tweed District water supply. Details of the operation of the dam are provided in section 3-6 (operation and water delivery) and section 6.1 (hydrology).

There is a requirement to augment the Tweed Shire district water supply by 2028. This is because of an increasing demand for water as a result of projected population growth, and the increasing uncertainty of water supply yield due to climate change.

Council proposes to raise the wall of Clarrie Hall Dam by 8.5 m to a height of 70 m Australian Height Datum (AHD) (RL 70 m), thereby increasing the capacity of the dam from 16,000 ML to approximately 42,300 ML (the Proposal).

The purpose of the Proposal is to ensure water security for the Tweed Shire region until at least 2065.

The former Department of Planning and Environment (DPE) – now referred to as Department of Planning, Housing and Infrastructure (DPHI) – released the Far North Coast Regional Water Strategy (FNCRWS) (DPE 2023a), which provides a 20-year Far North Coast region-specific strategy to improve the security and certainty of water resources. The raising of Clarrie Hall Dam is discussed in the FNCRWS, which states it would assist Council to achieve some of the objectives of the FNCRWS. This is discussed further in section 2.2.2.

The regional context of the Proposal is shown in Figure 1-1.

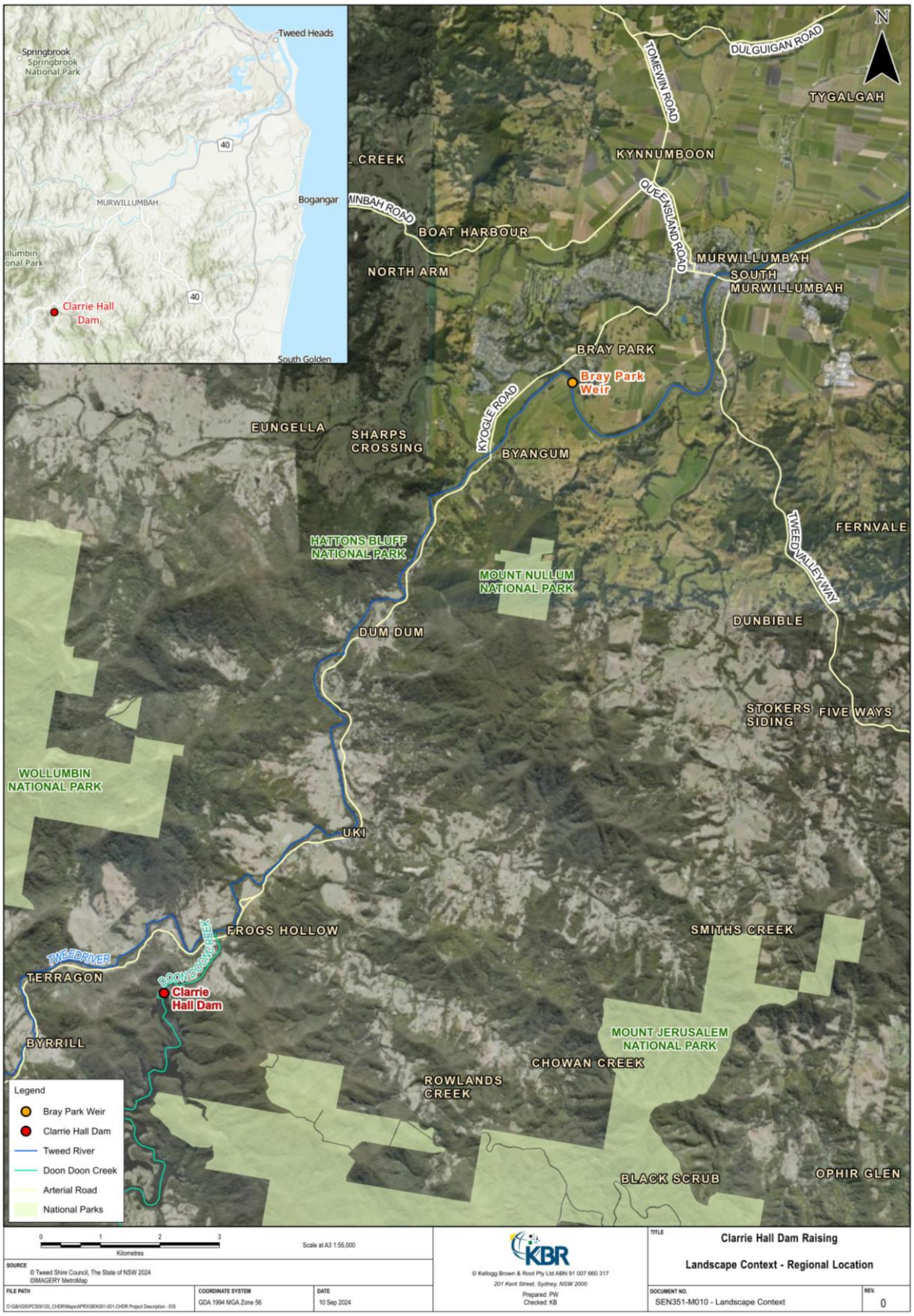


Figure 1-1 Regional context of the Proposal

1.2 PROJECT OVERVIEW

The Proposal would include the following main activities and elements, with construction staging and sequencing provided in section 3.5.1:

- raising the dam wall by 8.5 m
- a new spillway channel constructed higher in the left abutment with a flip bucket at the downstream end
- re-establishment of the quarry used to construct the existing dam for the purpose of sourcing rock material to raise the dam wall
- construction of associated haul roads to transport quarry material for the proposed raising of the dam wall
- establishment of a construction area for plant, equipment, storage, material handling and offices
- establishment of stockpile sites associated with construction
- construction of work compounds and site offices
- establishment of materials storage and handling facilities
- construction of workers accommodation
- construction of a concrete batching plant
- realignment of Clarrie Hall Dam Road higher in the right abutment
- raising of the existing intake tower and bridge
- decommissioning of existing recreational facilities at the dam wall area
- construction of new dam operational facilities including signage, car parking, security fences, lighting, monitoring equipment and a boat ramp
- removing or reconstructing impacted recreational infrastructure and facilities at Crams Farm
- upgrading the Kyogle Road and Clarrie Hall Dam Road intersection
- replacing McCabes Bridge and realignment of Commissioners Creek Road
- relocating existing power and telecommunications utilities
- construction of new recreation facilities including an amenities block, public shelters, viewing areas, interpretation signage, paths, car parks, and landscaping.

The detailed design will need to check that the existing tunnel, valves and control systems remain suitable for new design flow velocities and pressures from the raised dam and that their condition is suitable for extended service life.

The upgraded dam operational footprint would increase the area of inundation to below the RL 70 m contour, which is the waterline at full supply level (FSL).

The Proposal footprint is shown in Figure 1-2. Further information on the location and description of the Proposal site are provided in Chapter 2. A detailed description is provided in Chapter 3.

1.2.1 Timing

It is anticipated that construction would start in 2026, subject to obtaining all necessary approvals. The raised Clarrie Hall Dam would be operational from 2028.

An indicative construction methodology is provided in Chapter 3.

1.2.2 Approval requirements

The Proposal is classified as State significant infrastructure (SSI-65020460) and is subject to approval by the NSW Minister for Planning and Public Spaces under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act).

On 27 February 2019, Council was advised that the Proposal is a Controlled Action (2018/8339) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the requirements of this Act were incorporated into the Secretary's Environmental Assessment Requirements. The EIS has therefore been prepared in accordance with the bilateral agreement between the NSW and Australian governments.

1.2.3 Related development infrastructure

The Bray Park Weir Tidal Protection Project is a related infrastructure project that is subject to a separate approval process. Bray Park Weir was built in 1960 and is a critical component of Council infrastructure, as it provides in-stream storage for the Bray Park Water Treatment Plant. Most of the Tweed Shire's potable water is sourced from the Tweed River at the Bray Park Weir.

Climate change is causing more frequent extreme weather events. It is also causing sea levels to rise and is reducing the flow of water in the Tweed River. The rise in sea level is increasing the risk of tidal salt water overtopping the Bray Park Weir, which could affect the quality of the water supply. Council is developing and assessing options to mitigate this risk separately to the Proposal.

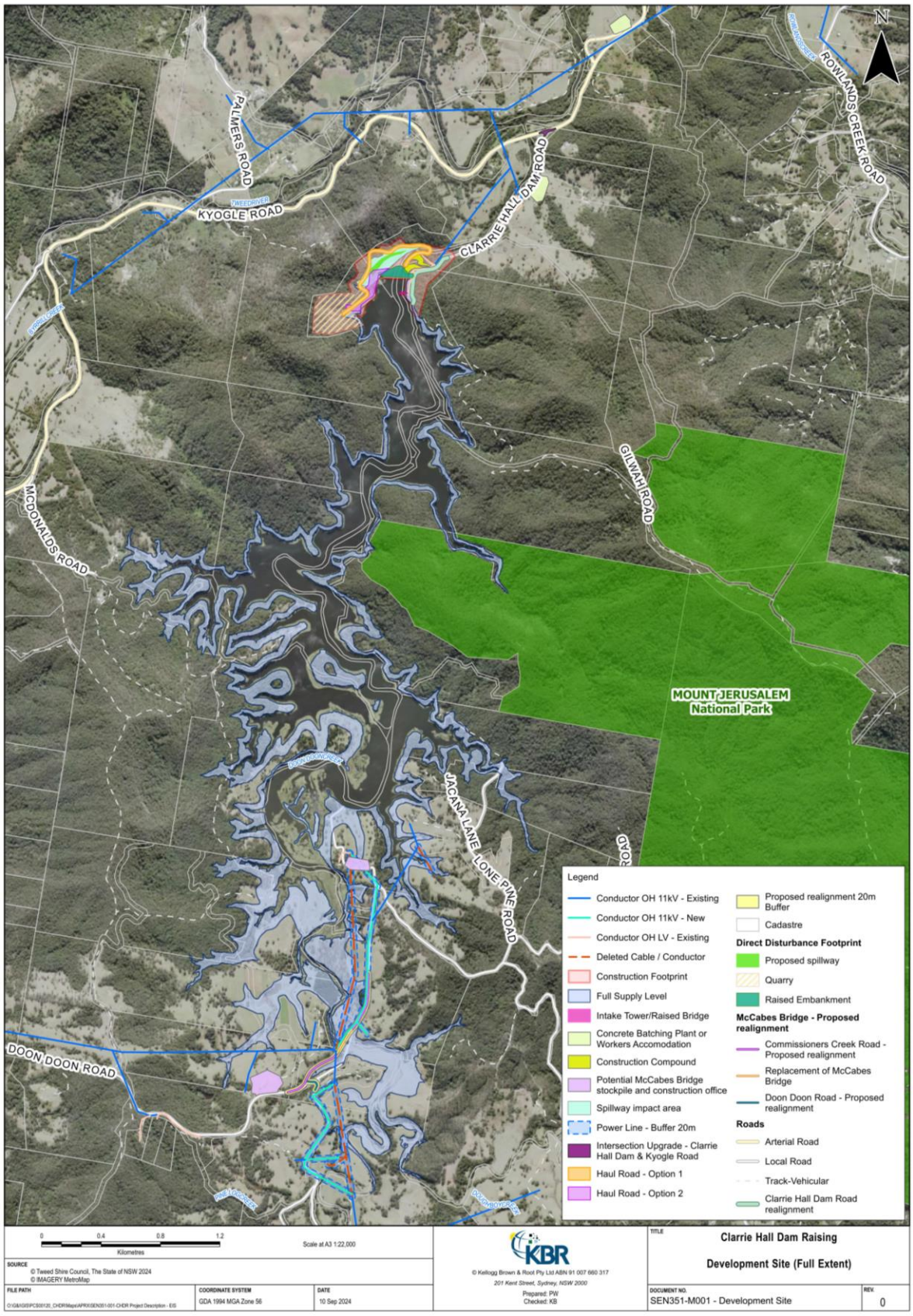


Figure 1-2 Proposed development footprint

1.3 OBJECTIVES OF THE PROJECT

Council aims to ensure that the Tweed Shire community continues to be provided with a safe and secure water supply beyond 2028, which could be achieved by raising Clarrie Hall Dam.

The Proposal considers the future growth projections and the predicted impacts of climate change. In conjunction with other water conservation actions, the Proposal aims to provide increased water storage to allow for the continued growth of the region and ensure the resilience of the community, even in drought conditions, which are predicted to become more frequent and of longer duration due to climate change. This increased storage would provide adequate water supply to the Tweed Shire until at least 2065.

Clarrie Hall Dam is operated in accordance with the Tweed River Area Unregulated and Alluvial Water Sources Water Sharing Plan (WSP) 2023 (NSW Government 2023). The Proposal has been designed to meet the WSP objectives.

The water supply objective of Council, stated in section 2.1.1 of the Tweed Shire Council Delivery Program 2022-2026 and Operational Plan 2024-2025 (TSC 2024a) is:

> To provide secure, high quality and reliable drinking water which meets health and environmental requirements.

So that Council can fulfil the requirement of ensuring that all customers are provided with a safe and secure water supply, the Proposal would satisfy the principal objectives identified by Council for water supply services, including:

- providing water supply services within a strategic business planning framework
- providing best practice management of the urban water supply in accordance with Council's Integrated Water Cycle Management Strategy
- meeting legislative requirements, including licence requirements regarding surface and groundwater supply extraction conditions
- providing additional system capacity that meets sustainable growth projections to operate the water supply systems efficiently and sustainably
- providing an equitable, responsive and cost-effective water supply service
- providing a high quality, reliable and sufficient water supply service
- promoting water cycle education, including conservation and reuse
- managing assets on a whole-of-lifecycle cost basis to ensure the ongoing adequate provision of water supply services
- implementing a management regime for all matters relating to the provision of the water supply service.

The proposed raising of Clarrie Hall Dam would also meet relevant objectives of the Far North Coast Regional Water Strategy as discussed in Chapter 2.

1.4 PURPOSE AND STRUCTURE OF THIS ENVIRONMENTAL IMPACT STATEMENT

This environmental impact statement (EIS) supports an application for approval of the Proposal in accordance with Division 5.2 of the EP&A Act. It addresses the environmental assessment requirements of the Secretary of the Department of Planning, Housing and Infrastructure (SEARs).

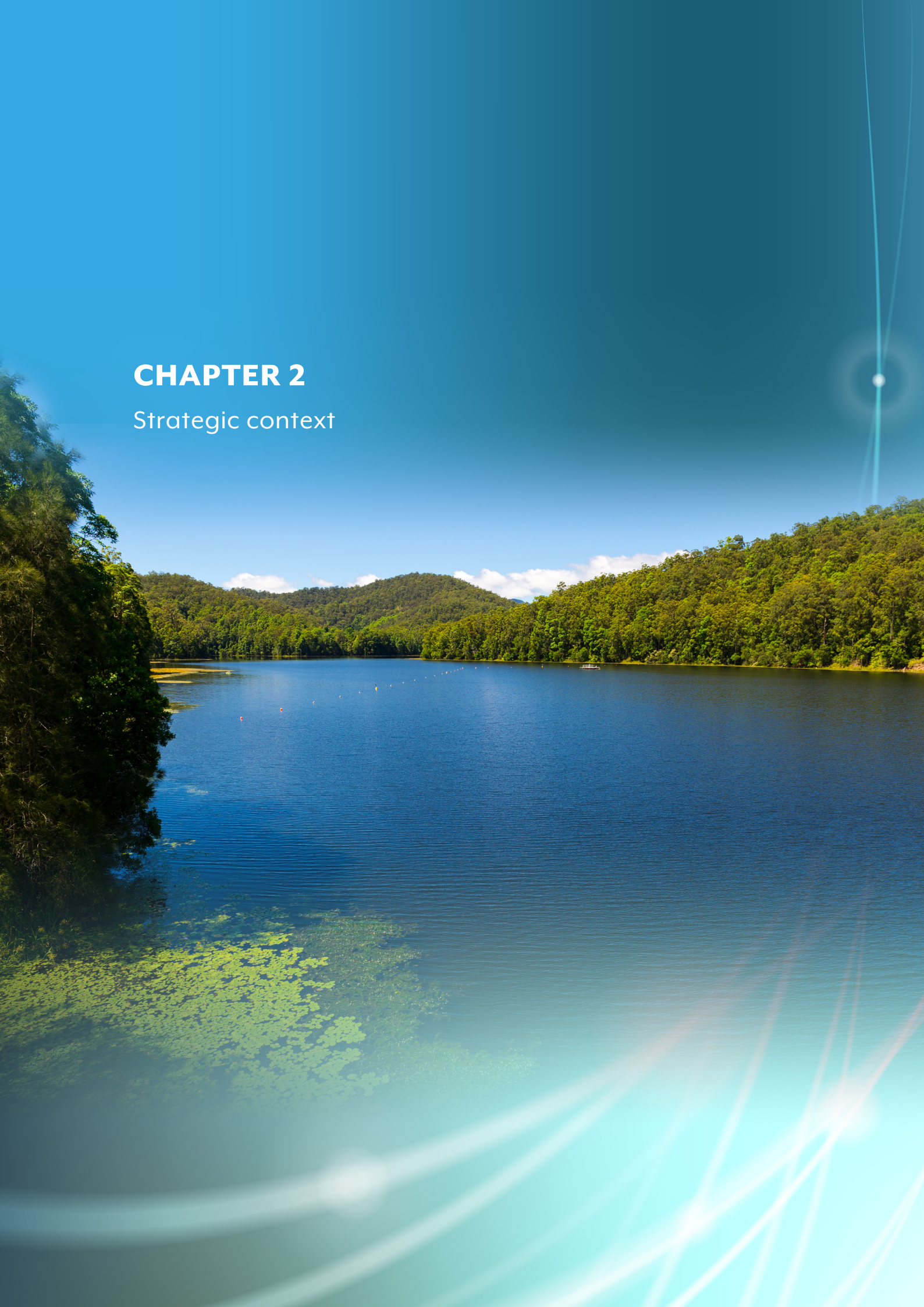
In accordance with the SEARs compliance table (Appendix A), this EIS also addresses the EIS form and content requirements of the *Environmental Planning and Assessment Regulation 2000*. This EIS has also been prepared with regard to the State Significant Infrastructure Guidelines (DPIE

2021b), and in particular *State significant infrastructure guidelines – preparing an environmental impact statement* (DPIE 2021a), and other relevant technical guidelines.

This EIS is structured as follows:

- Chapter 1 – Introduction
- Chapter 2 – Strategic context
- Chapter 3 – Project description
- Chapter 4 – Statutory context
- Chapter 5 – Engagement
- Chapter 6 – description and assessment of environment, social, economic and cumulative impacts of the Proposal
- Chapter 7 – Project justification
- Appendix A – SEARS compliance table
- Appendix B – Concept Design Report
- Appendix C – Statutory compliance tables
- Appendix D – Stakeholder Engagement Technical Report
- Appendix E – Mitigation measures table
- Appendix F – Flooding Assessment
- Appendix G1 - Hydrology Assessments
- Appendix G2 – Groundwater Assessment
- Appendix H – Biodiversity Development Assessment Report
- Appendix I – Aquatic Ecology Assessment
- Appendix J – Aboriginal Cultural Heritage Assessment Report
- Appendix K – Historic Archaeological Assessment
- Appendix L – Social Impact Assessment
- Appendix M – Land, Soils and Erosion Assessment
- Appendix N – Preliminary Site Investigation
- Appendix O – Climate Change Risk Assessment
- Appendix P – Noise and Vibration Assessment
- Appendix Q – Air Quality Assessment
- Appendix R – Bushfire Risk Assessment
- Appendix S – Transport and Traffic Assessment

The supporting technical reports provided as appendices include the detailed assessments of the potential impacts of the Proposal as they relate to the key environmental issues defined by the SEARs.



CHAPTER 2

Strategic context

2 Strategic context

The Proposal is of significance to the Tweed Shire region, as the outcome would provide vital water security in the face of climate change and population growth. The strategic issues in relation to the Proposal are discussed in this chapter.

The relevant SEARs and where in the EIS they are addressed are provided in Table 2-1.

Table 2-1 Relevant SEARs – strategic context

Relevant key issue requirement/s	Where addressed
C) A summary of the strategic need for the proposal with regard to its State Significance and relevant State Government Policy.	Sections 2.1 and 2.2
D) A description of how alternatives to and options within the project were analysed and optimised to inform the selection of the preferred alternative/option	Section 2.4

2.1 STRATEGIC NEED FOR THE PROJECT

Due to increasing demand for water as a result of projected population growth, and the increasing uncertainty of water supply yield associated with climate change, there is a requirement to augment the Tweed Shire district water supply by 2028. Peak demand is expected to exceed secure yield by 2028, when factoring in ongoing implementation of demand management and revisions of the secure yield of the Tweed district water supply based on an increase of one degree Celsius by the year 2030 (NSW Urban Water Services 2016).

6 water supply augmentation options were assessed after 9 options were first considered in 2009–2010 (MWH 2009). Environmental, social and economic analysis of the 6 water supply options consistently indicated that raising Clarrie Hall Dam was the most advantageous to Council and the community (see section 2.4 for a discussion on alternatives).

A review of the strategic water supply options was recently completed by Stantec (2024) which found that the raising of Clarrie Hall Dam remained the preferred option. Further details on the updated review are provided in section 2.4.2.

2.1.1 Water demand

In August 2021, Council engaged an external consultant to update the forecast demand for the Tweed District Water Supply (Hydrosphere Consulting 2020) and a second external consultancy to update the secure yield modelling including using the latest climate predictions to assess the strategic need and climate change risk to the present and proposed water supply system (NSW Urban Water Services 2021). The updated secure yield modelling shows that a raised Clarrie Hall Dam, as proposed, would be able to provide a secure water supply to the Tweed until at least 2065, and probably beyond.

2.1.2 Council's responsibilities

Council has the following responsibilities relating to water supply:

- Under section 60 of the *Water Management Act 2000*, critical human needs are the first priority during extreme events, such as drought, so it is Council's responsibility to ensure adequate supply during these times.

- A new regulatory and assurance framework that applies to local water utilities in regional NSW, such as Tweed Shire Council, commenced from 1 July 2022. This means that Tweed Shire Council, who is exercising water supply functions under Division 2 of Part 3 (Chapter 6) of the *Local Government Act 1993*, and exercising water supply functions under the Water Management Act 2000, is required to ensure local water utilities' risks are managed effectively and strategically.

Council also has obligations to implement the objectives and actions of the FNCRWS, as discussed in section 2.2.3.

2.2 STRATEGIC PLANS AND POLICIES

The Proposal supports the priorities identified in the NSW Water Strategy (DPIE 2021a) (refer to section 2.2.1) and is identified in the Far North Coast Regional Water Strategy (FNCRWS) (DPE 2023a) (refer to section 2.2.2). Consistency with relevant local planning policies, strategies and plans is discussed in section 2.2.4.

2.2.1 NSW Water Strategy

The NSW Water Strategy (DPIE 2021) is a 20-year state-wide strategy to improve the security, reliability and quality of the state's water resources over the coming decades. The strategy addresses key challenges and opportunities for water management and service delivery across the state and sets the strategic direction for the NSW water sector over the long-term. This state-wide, high-level strategy works in tandem with 12 regional water strategies (including the FNCRWS) and two metropolitan water strategies.

Regional water strategies will set out a long-term 'roadmap' of actions to deliver 5 objectives:

- Deliver and manage water for local communities
- Enable economic prosperity
- Recognise and protect Aboriginal water rights, interests and cultural values
- Protect and enhance the environment
- Affordability.
- The NSW Water Strategy identifies 7 strategic priorities focused on meeting core objectives based on the NSW *Water Management Act 2000*. A set of principles have also been developed to guide the long-term strategic planning for water resource management in NSW.

The Proposal supports the priorities identified in the NSW Water Strategy, and specifically:

- Increase resilience to changes in water availability
- Support resilient, prosperous and liveable cities and towns
- Support economic growth within a capped system.

2.2.2 North Coast Regional Plan

The North Coast region extends from Port Macquarie north to the Queensland border, and west to the Great Dividing Range and hinterland. There are two distinct sub-regions, which are the Northern Rivers and the Mid North Coast. As the popularity of the region has increased, the *North Coast Regional Plan 2041* (DPE 2022a) sets a 20-year strategic land use planning framework for the region, aiming to protect and enhance the region's assets and plan for a sustainable future.

The North Coast region has been declared a region pursuant to section 3.2 in the EP&A Act. The Regional Plan provides an overarching framework to guide subsequent and more detailed land use

plans, development proposals and infrastructure funding decisions at a regional, subregional and local level.

The Proposal is consistent with the following objectives outlined in the Regional Plan:

- Objective 5: Manage and improve resilience to shocks and stresses, natural hazards and climate change
- Objective 9: Sustainably manage and conserve water resources.

Climate modelling has found that droughts in the region may be more severe in the future. During extreme droughts, the focus is on securing essential town, domestic and stock water supplies. The region is also likely to see seasonal shifts in rainfall patterns, higher rates of evaporation and more hot days and more intense storm events. Sea-level rise and saline intrusion is an additional risk to future town water security. The Proposal is considered consistent with Strategy 9.3 of the Regional Plan, which states:

> Encourage a whole of catchment approach to land use and water management across the region that considers climate change, water security, sustainable demand and growth, the natural environment and investigate options for water management through innovation.

The Implementation Plan for 2022–2026 supports the Regional Plan.

2.2.3 Far North Coast Regional Water Strategy

The FNCRWS (DPE 2023a), provides a 20-year Far North Coast region-specific strategy to improve the security and certainty of water resources.

The raising of Clarrie Hall Dam would assist Council to achieve objective 1 of the FNCRWS – with the exception of flood management – which states:

Deliver and manage water for local communities: improve water security, water quality and flood management for regional towns and communities.

The FNCRWS identifies the following opportunity in response to the challenge of water security for towns and communities in the Far North Coast:

Opportunity: Improve the resilience of town water supplies by planning for the uncertainties of population growth and projected climate change.

The FNCRWS identifies population growth as putting pressure on town water supply systems in the Far North Coast region. It also finds that the risks to these systems could increase with the increasing frequency and severity of dry periods likely to occur in the future.

Furthermore, NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) modelling suggests that the risks to town water supplies in the Far North Coast region occur mostly during extreme dry periods and notes this is of particular concern for the Tweed Shire Council and Rous County Council water supply systems because they service large populations, and the consequences of shortages could be severe.

Furthermore, the FNCRWS states:

> Both Rous County Council and Tweed Shire Council have limited water storage available, with roughly 12–18 months of water storage available for the major urban supplies in the Far North Coast.
>
> If a drought were to occur for longer than this period, Council would need to rely on emergency supplies such as temporary desalination plants. This is impractical as the lead times for this infrastructure can be one to two years, requiring a decision on implementation very early on in a drought.

> Tweed Shire Council currently needs to plan for emergency supplies once Clarrie Hall Dam drops to about 97% capacity. Projections suggest that in the future demand will increase and climate change will reduce inflows. This will lead to dam levels dropping faster. As a result, planning for emergency augmentations will need to happen much earlier. Some models suggest that by 2030 Tweed Shire Council will need to start planning emergency augmentations when Clarrie Hall Dam is completely full.

In addition, there can be significant costs to maintaining reliable water supplies during drought. The FNCRWS states that councils in the Far North Coast region need to consider the levels of risk that Far North Coast communities are willing to endure and need to balance these with the associated costs of their emergency supplies.

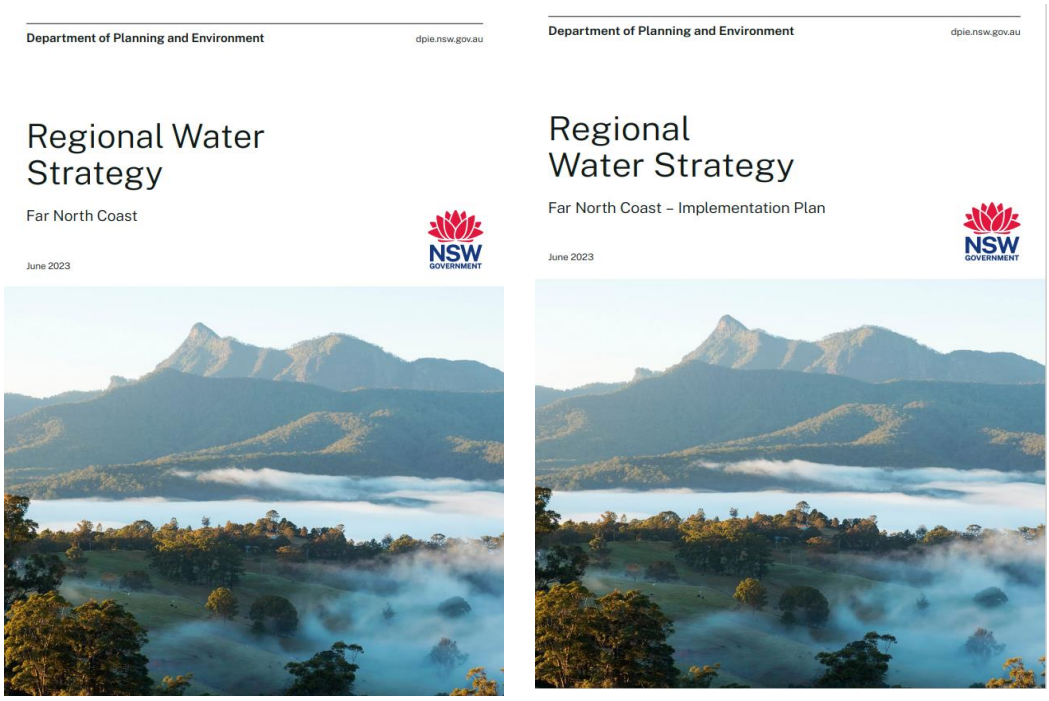
The FNCRWS identifies Tweed Shire Council as already focusing on reducing the risks to supplies through actively trying to reduce general water use, while also augmenting Clarrie Hall Dam to increase supply. The FNCRWS states that these kinds of actions can reduce system risk by delaying the need for emergency supplies.

The Millennium Drought from 2006 to 2010, was south east Australia's lowest recorded 13-year rainfall since 1865. During this drought, water storage in Clarrie Hall Dam dropped to just over 30%.

The 2017–2020 drought highlighted that the region's town water supply systems can be put under pressure during drought. The FNCRWS therefore identifies the raising of Clarrie Hall Dam as a key initiative for the region.

Tweed Shire Council is planning augmentation of Clarrie Hall Dam (from 16 GL to 42.3 GL capacity).

This is further discussed as action 4.3 in the Far North Coast Implementation Plan Regional Water Strategy 2023, shown in Figure 2-1.



Action	Our starting point	What we will do next	What we will do later	Lead	Supported by
Action 4.3: **Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast**	Rous County Council is undertaking planning, design and approvals for the short- and medium-term actions identified in its Future Water Project 2060: • Stage 1: Upgrade of Marom Creek water treatment plant, accessing Alstonville and Woodburn groundwater • Stage 2: New groundwater source at Tyagarah. Tweed Shire Council is continuing to plan the Clarrie Hall Dam augmentation and is completing, and seeking approval for, an environmental impacts statement. Byron Shire Council is working on emergency connections for Mullumbimby to the Rous County Council bulk water supply with NSW Government funding for flood resilience.	Rous County Council will construct/improve Alstonville and Woodburn groundwater source infrastructure.	Rous County Council to operate Marom Creek Water Treatment Plant upgrade and Alstonville/Woodburn groundwater schemes. Tweed Shire Council to construct Clarrie Hall Dam augmentation (pending approval). Investigate the feasibility, including whole-of-life costs, yield assessments, lead times, community acceptance, environmental impacts, technical complexity and regulatory barriers for: • linking the Tweed Shire Council and Rous County Council water systems • connecting smaller systems in the Richmond/Brunswick catchments (Casino, Nimbin, Mullumbimby) to the Rous County Council bulk water supply on a permanent basis • constructing a regional desalination facility.	Local councils	DPE–Water

Figure 2-1 Actions to plan and conduct the EIS for the proposed raising of Clarrie Hall Dam, in the Regional Water Strategy Far North Coast Implementation Plan

2.2.4 Local planning

Council has developed a number of plans and strategies aimed at ensuring water security for the Tweed region. Relevant plans and strategies are summarised in Table 2-2.

Table 2-2 Local planning context

Policy / Plan	Relevance to the Proposal
Community Strategic Plan 2022–2032	The Community Strategic Plan has been developed to align with the NSW government priorities. The Proposal is consistent with the plan's goal to 'provide safe, sustainable and affordable water supply and wastewater services as the foundations of a healthy community' (Goal 2.1).
Delivery Program 2022–2026 and Operational Plan 2023–2024	Consistent with the Community Strategic Plan 2022–2032 Goal 2.1 to 'provide safe, sustainable and affordable water supply and wastewater services as the foundations of a healthy community', this plan has identified the current Proposal as a significant project over the financial years of 2022/2023, 2023/2024 and 2024/2025. Should the Proposal be approved, the detailed design, tendering and construction has been identified as a key project for 2024/2025 and 2025/2026.
Tweed Local Strategic Planning Statement 2020	The Local Strategic Planning Statement presents Council's 20-year vision for land use in the local area, the values to be preserved and the management of future change. This statement and the Community Strategic Plan complement each other to bring together the community vision and goals and align them with the vision and goals in the North Coast Regional Plan 2041. The Proposal is consistent with the statement's planning priority to 'reduce carbon emissions and sustainably manage energy, water, waste and development impacts' (Planning priority 4). In particular, the statement refers to the current Proposal to ensure the security of the Tweed's long term water security.
Integrated Water Cycle Management (IWCM) Strategy 2014	The IWCM Strategy identifies current and emerging issues that Council and the community will face over the next 30 years. The Proposal is consistent with, and provides a preferred outcome to, the following identified issues: • Issue 4: Uncertainty regarding the preferred Tweed district water supply augmentation option creates confusion regarding land use planning • Issue 13: Augmentation of the Tweed District Water Supply will be required in future due to population growth although the timing and additional supply required are unclear. A broad range of management options were identified to address the identified issues. The strategy identifies increased community engagement and the need to undertake additional studies and modelling to manage these issues. The Proposal and the level of detailed investigation undertaken to date are consistent with these management options. To address the relevant provisions in the IWCM Strategy, Council has: • Updated demand estimates and working on better population estimates (Issue 3) • Considered Climate Change and sea level rise (Issue 7) • Substantially comply with best practice (Issue 9) • Identified augmentation options (Issue 13) and preferred option • Undertaken demand management • Developed drought contingency measures (restrictions policy etc) (Issue 16) • Updated the secure yield. Council is currently working on updating the IWCM Strategy. An IWCM Issues Paper is due to be completed by the end of 2024

Policy / Plan	Relevance to the Proposal
Water Supply Strategic Business Plan	The IWCM Strategy and the Water Supply Strategic Business Plan (SBP) are done every 8 years and are 4 years out of step. The draft SBP was prepared in 2019 and also identifies the need to augment the water supply. The following statements are outlined in the draft SBP: • Water Availability - the IWCM Strategy identifies the need for an augmentation to the water supply by about 2030. This has subsequently been updated by comparing projected demand with secure yield as influenced by climate change and the requirement for a new water supply is now at 2028 (this was originally identified as 2026 however subsequent assessments by NUWS identified that the increased water supply would be needed by 2028. Council has resolved to undertake the planning and land acquisition for raising Clarrie Hall Dam. • Emerging Issues - there are a number of major issues to be addressed by Council including the future water supply. It is anticipated demand will exceed secure yield by 2028. In December 2015 Council resolved to undertake the planning and land acquisition for the raising of Clarrie Hall Dam. This work is progressing. • Corporate Risk - a risk analysis was completed in 2013 and is reviewed annually. The risks were categorised into 12 categories. The risks are recorded in the Corporate Risk Register within the categories of water source capacity failure and demand exceed supply.

2.3 KEY FEATURES OF THE SITE

Key features of the site and surrounds that could affect or be affected by the Proposal are discussed below.

2.3.1 Local and regional community

Clarrie Hall Dam is situated on Clarrie Hall Dam Road, Uki, in the small rural locality of Doon Doon, approximately 15 km south-west of Murwillumbah and 4 km south-west of Uki in the Tweed Shire LGA (see Figure 1-1).

Access to the dam wall and spillway area is from Clarrie Hall Dam Road, which runs south from Kyogle Road. The southern extent of Clarrie Hall Dam is accessed from Crams Farm, located off Commissioners Creek Road.

The majority of the Doon Doon sub-catchment of the Tweed River Catchment consists of rural and agricultural land uses (more than 70% of land is zoned 1a Rural).

Land tenure

The Proposal is situated within several different existing land tenures, as shown in Figure 2-2 to Figure 2-4.

Seventeen properties have been identified as impacted by the implementation of the Proposal. To date, Council has either acquired, and/or has under contract, all, or a sub-divided portion, of 15 of the 17 identified affected properties. One property owner is not negotiating further until the EIS has been determined and Council has resolved to implement the Proposal. An area of about 1.91 hectares (ha) has been revoked from Mount Jerusalem National Park (further discussion on land tenure is provided in Chapter 4 and section 6.4).

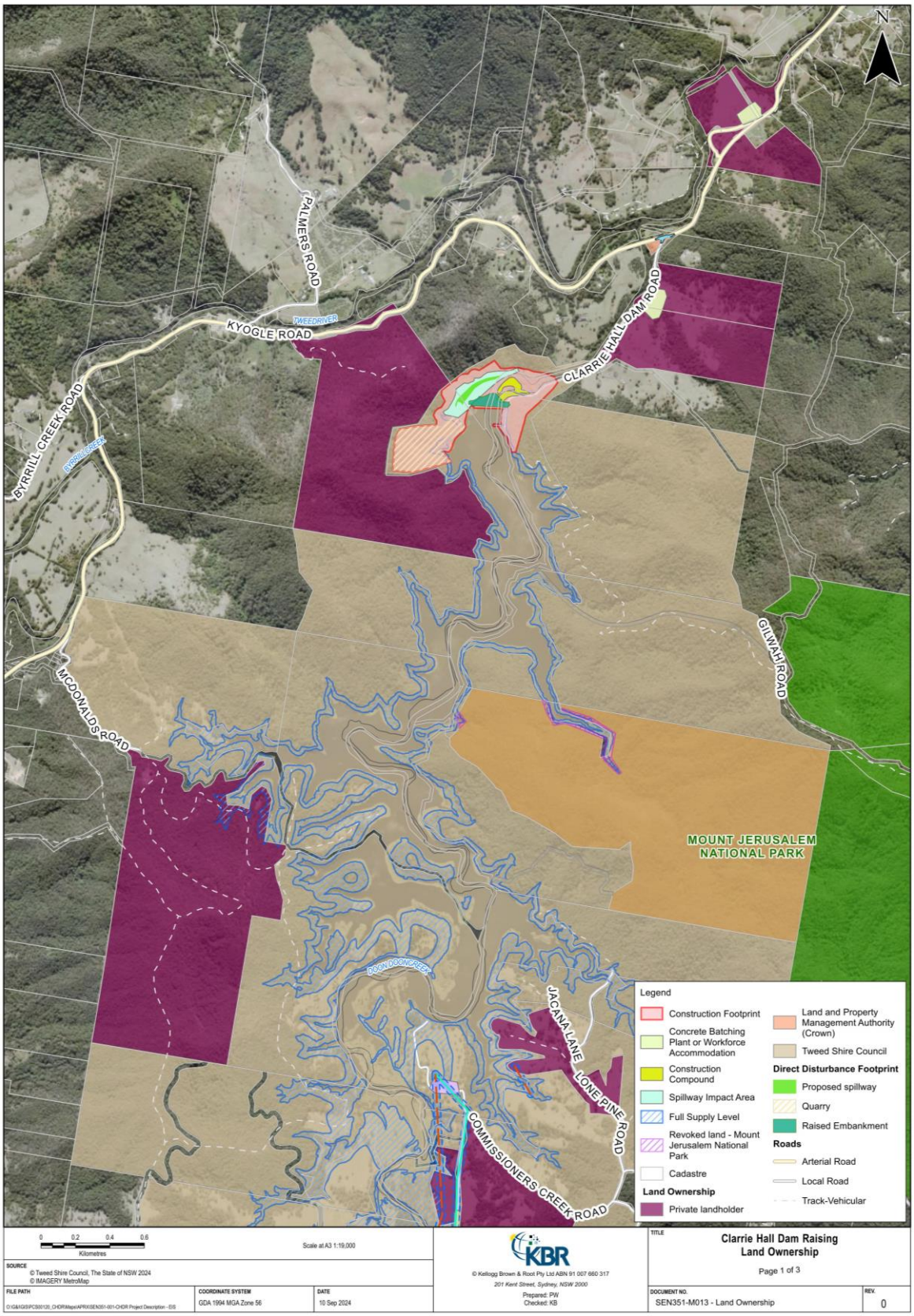


Figure 2-2 Land tenure (north)

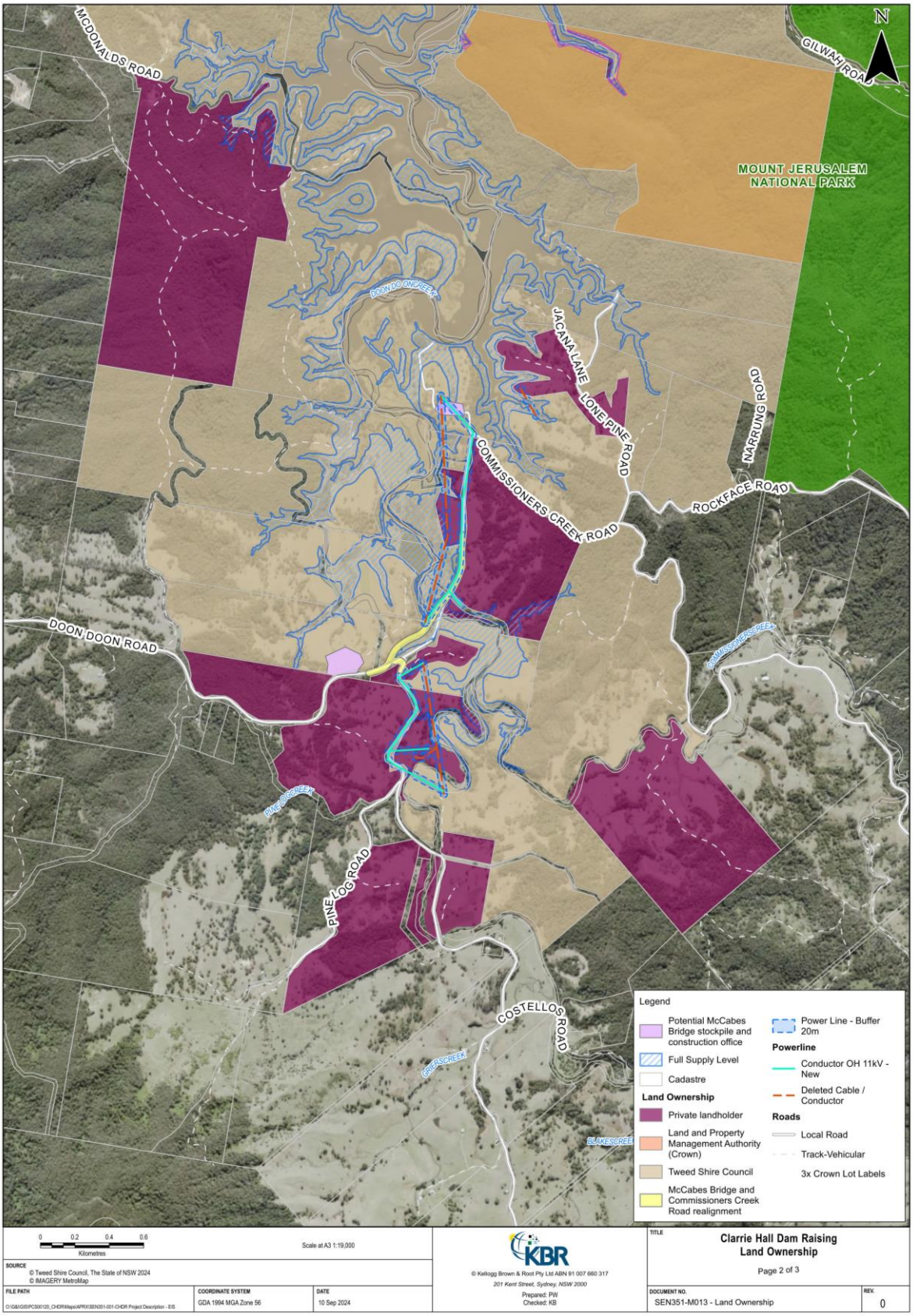


Figure 2-3 Land tenure (south)

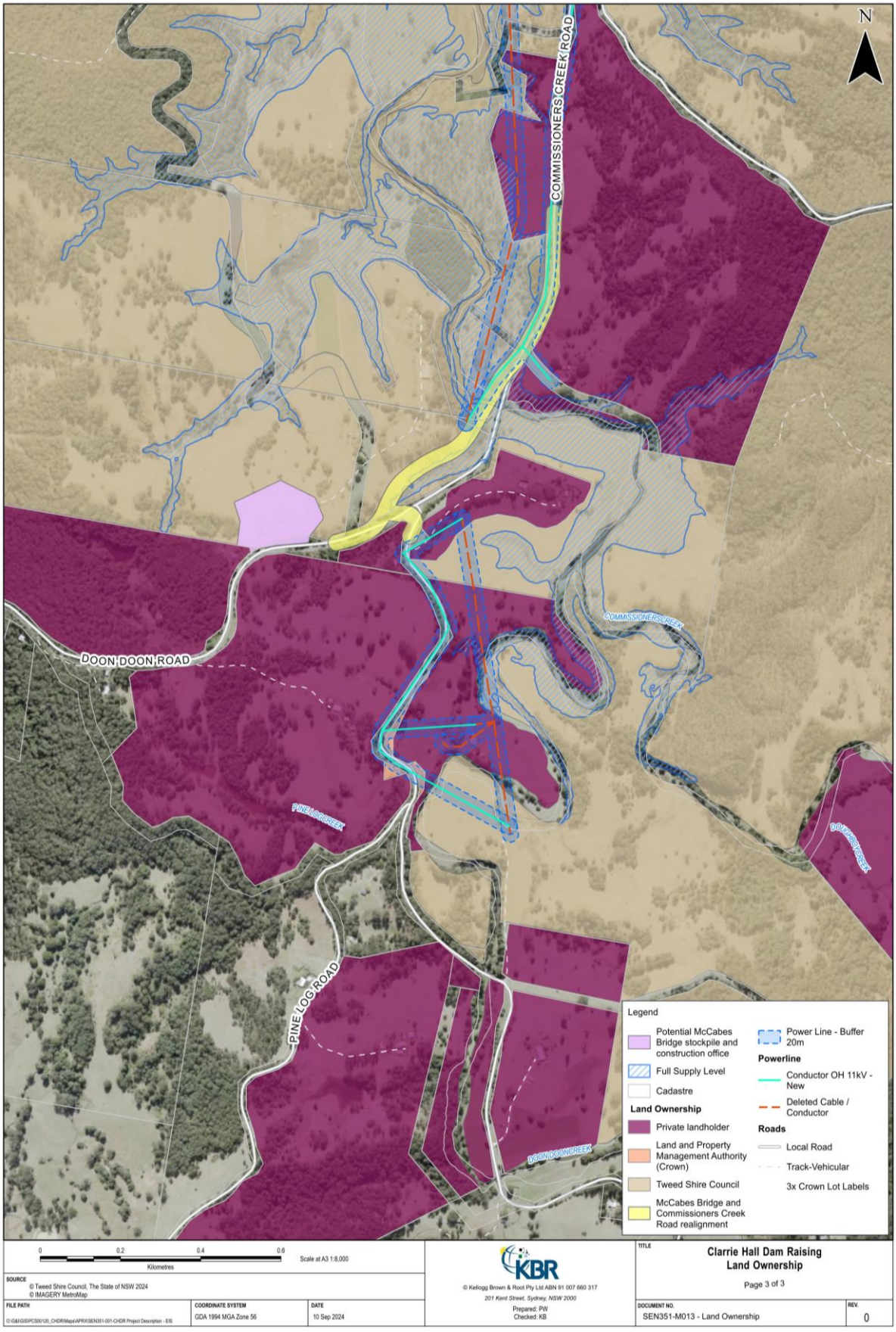


Figure 2-4 Land tenure (south, detailed)

2.3.2 Landscape features

Important landscape features are discussed below.

Clarrie Hall Dam

Clarrie Hall Dam (Figure 2-5 and Figure 2-6) consists of a concrete faced rockfill embankment, a concrete lined spillway, intake and outlet works constructed on a foundation of very hard/strong Rhyolite rock (of volcanic origin). The rockfill embankment has a height of 43 m, crest length of 175 m and a volume of about 160,000 cubic metres (m^3). The crest width is 6 m, and the upstream and downstream slopes are 1V (vertical) to 1.3H (horizontal). The upstream slope is covered by a 300 millimetre (mm) thick concrete face slab which connects at the top to a wave wall along the embankment crest.

The present FSL of the dam is RL 61.5 m, which is 7 m below the embankment wave wall crest level (RL 68.5 m). The spillway is an ungated concrete chute with ogee weir and flip bucket located on the left abutment. The spillway chute and approach area between the dam toe slab and spillway crest are fully lined and have walls 6 to 8 m high. The spillway chute is 110 m long. The spillway crest is 22 m wide, and the chute width narrows to 12 m for much of its length.

Clarrie Hall Dam is located in a relatively remote rural setting. Recreational access to Clarrie Hall Dam is either via Clarrie Hall Dam Road to the spillway end of the dam, or from Crams Farm via Doon Doon Road and Commissioners Creek Road at the southern end of the reservoir. Clarrie Hall Dam is open to the public from 7 am to 5 pm (6 pm during daylight savings). Access is via security gates at the two access points: at the entrance to Crams Farm and at the intersection of Kyogle Road and Clarrie Hall Dam Road.



Figure 2-5 Panoramic view of the spillway, dam wall and intake tower



Figure 2-6 Clarrie Hall Dam intake tower

Permitted recreational uses at the dam and its catchment include bushwalking, nature appreciation (bird-watching, nature photography), picnicking, recreational fishing, sailing, canoeing, kayaking and rowing, motorboating (electric motors only – fuel motors should be removed from boats), and special uses approved by Council (such as fuel motorboats for research and monitoring). Camping and overnight stays are prohibited.

Recreational facilities at the spillway area include an amenities facility, shade shelters, a viewing area to the dam wall and spillway consisting of seating and interpretive signage, walking paths, visitor car parking, a boat ramp and security fencing. The public can walk across the top of the dam wall towards the spillway. Recreation infrastructure at Crams Farm includes an amenity building, shade structures and barbeques, a boat ramp and adjacent pontoon, a sealed access road and informal car parking (see Figure 2-7). Local heritage items identified include Doon Doon Hall and the Crams Farm complex, are also located at Crams Farm (refer to section 6.6 and Appendix K for information on historic heritage). Doon Doon Hall is used for functions, with bookings managed by Council.



Crams Farm internal road leading to pontoon and canoe/boat launch



Crams Farm internal road leading to canoe/boat launch area



Crams Farm internal road and picnic area



View of the dam from Crams Farm Pontoon

Figure 2-7 Crams Farm recreation area

Surrounding catchment

The Doon Doon catchment incorporates parts of Nightcap National Park in the south-west and Mount Jerusalem National Park in the east and south (partially excised). The sub-catchment is predominantly vegetated with native bushland; however, a large portion is cleared and is mainly used for cattle grazing. The surrounding Council-owned land does not allow cattle, as it is managed for drinking water protection.

2.3.3 Risks and hazards

Hazards and risks identified during the risk workshops undertaken in 2017 for the Proposal relate to design and construction risk and hazards. Design risks that are being further investigated relate to site-specific seismic assessments, hydraulic performance of the new spillway to cater for predicted design floods, and flood security of the dam in relation to construction stages. This is discussed further in section 6.1, 6.10 and 6.12 and would be investigated during detailed design.

During construction, likely hazards and risks include restricted access due to floods, working under flood protection structures, bushfire, hazardous substances, and working in and around dangerous machinery.

An interim Dam Safety Emergency Plan (approved by the NSW Dams Safety Committee) for the construction period that takes into account the changed conditions and operation of the dam during the works would be required, as discussed in section 6.13.

Risks and hazards associated with flooding, bushfire prone land, contaminated land, soils and potential landslips and climate change are discussed in sections 6.1, 6.8, 6.10 and 6.13.

2.4 FEASIBLE ALTERNATIVES

In 2009, Council commissioned an options study to augment the Tweed District water supply (MWH 2009), as discussed in section 2.4.1. The options study was reviewed in 2015 in conjunction with other matters prior to Council making a decision on a preferred option to augment the water supply. This was updated in 2024, as discussed in section 2.4.3.

2.4.1 Options study in 2009

The options study (MWH, 2009) considered 9 options, summarised in Table 2-3.

Table 2-3 Option consideration

Option no.	Option summary	Reason not pursued
1	Raising the existing Clarrie Hall Dam	N/A
2	New dam on Byrrill Creek	There was potential for considerable escalation of costs due to the long lead time envisaged before construction could commence.
3	New dam on Oxley River, near Tyalgum (Rocky Cutting site)	There was potential for considerable escalation of costs due to the long lead time envisaged before construction could commence. There was significant habitat for threatened flora and fauna species near the proposed site, and there would be the social impacts due to the proximity to Tyalgum. There was also the potential for flooding parts of the village and rural properties. These issues would contribute to planning approval difficulties.
4	Pipeline link to Rous Water, at Ocean Shores	This option did not meet the secure yield required (5,250 ML/annum) and established technologies and feasibility criteria. It would only be able to provide approximately 1,825 ML/annum.
5	Pipeline link to the South East Queensland Water Grid, near the Tugun desalination facility)	This option had many political and legislative difficulties due to interstate transfer of resources. These impacts would not likely be diminished during periods of prolonged drought, when alternative supplies are needed most.
6	Desalination	This option was too expensive and involved significant environmental impacts associated with disposal of brine waste.
7	Groundwater supply	This option did not meet the secure yield required (5,250 ML/annum) and established technologies and feasibility criteria. It would only be able to provide approximately 1,470 ML/annum.
8	Indirect potable reuse	This option was expensive and not socially acceptable. These issues would contribute to planning approval difficulties.
9	Direct potable reuse	This option did not meet the secure yield required (5,250 ML/annum) and established technologies and feasibility criteria. It was also expensive and not socially acceptable. These issues would contribute to planning approval difficulties.

Council, through further studies and consultation with the community, shortlisted 3 options for further consideration. Those options were:

- Raising Clarrie Hall Dam
- Byrrill Creek Dam construction
- Pipeline to the SEQ Water Grid.

The options were reconsidered by Council in 2014. The options considered were:

- Raising Clarrie Hall Dam
- Small Byrrill Creek Dam construction

- Large Byrrill Creek Dam construction
- Staged Byrrill Creek Dam construction
- Pipeline to the SEQ Water Grid
- Pipeline link to City of Gold Coast.

The consideration noted that the Byrrill Creek Dam options had been prohibited by the Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2010. The consideration also included updated costings (PWA 2015), advice from Seqwater on the costs of connection to the SEQ Water Grid and revised secure yield and demand projections. A cost risk assessment of the raised Clarrie Hall Dam option was updated by PWA in 2018 and again in 2023. Biodiversity offset costs were not included in the options assessments, and for the preferred option, offsets costs would be estimated as part of the biodiversity assessment.

Consideration of these water supply augmentation options, including analysis of environmental, social and economic factors, indicated that raising Clarrie Hall Dam was the most advantageous option to Council and the community. In December 2015, Council resolved to adopt the raising of Clarrie Hall Dam as the preferred option for future water security and proceed with the planning approval and land acquisitions phase for the Proposal.

In October 2016, Council approved the commencement of a range of investigations at Clarrie Hall Dam to further inform the Proposal team, Councillors and the community of the potential impacts of the Proposal, and to further guide decision-making in relation to a preferred option. As a result of these studies and ongoing augmentation assessments, Council is progressing the preferred option to raise Clarrie Hall Dam, consistent with the 2015 resolution.

In 2018, investigations into the biodiversity, heritage, hydrology and geology of the Proposal area were undertaken and informed the development of a concept design for the Proposal prepared by NSW PWA.

During the concept design stage completed by the PWA, 5 dam raising options were assessed:

- single-stage construction to FSL at RL 70.0 m (AHD)
- single-stage construction to FSL at RL 67.0 m (AHD)
- single-stage construction to FSL at RL 64.5 m (AHD)
- two-stage construction to FSL at RL 67.5 m (AHD), and then from FSL at RL 67.5 m (AHD) to FSL at RL 70.0 m (AHD)
- two-stage construction, to FSL at RL 64.5 m (AHD), and then from FSL at RL 64.5 m (AHD) to FSL at RL 70.0 m (AHD).

The study showed that the optimum dam size for Clarrie Hall Dam was considered to have a FSL of RL 70.0 m (AHD). Inundation mapping of the storage levels showed that above a storage level of RL 70.0 m (AHD), significant breakouts could occur in the upstream storage, which would result in the need for saddle dams. That would significantly increase the cost of the Proposal.

Cost estimates that were completed for each option showed that the single-construction option was far more economical than raising the dam in stages. It was also noted that single-stage dam raising had less impact on the surrounding environment and constructability of the works. Operation of the dam would also be disrupted further by staged dam raising. The study therefore recommended that single-stage construction to FSL RL 70.0 m (AHD) be adopted for concept design.

2.4.2 Water strategies project reference group

In March 2018, Council resolved to appoint a Project Reference Group (PRG) to undertake a comprehensive Review of the Tweed District Water Supply, Demand Management and Drought Management strategies. As per the Council resolution of March 2017, membership of the PRG was drawn from the reconvened original Community Working Group plus new Councillor representatives.

On 7 March 2019 Council endorsed the appointment of eight members and two councillors for the PRG. Four council officers initially, and then three, also worked with the PRG throughout the process.

The PRG commenced the review in March 2019 and met 19 times. As per the Terms of Reference, the PRG identified options and strategies for the three review areas, which required further investigation. The PRG prepared scopes of work for the appointment of consultants to:

- further investigate options
- review best practice in other jurisdictions
- develop strategies for consideration by the PRG.

As part of a tender process, the PRG developed consultant selection criteria and weightings to assist in assessing the selection of consultants. Council subsequently appointed two consultants, HARC and Hydrosphere Consulting to review and provide findings and recommendations regarding water supply augmentation and water demand management respectively.

The PRG reviewed the findings of the reports and presentations from the consultants. After considerable research, discussion and debate, the PRG developed options selection criteria and used qualitative multicriteria analysis to rank the priorities for water supply augmentation, and undertook detailed analysis of the water demand management and drought management issues and options. From this analysis, the PRG developed findings and recommendations for consideration by Council.

The findings of the PRG included:

- Clarrie Hall Dam and integrated water management approach – The majority of the PRG supported the raising of the Clarrie Hall Dam; and continuing the work on planning and land acquisition in accordance with the existing project schedule for this work, consistent with the Council resolution. The PRG recognised that this option is rainfall dependent and considered it should be one option as part of an adaptive strategy by Council to be considered in the context of rainfall uncertainty in the future.
- The PRG recommended that Council adopts an integrated water management approach that is climate resilient. If Clarrie Hall Dam is the short-term current choice for augmentation, then other sustainable, adaptive choices that are not reliant on rainfall capture need to be implemented for future water supply.

  The PRG also recommended these other options be further investigated while the work is progressing on planning and land acquisition for raising the Clarrie Hall Dam, to assist Council to understand the viability of other options that may improve secure yield, and diversify supply enabling less rainfall dependence.
- Byrrill Creek Dam (large and small options) – the majority of PRG members did not support pursuing this option, either a small or large dam at this site, with two PRG members supporting the commencement of planning for the Byrrill Creek Dam and leaving this option for further consideration. The PRG recommended that this option not be pursued further due to the inundation of environmentally sensitive areas of land, which will not be useable in future for either agriculture or natural environment, and the likely impact on productivity and wellbeing

of the community as a result of this option. In addition, another dam is also rainfall dependent, like the Clarrie Hall Dam.

- Other options – the PRG recommended proceeding with construction of the mini link between the Tweed and City of Gold Coast and investigation of the feasibility of a desalination plant or linking to the existing Tugun plant as a matter of urgency as such a supply is not reliant on rainfall.

2.4.3 Review of strategic water supply options report 2024

In 2024, Council engaged Stantec to review the rankings of the water supply augmentation options previously identified to confirm (or otherwise) the raising of Clarrie Hall Dam was the most appropriate option to augment the Tweed District Water Supply. This options review was documented in the Review of Strategic Water Supply Options Report (Stantec 2024).

The review methodology included the following tasks to determine the preferred option for water supply augmentation:

- a simplified financial assessment using net present cost (NPC) to ensure all options were comparable on a financial basis
- a multi-criteria assessment (MCA).

The assessments considered the following 3 options:

- Raise Clarrie Hall Dam
- Desalination Plant
- Link to SEQ Water.

A description of the options is provided in Table 2-3.

Whilst other options were considered in previous studies, the MCA acknowledged that Byrrill Creek Dam and the Mini-Link between the Tweed and City of Gold Coast were not considered as viable options due to feasibility issues, inability to meet security of yield, cost, and/or constructability, approvals, environmental and socials constraints.

Multi-criteria assessment

An MCA framework was developed to compare the 3 options, using the following criteria:

- financial – a quantitative assessment based on the NPC outcomes
- technical/deliverability – a qualitative assessment that considered:
  - construction complexity and timing risks
  - ease of operation
  - resilience and reliability
  - security
- planning and approvals – a qualitative assessment that considered:
  - adaptability and sensitivity to possible future impacts of climate change and lower flows
  - planning approvals complexity
  - native title impacts
- sustainability and environment – a qualitative assessment that considered:

  - environment and heritage values – impacts to environment, and Aboriginal and cultural heritage
  - greenhouse gas emissions – assessed based on power consumption
  - waste production – levels of solid or liquid waste generated over the lifetime of an option
- social and community – a qualitative assessment that considered:
  - residential and local communities – impact to nearby residents in the form of noise, traffic, odour
  - social licence – level of community support / acceptance.

Each option was assessed and given a score of 1 to 5 against each criterion, with a score of 1 reflecting a least favourable outcome and a score of 5 reflecting a the most favourable outcome. The results are shown in Table 2-4.

Table 2-4 Options description and MCA outcomes

Option	Summary	MCA outcomes	Ranking
Raise Clarrie Hall Dam	This option involves raising the dam wall height by 8.5 m to 70 m AHD, which is equivalent to its full supply level (FSL) by 2028. The assessment completed by NSW Urban Water Services in November 2021 as part of the Clarrie Hall Dam Yield Study Report estimates an increase in dam capacity from 16,000 megalitres (ML) to approximately 42,300 ML due to the dam raise. For the Review of Strategic Water Supply Options Report, the increased supply capacity resulting from the raising of Clarrie Hall Dam is assumed to be approximately 30 ML/day.	Lowest NPC value MCA score: 82.2	1
Desalination Plant	This option consists of construction of a reverse osmosis desalination plant at Kingscliff in 2 stages; 2 x 15 ML/day. The assessment completed by HARC in October 2020 as part of the WSR Review of Water Augmentation Strategy identifies 2 possible sites for the desalination plant – Hastings Point or Kingscliff. This would require a 3.1 km intake pipeline to be constructed at the mouth of the Cudgen Creek to draw sea water to the desalination plant located at the treatment plant south of Kingscliff near the north of Bogangar beach	Middle NPC value MCA score: 54.2	2
Link to SEQ Water	Also known as the Maxi-Link, this option connects the Seqwater water network and Tweed Shire to allow a transfer of water between the 2 systems via a pipeline and a pump station. This option involves a connection from Seqwater's Network Integration Pipeline (NIP) at Bilinga reservoir and TSC's Banora Point reservoir. The pipeline system allows for approximately 36 ML/day; however, for the purposes of the Review of Strategic Water Supply Options Report, the daily flow (excluding losses in transfer) is assumed to be approximately 30 ML.	Highest NPC value MCA score: 52.2	3

The MCA determined that Option 1 – Raising Clarrie Hall Dam was the preferred option as it has the lowest NPC value and offers the best technical and deliverability outcomes.

2.4.4 Justification of the raising of Clarrie Hall Dam as the preferred option

The preferred dam raising option incorporates increasing the height of the existing concrete faced rockfill embankment and constructing a new concrete lined spillway higher up in the left

abutment. The existing intake tower and access bridge would also be raised. Updates to the existing tunnel, valves and control systems will be confirmed during detailed design.

The Far North Coast Regional Water Strategy (DPE 2023a) shows that Clarrie Hall Dam inflows are likely to reduce by 5% due to climate change and by 34% under extreme dry conditions. Council has limited water storage available, with 12–18 months of water storage available for major urban supplies of the Far North Coast. In drought situations, local councils would have to rely on emergency supplies, which can have long lead times (12–24 months). This would mean that emergency supplies would have to be organised very early on in the drought. Specifically for Clarrie Hall Dam in its current state, Council would need to plan for emergency supplies once Clarrie Hall Dam drops to 97% capacity. Climate change modelling predicts reduced inflows leading to dam levels dropping faster. If the Proposal is not carried out, models suggest that by 2030 emergency augmentations would need to be planned by Council when Clarrie Hall Dam is completely full.

2.5 CUMULATIVE IMPACTS

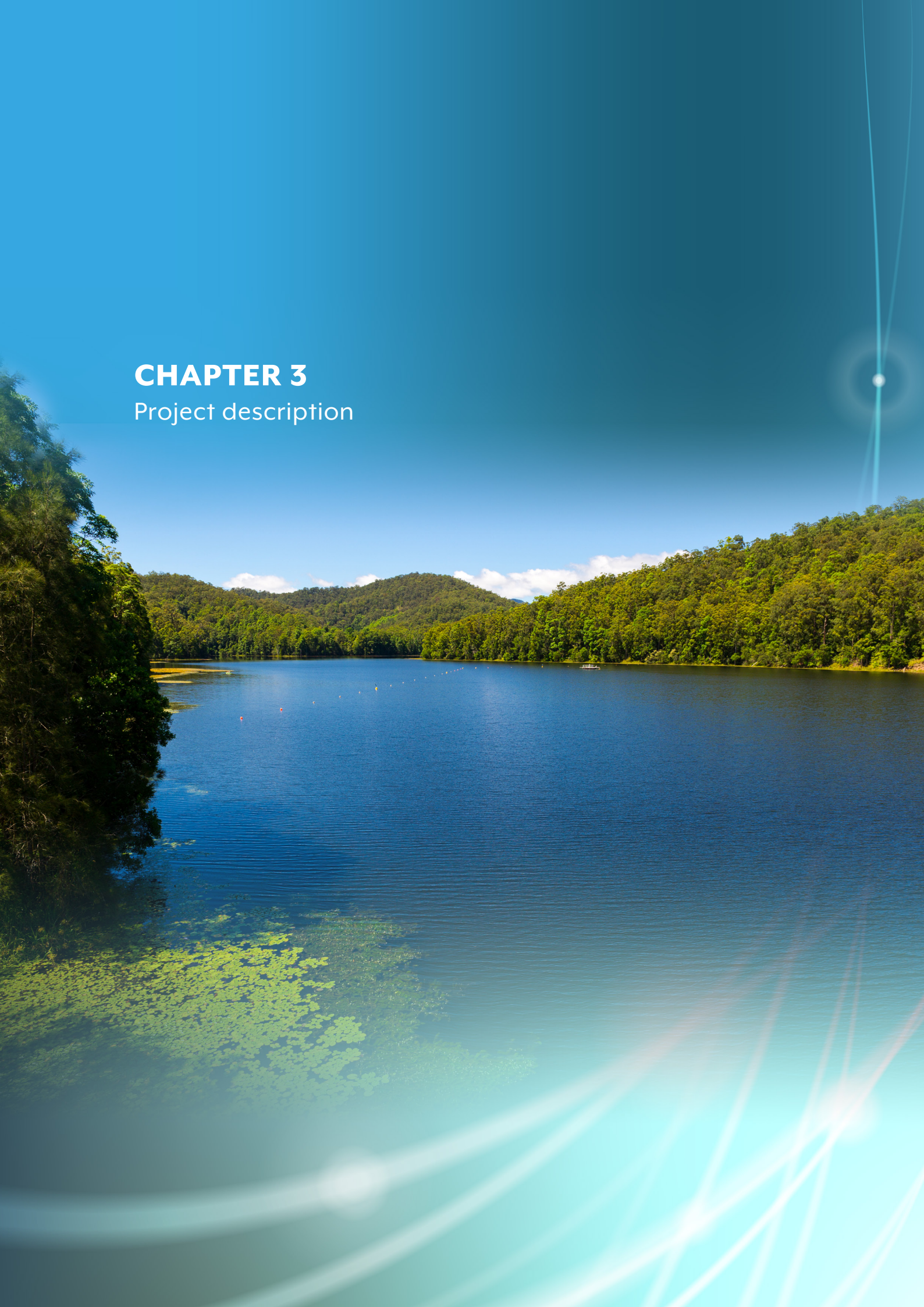
A cumulative impact assessment has been undertaken in accordance with the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPE 2022b). This is discussed in section 6.15.

The key findings of the cumulative impact assessment determined that the Proposal would result in cumulative impacts to biodiversity and Aboriginal heritage. This is due to a loss of native vegetation and Aboriginal sites or objects as a result of the Proposal and other development within the Tweed Shire region. These impacts can be mitigated through the implementation of management measures during the development, construction and operation of the Proposal. Specific to the proposal, a biodiversity offset strategy would be developed by Council to reduce impacts to the biodiversity of the Tweed Shire region and specific management measures for the protection and conservation of Aboriginal objects in collaboration with registered Aboriginal parties.

The Proposal would not significantly involve any material cumulative impacts in relation to other future projects in the region.

2.6 EXISTING AGREEMENTS

The proposed raising of Clarrie Hall Dam would require the acquisition of inundated land and would include a 7 m maintenance zone above RL 77 m. All landholders affected by the proposed raising of Clarrie Hall Dam have been approached to discuss and resolve property acquisitions, boundary adjustments including fencing realignments, gates, and any other special requirements such as temporary leases. The partial acquisition of two remaining properties is outstanding. All other property, to be impacted by the raised dam, is now owned by Tweed Shire Council.



CHAPTER 3
Project description

3 Project description

This chapter describes the key components of the concept design required to build and operate the Proposal.

Tweed Shire Council proposes to raise the wall (embankment) of Clarrie Hall Dam by 8.5 m, thereby increasing the capacity of the dam from 16,000 ML to approximately 42,300 ML.

The EIS must provide the project description to address the SEARs as shown in Table 3-1.

Table 3-1 SEARs requiring project description information

Relevant key issue requirement/s	Where addressed
The Environmental Impact Statement (EIS) must meet the minimum form and content requirements in Section 190 and Section 192 of the *Environmental Planning and Assessment Regulation 2021* and must have due regard to the *State Significant Infrastructure Guidelines*.	Entire EIS
The EIS must include, but not necessarily be limited to, the following:	-
a) An executive summary	Executive summary
b) A full description of the water storage and associated infrastructure proposed (the project), including:	Chapter 3
i) The design for the project that is proposed to be constructed and operated including: the strategic objectives of the proposal; the size, volume and type of the operation; the nature of any treatment processes, products, by-products and wastes produced.	Sections 3.1, 3.2 and 3.6
ii) Details of all components, disturbance areas, materials, activities, site preparation and construction infrastructure required to construct the project, including any ancillary development that may require separate approvals.	Sections 3.2, 3.3 and 3.4
iii) A construction timetable and staging; hours of construction, proposed construction methods, including any earthworks or site clearing, reuse and disposal of cleared material.	Sections 3.5.1, 3.5.2, 3.5.3 and 3.5.10
iv) Details of the operation of the project, and associated infrastructure that is proposed to be constructed.	Section 3.6
v) Site plans, maps, drawings and diagrams at an adequate scale with dimensions in an electronic format that enables integration with mapping and other technical software, showing: – The location and dimensions of all project components. Include a site diagram showing the site layout and location of environmental controls and proximity to water resources. – Existing infrastructure, land use, and environmental features, as well as details of any acquisitions or easements that may be required.	Figure 1-2 and Figure 3-1 to Figure 3-22
vi) The likely interactions between the project and any other existing, approved, proposed, reasonably foreseeable development in the vicinity of the site, including an assessment of the cumulative impacts on the environment.	Section 6.15

3.1 PROJECT OVERVIEW

In 2018, a detailed concept design (Appendix B) was prepared by NSW Public Works Advisory (PWA). The options assessment and detailed concept design for the raised dam and its components were based on hydrological studies, geotechnical investigations, and seismic and structural assessments. The preferred option for the dam raising incorporates increasing the height of the existing concrete faced rockfill embankment and constructing a new concrete lined spillway higher up in the west abutment. The existing intake tower and access bridge would also be raised.

The optimum size of the proposed raised Clarrie Hall Dam is 42,300 ML, based on raising the dam wall height by 8.5 m to a height of RL 70 m AHD. The raised dam would, as a result, provide adequate water supply to the Tweed Shire until at least 2065. Raising the wall height further was not considered feasible due to topographical constraints in the catchment.

The detailed concept design includes:

- constructing access roads to construction areas and establishing the construction site
- re-establishing the quarry used to construct the existing dam
- removing and storing parapet walls for reuse
- increasing the base width of the valley-side abutment and raising the crest of the concrete faced rockfill embankment to RL 70 m
- constructing a new concrete lined spillway higher on the west abutment
- extending the upstream concrete face to the new crest height
- raising the intake tower and access bridge
- constructing a new section of the Clarrie Hall Dam Road to provide access to the east abutment of the dam wall
- establishing new recreation and operational facilities including an amenities block, public shelters, viewing areas, interpretation signage, paths, car parks, landscaping, security fences, lighting, monitoring equipment and a boat ramp.

The detailed Concept Design Report is provided in Appendix B.

The operational footprint of the upgraded dam would increase the area of inundation to below the RL 70 m contour, which is the waterline boundary at full supply level (FSL).

In addition, construction activities for ancillary works would include:

- upgrading the Kyogle Road and Clarrie Hall Dam Road intersection
- replacing McCabes Bridge and realigning Commissioners Creek Road
- removing or reconstructing impacted infrastructure and facilities at Crams Farm
- relocating Telstra assets
- realigning powerline easements along Doon Doon Road and Commissioners Creek Road.

Further work has recently been completed that identified options for locating workers accommodation, the concrete batching plant and site offices during construction. These locations are discussed in sections 3.3.8 and 3.5.3.

A summary of the main elements of the Proposal is shown in Table 3-2. An overview of the Proposal is provided in Figure 3-1 to Figure 3-3.

Table 3-2 Proposal summary

Project element	Summary of the Project
Operation	
Description	Raising the embankment wall of Clarrie Hall Dam by 8.5 m
Operational footprint	Approximately 209 ha for the proposed FSL Approximately 248 ha for the area between the proposed FSL and the PMF.
Dam wall infrastructure	• Increasing the base width of the valley-side abutment and raising the crest of the concrete faced rockfill embankment to RL 70 m • Constructing a new concrete lined spillway higher on the west abutment • Extending the upstream concrete face to the new crest height • Raising the intake tower and access bridge • Constructing a new section of the Clarrie Hall Dam Road to provide access to the east abutment of the dam wall • Establishing new recreation and operational facilities including an amenities block, public shelters, viewing areas, interpretation signage, paths, car parks, landscaping, security fences, lighting, monitoring equipment and a boat ramp.
Ancillary works	• Upgrading the intersection of Clarrie Hall Dam Road and Kyogle Road • Replacing McCabes Bridge over Doon Doon Creek • Realigning an approximately 1,000 metre section of Commissioners Creek Road • Removing or reconstructing impacted infrastructure and facilities at Crams Farm • Realigning overhead power lines and Telstra assets.
Construction	
Construction impact area	Approximately 49.6 ha, consisting of 26.2 ha at the dam wall, 6.6 ha of construction compound and workers accommodation areas and 16.8 ha of ancillary sites for road realignments and relocating overhead power lines. There is an overlap of approximately 8 ha for the construction and operational impact areas. The removal of the existing overhead power line is not included in the impact area.
Workforce	Estimated peak of 180 persons at the main dam wall site.
Cut/fill	Approximately 100,000 m^3 to 110,000 m^3 (minimum) of fill material would need to be derived from the quarry adjacent to the existing dam. Further information is provided in section 3.5.1.
Ancillary works	• Constructing access roads to construction areas and establishing the construction site • Re-establishing the quarry used to construct the existing dam • Establishing a concrete batching plant • Establishing construction compounds including site offices and areas for materials stockpiling • Establishing a workers accommodation site compound.
Dam drawdown	Lowering dam storage by approximately 300 mm below FSL during construction
Property	Permanent and temporary property adjustments and property access refinements
Capital investment value	Approximately $304 million

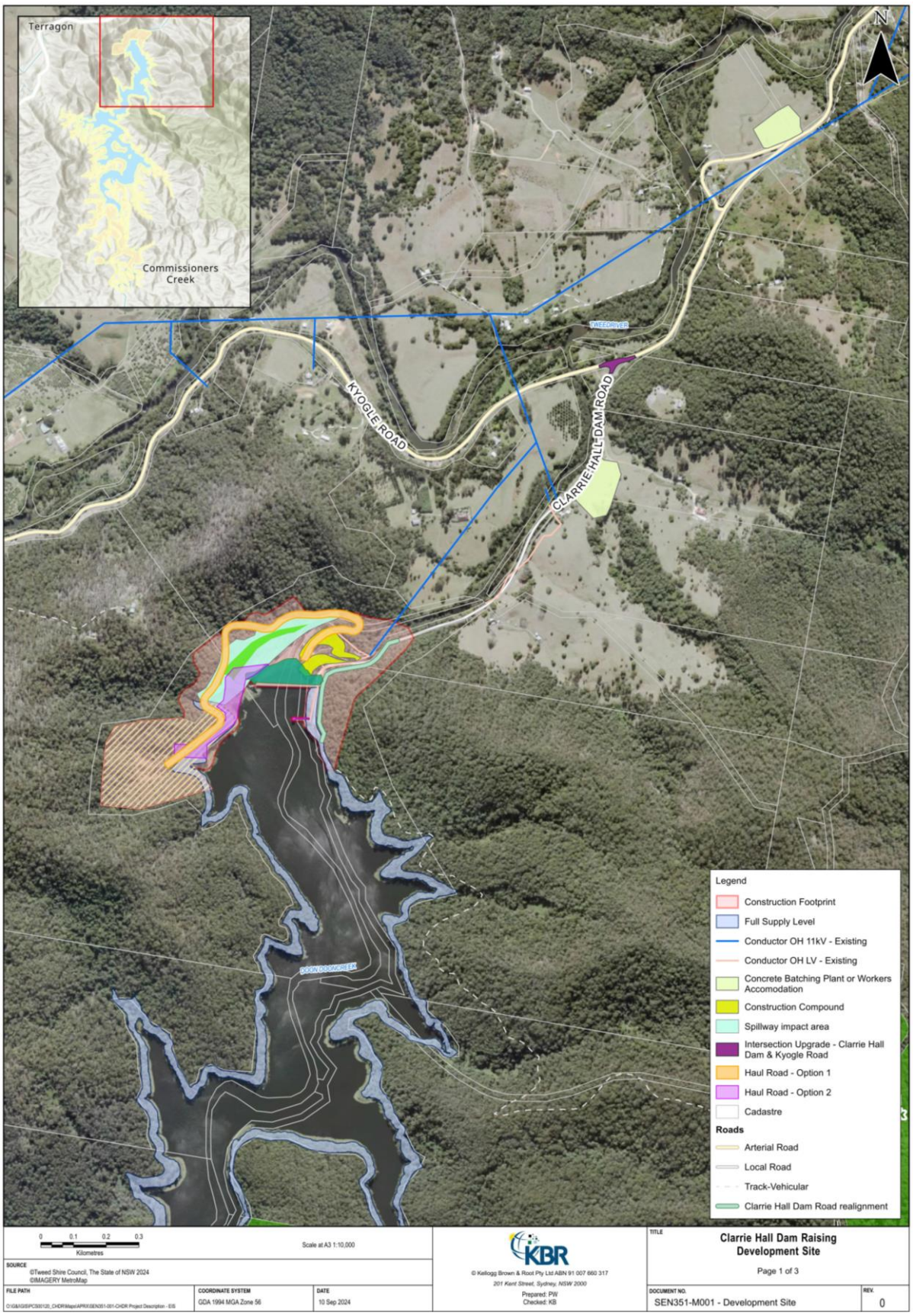


Figure 3-1 Proposal overview – northern section

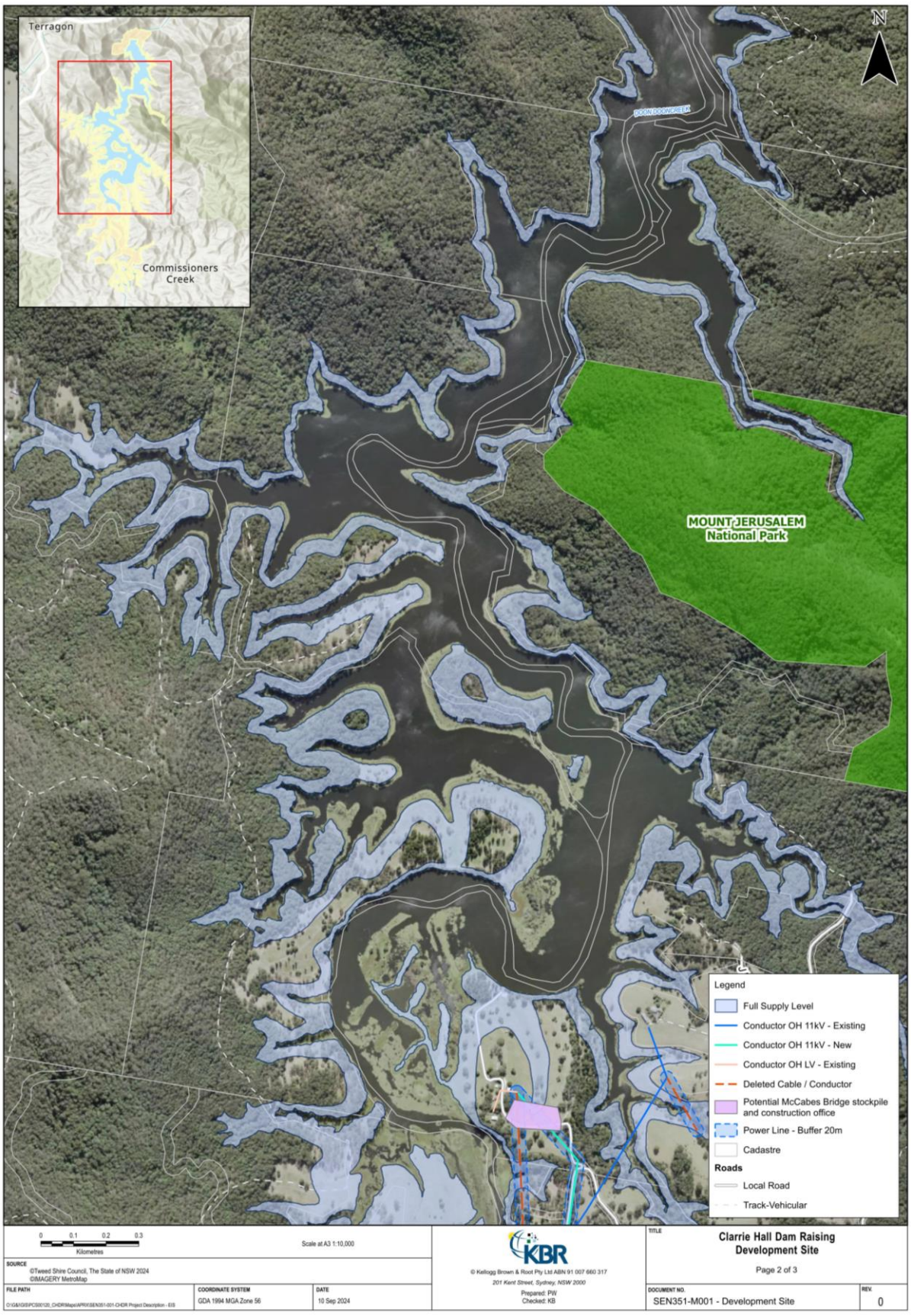


Figure 3-2 Proposal overview – central section

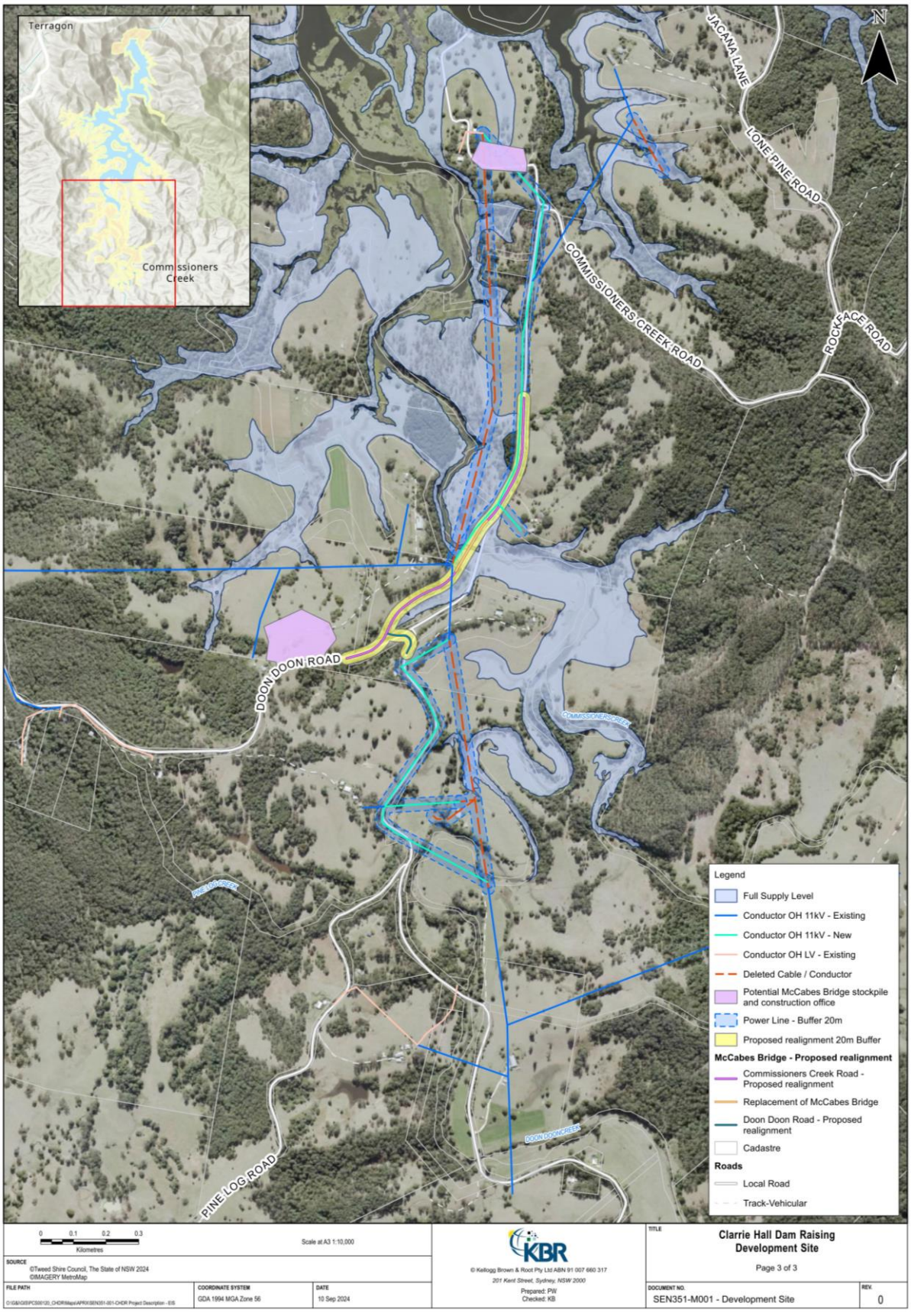


Figure 3-3 Proposal overview – southern section

3.2 DAM RAISING INFRASTRUCTURE

The detailed concept design for the dam wall raising, including the spillway, embankment and intake tower, is shown in Figure 3-5 to Figure 3-8.

Further design details of these elements are provided below.

3.2.1 Spillway

The existing spillway would be covered over by the raised embankment. To ensure the dam has suitable discharge capacity, a new spillway channel has been designed to pass the probable maximum flood (PMF), which is a peak water level of 76.94 m AHD. The new spillway is proposed to be located higher in the western abutment, as shown in Figure 3-1 and Figure 3-4. The proposed new spillway channel is a fully concrete lined structure. The new spillway crest is designed at RL 70.0 m AHD, which corresponds to the FSL of the raised dam. The spillway crest design is 40 m wide, and the spillway channel would reduce to 15 m wide at the downstream end, with a flip bucket as the terminal structure.

3.2.2 Embankment

Raising of the concrete face rockfill embankment is proposed, as shown in Figure 3-1 and Figure 3-4.

The new top of the parapet walls on the embankment wave wall crest would be at RL 77.0 m AHD to retain the PMF. The crest pavement level behind the parapet wall would be at RL 75.5 m AHD, and the crest pavement width would be 5 m.

The embankment upstream and downstream slopes would be 1.3H to 1V, matching the existing embankment slopes.

3.2.3 Intake tower, access bridge and hoist house

The intake tower is used to draw water out of the reservoir via the operation of stop boards, where water flows through to the outlet pipe into Doon Doon Creek. The valves in the outlet structure control the flow of water into Doon Doon Creek. The existing intake tower, which consists of a vertical reinforced concrete circular shaft, is proposed to be raised by 8.5 m, resulting in a total height of the proposed intake tower of 42.15 m. The raised tower would incorporate 3 additional water inlet ports, for a new total of 11 water inlet ports, to facilitate selective water withdrawal. The raised tower would support a series of trash racks and shutters with a crane over the tower deck to support the manoeuvring of the components.

The access bridge enables safe access to the intake tower. The current intake tower access bridge consists of 2 unequal spans 16 m and 28 m long, supported by a reinforced concrete pier and abutment block. The existing bridge is to be dismantled, and an additional pier and abutment will be added alongside a new third span of the bridge. The existing first and second spans of the bridge would be reused and placed on the extended piers to match the raised height of the intake tower. The location of the intake tower is shown in Figure 3-4.

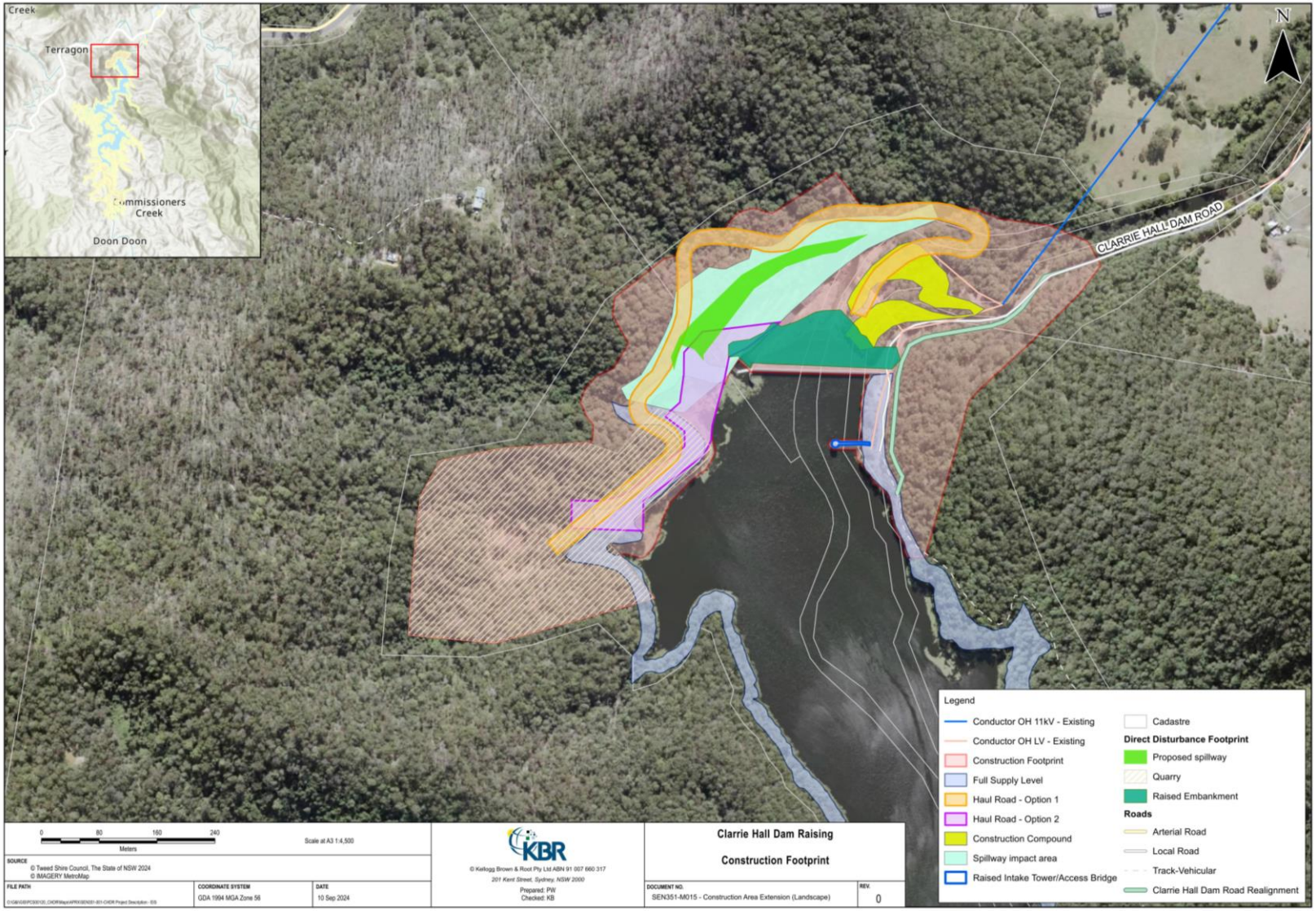


Figure 3-4 Embankment construction area

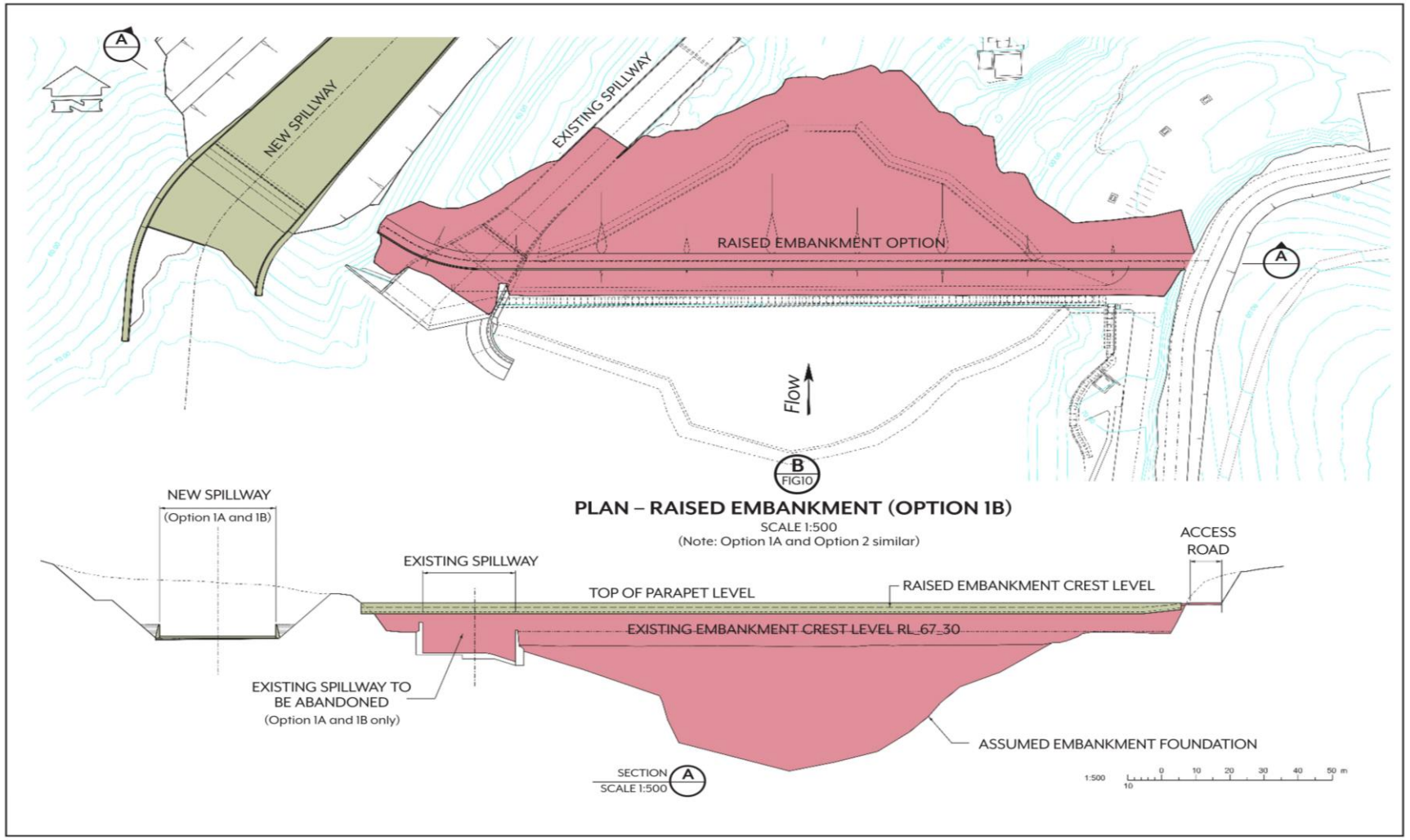
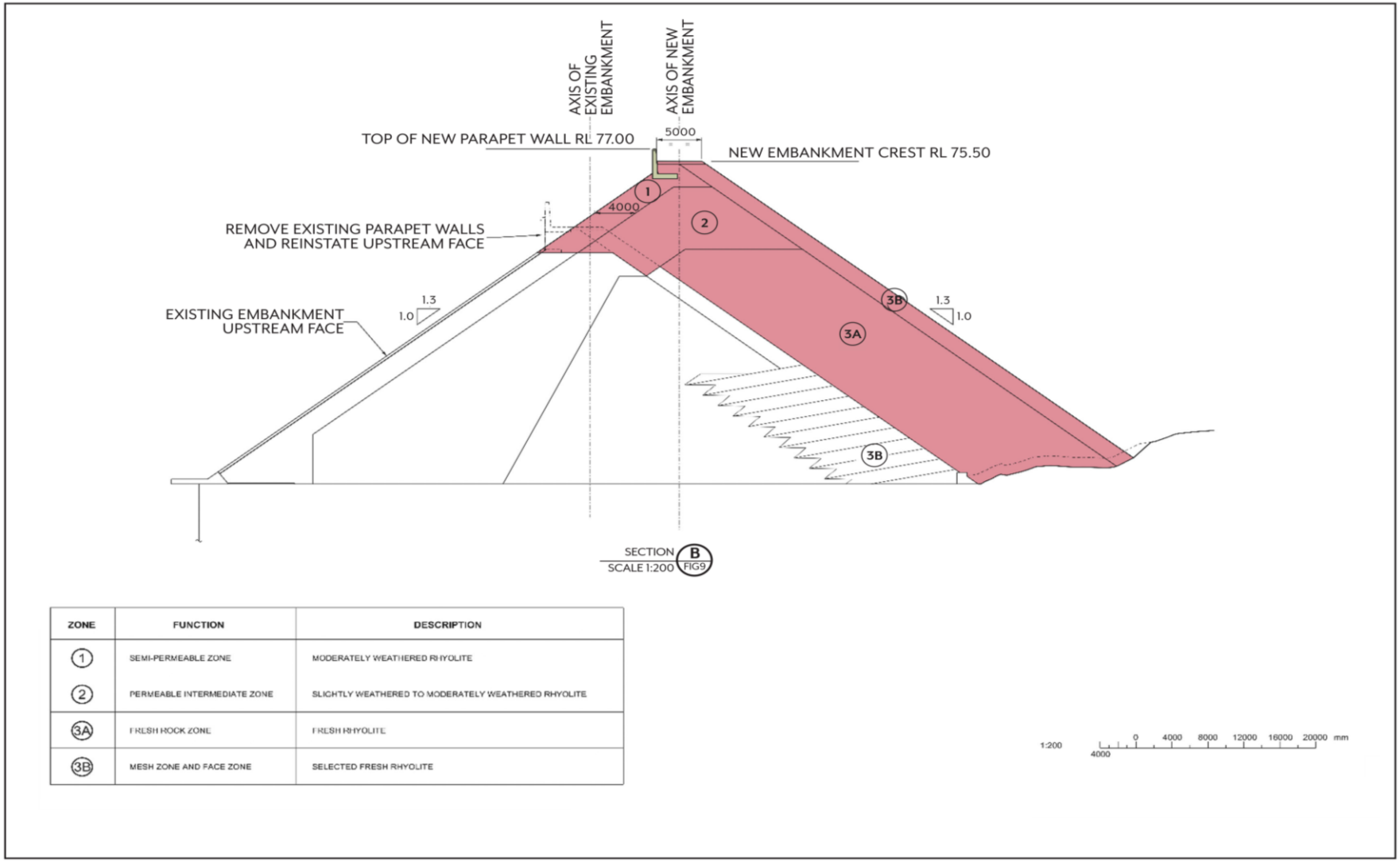


Figure 3-5 Concept design for the raised dam wall and new spillway

Source: PWA 2018



ZONE	FUNCTION	DESCRIPTION
1	SEMI-PERMEABLE ZONE	MODERATELY WEATHERED RHYOLITE
2	PERMEABLE INTERMEDIATE ZONE	SLIGHTLY WEATHERED TO MODERATELY WEATHERED RHYOLITE
3A	FRESH ROCK ZONE	FRESH RHYOLITE
3B	MESH ZONE AND FACE ZONE	SELECTED FRESH RHYOLITE

Figure 3-6 Concept design for the raised dam wall

Source: PWA 2018

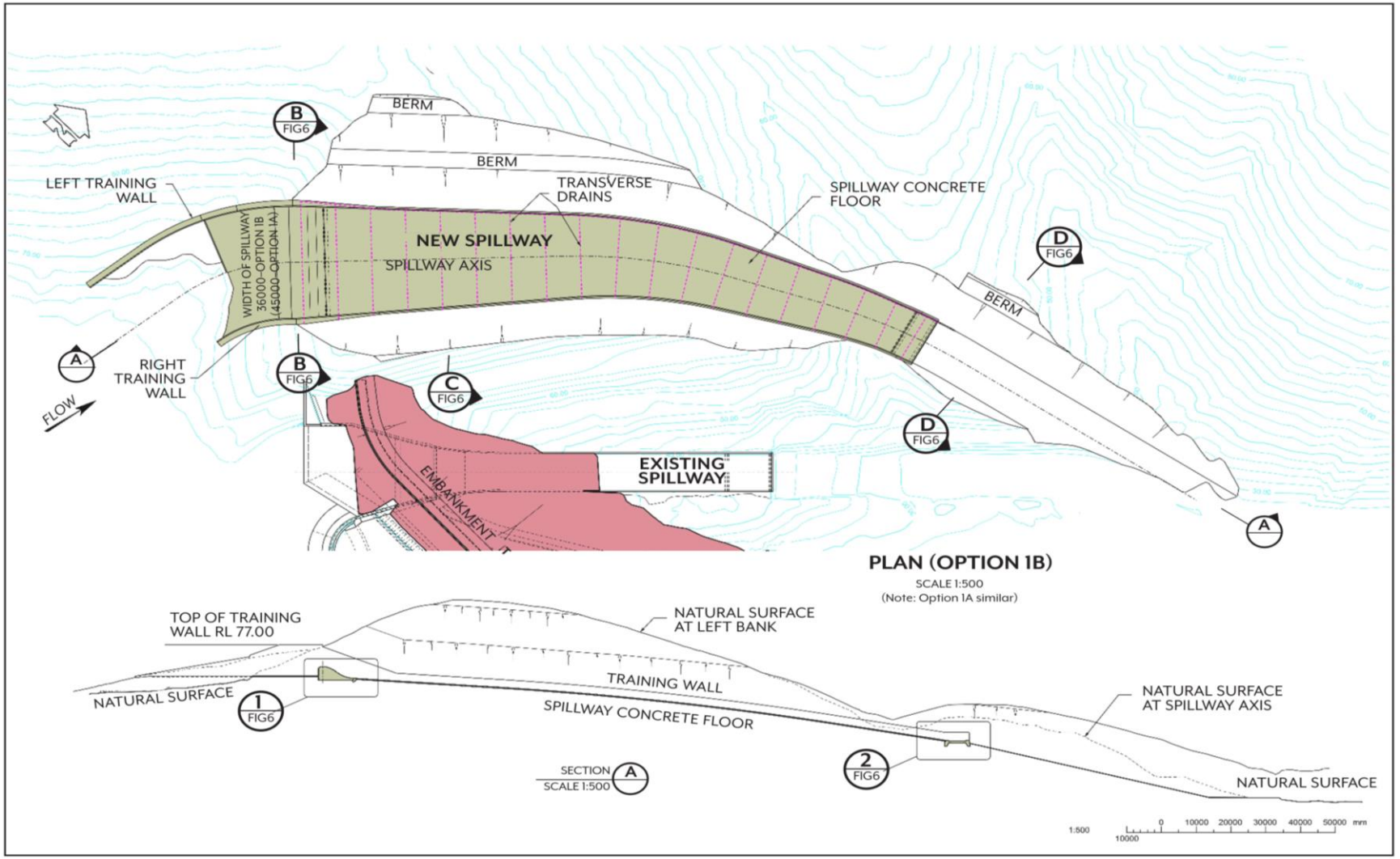


Figure 3-7 Concept design for the proposed new spillway

Source: PWA 2018

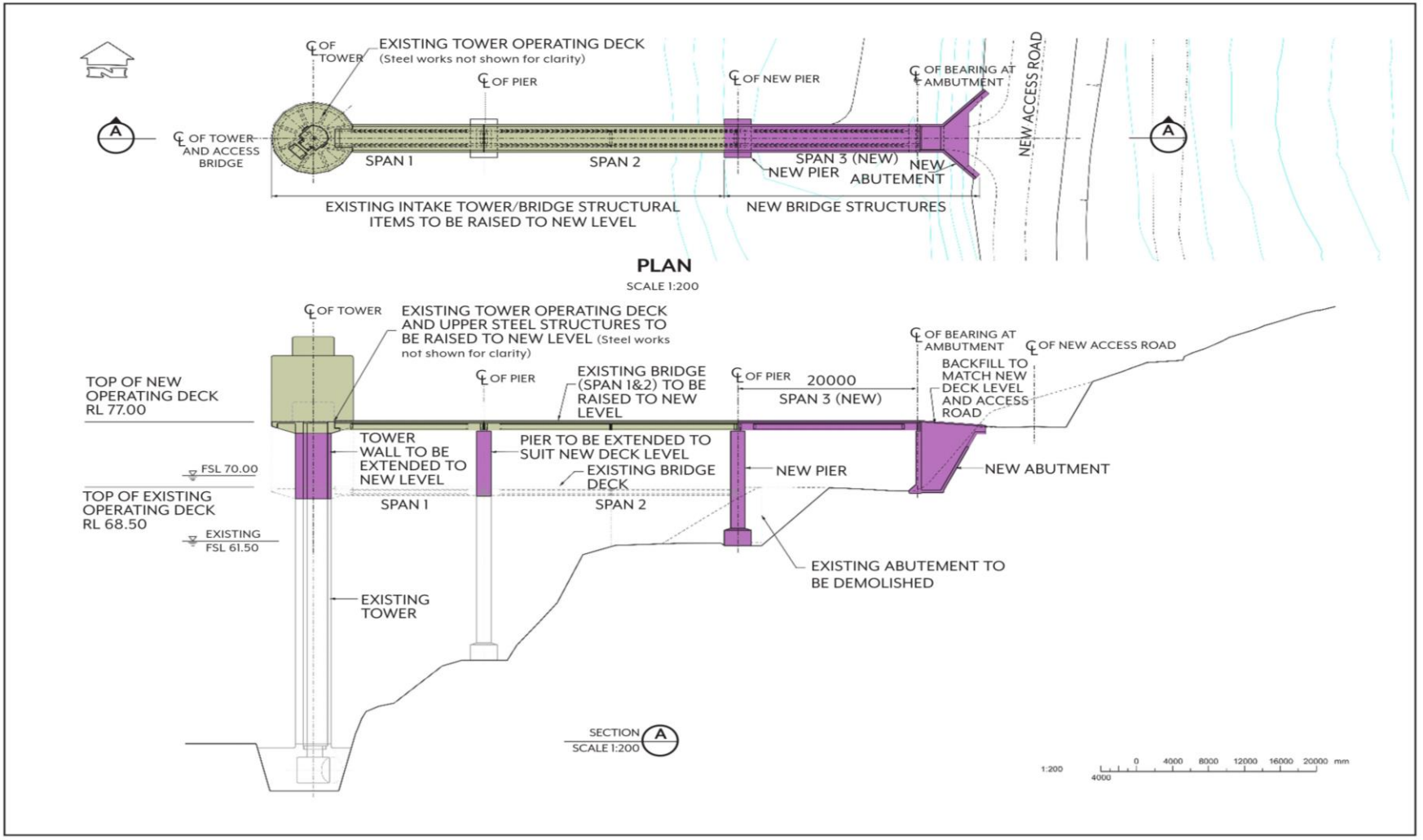


Figure 3-8 Concept design for the proposed new intake tower

Source: PWA 2018

3.3 ANCILLARY INFRASTRUCTURE

This section provides a description of the proposed temporary and ancillary infrastructure and activities that would enable the construction of the Proposal.

3.3.1 Quarry and haul road

A quarry was established during construction of the existing Clarrie Hall Dam to supply the required volumes of suitable rockfill material. The quarry is located approximately 300 m upstream of the existing dam wall, as shown in Figure 3-9. The quarry would be re-established and expanded to supply material required for the Proposal.

The area shown in Figure 3-9 contains 2 zones within the quarry: a primary site, referred to as Zone 1, and a secondary site to the north, referred to as Zone 2. This is to allow flexibility in quarry development to ensure adequate material can be sourced.

Haul roads suitable for heavy vehicles would be required to transport rockfill material between the quarry site and the dam wall embankment. Two haul route options are proposed, as shown in Figure 3-4. Discussion on the haul road options during construction is provided in section 3.5.7.

3.3.2 Clarrie Hall Dam Road realignment

A section of Clarrie Hall Dam Road would be upgraded to ensure alignment of the road with the new FSL, higher in the landscape (See Figure 3-4).

3.3.3 Upgrade to Kyogle Road and Clarrie Hall Dam Road intersection

An assessment of the Kyogle Road and Clarrie Hall Dam Road intersection was conducted as part of the traffic impact assessment discussed in section 6.13. The assessment found that temporary traffic management measures for may be required for this intersection during construction – this would be reviewed during detailed design. This intersection is shown in Figure 3-10.

3.3.4 Recreational facilities – Crams Farm

The proposed FSL would inundate areas of Crams Farm (refer to Figure 3-11). It is proposed to either remove or relocate various infrastructure, such as the boat ramp, pontoon, signage and access roads.

No inundation of the amenity facilities, picnic shelters, Bails and Dairy or Doon Doon Hall would occur.

The access road at Crams Farm would be inundated at PMF (refer to Figure 3-13).

3.3.5 Recreational facilities – dam wall area

The existing recreational infrastructure located in downstream construction areas would be relocated or removed. Upon completion of the dam raising, the construction laydown area would no longer be required. Therefore, the area would be developed into a new recreational and operational facilities area including amenities block, public shelters, viewing areas, interpretation signage, pathways, car parking, landscaping, security fencing and lighting. Dam operations monitoring equipment would be installed, and the boat ramp would be relocated to align with the new access road.

3.3.6 McCabes Bridge and Commissioners Creek Road realignment

The construction disturbance area of the McCabes Bridge and Commissioners Creek Road realignment is shown in Figure 3-11.

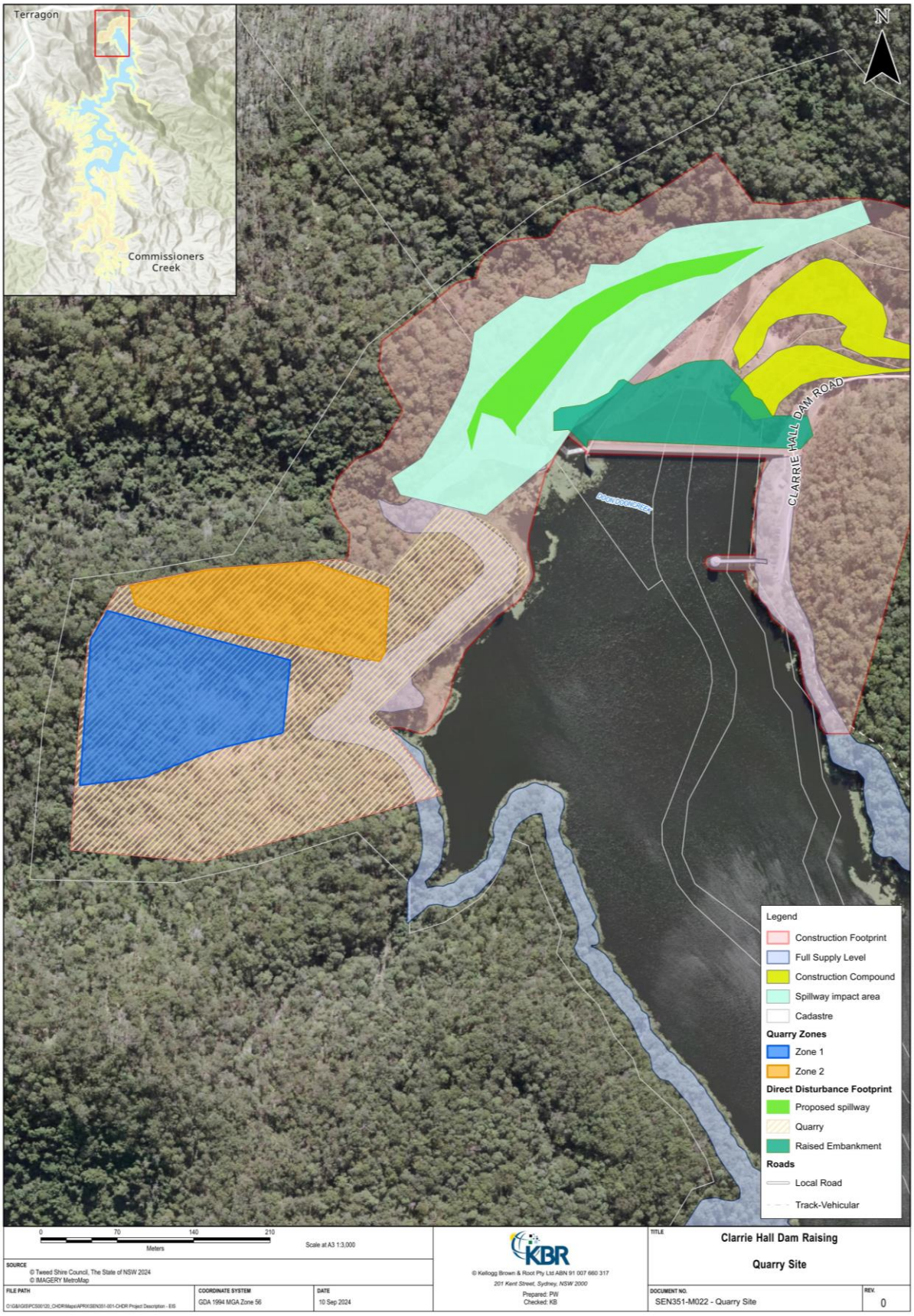


Figure 3-9 Quarry site

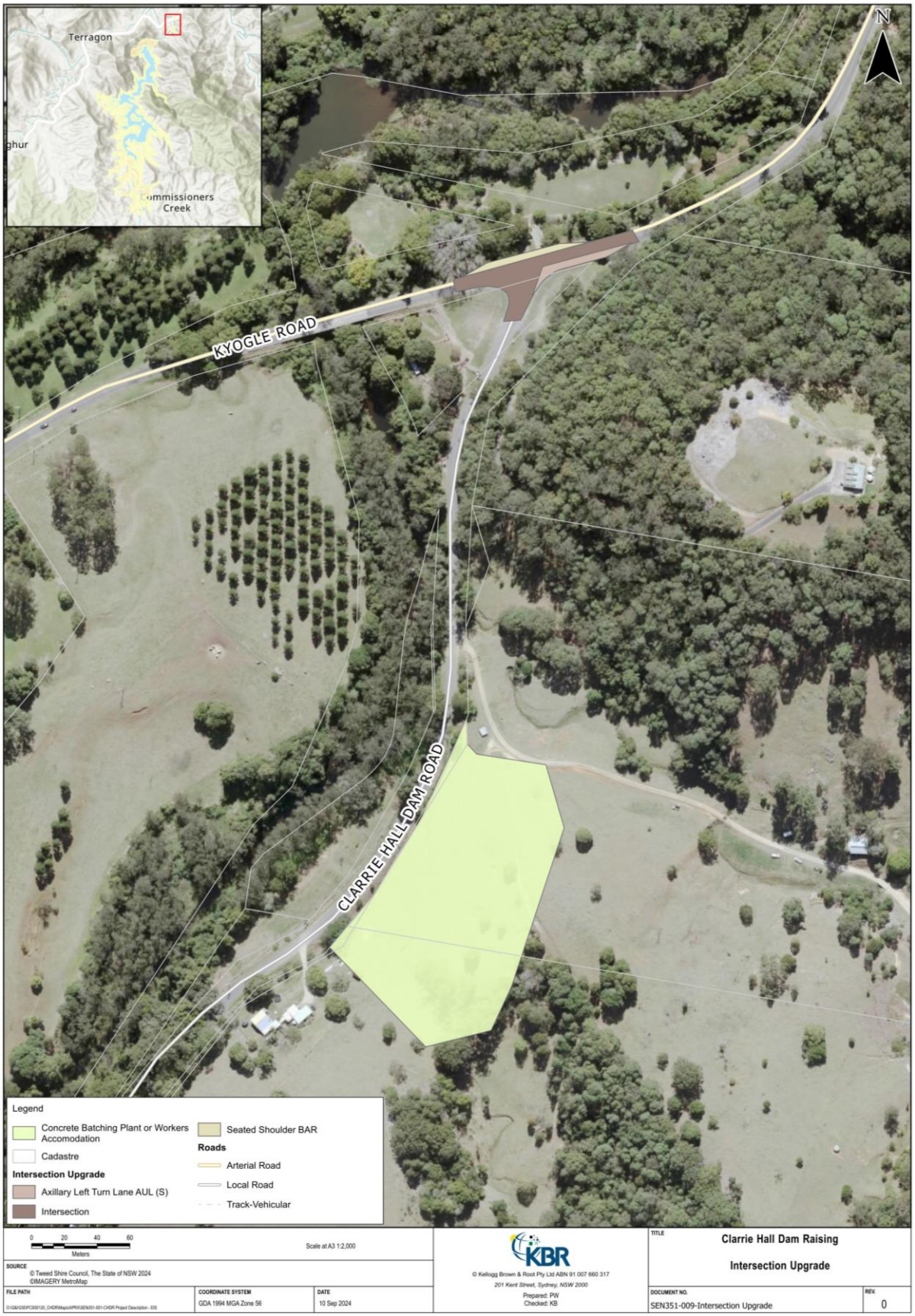


Figure 3-10 Kyogle Road and Clarrie Hall Dam Road intersection area

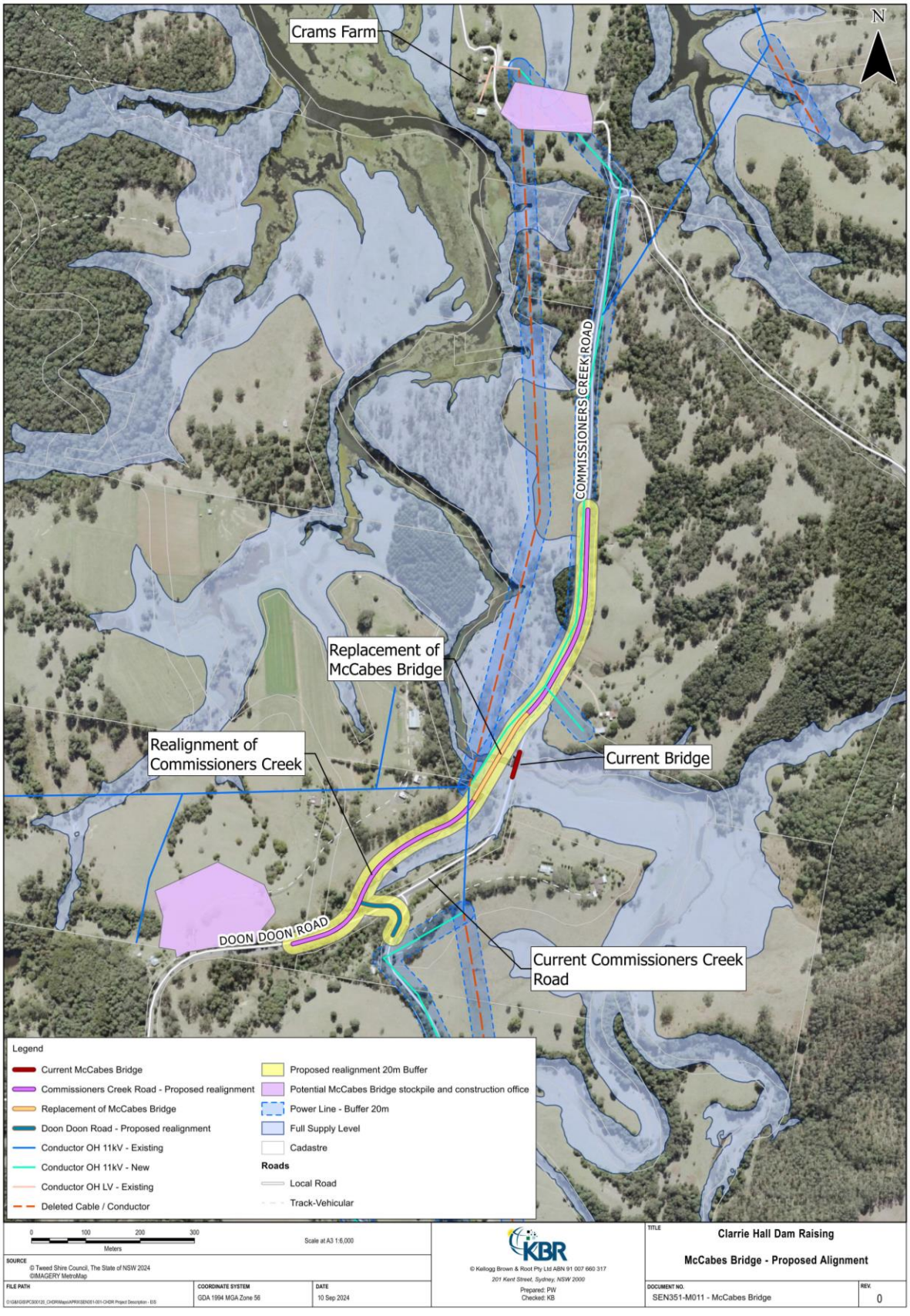


Figure 3-11 Construction disturbance footprint of the McCabes Bridge and Commissioners Creek Road realignment

3.3.7 Utilities

At the southern end of the dam, some existing service provision assets are located within the proposed FSL area. Telstra assets located within the FSL near Doon Doon Road and Commissioners Creek Road would be relocated. Powerlines located within or crossing over the proposed FSL would be realigned to ensure continued power supply to local residents, as shown in Figure 3-3. New poles and connections would be located along the roadside for sections of Doon Doon Road and Commissioners Creek Road.

Relocation of the water supply to public toilets and other facilities may also be required.

3.3.8 Timber harvesting within the FSL

Timber harvesting of some existing plantation areas would occur, including harvesting some selected trees for fencing establishment purposes. Other areas within the FSL may be cleared with stumps retained for soil stabilisation purposes in addition to reducing impacts to water quality, aquatic ecology and greenhouse gas impacts. The areas proposed for vegetation clearing would be determined during detailed design and would be based on information provided in sections 6.2 and 6.8.

3.3.9 Construction compounds

Options for the location of construction site offices, construction compounds, laydown areas and other facilities associated with the main construction area are shown in Figure 3-12. Each of these sites has been assessed as part of the construction disturbance footprint throughout the EIS.

Concrete batching plant

Two options are proposed for the location of a concrete batching plant, as shown in Figure 3-12. The concrete batching plant requires a minimum area of 5,000 m^2. This includes areas for the batching plant, silos, conveyors, material bins, offices, material stockpiles and yard, delivery and concrete truck movement and circulation.

The 2 options are located north of the main construction area at the dam wall along Kyogle Road/Tarcoola Lane and Clarrie Hall Dam Road. These options were selected based on available areas, proximity to the main construction area, consultation with landowners, and accessibility of the site from nearby roads.

Site-office compound

The main site-office complex could be located as one complex or as multiple discrete elements.

Each work zone will likely have its own satellite offices and facilities in addition to the main office complex.

The options proposed for the location of the main site office are shown in Figure 3-12 within the construction footprint.

2 construction compound site options are proposed for the works associated with the replacement of McCabes Bridge. The two options are located; one on Crams Farm and another along Doon Doon Road, as shown in Figure 3-11.

Workers accommodation

The number of workers per activity based on the concept design construction schedule was estimated to be a peak workforce of around 180 persons at the main dam site.

The local towns of Uki, 5 minutes from Clarrie Hall Dam, or Murwillumbah, 20 minutes from Clarrie Hall Dam, do not have sufficient hotels or other accommodation that could provide sufficient temporary workers accommodation.

Tweed Heads and other coastal areas would offer suitable accommodation options; however, 50 minutes travel time or more to and from site may be considered excessive and may potentially lead to fatigue and safety issues both onsite and whilst travelling. A shuttle bus service is an option to mitigate this risk. However, the logistics of these services are complex and are often not fully utilised by workers.

Therefore, onsite temporary workers accommodation has been considered. Two options are proposed for the location of the workers accommodation, as shown in Figure 3-12. The 2 options are located north of the main construction area at the dam wall along Kyogle Road/Tarcoola Lane and Clarrie Hall Dam Road. These options were selected based on available areas, proximity to the main construction area, consultation with landowners, and accessibility to the site from nearby roads. A review of accommodation site locations will be conducted during detailed design.

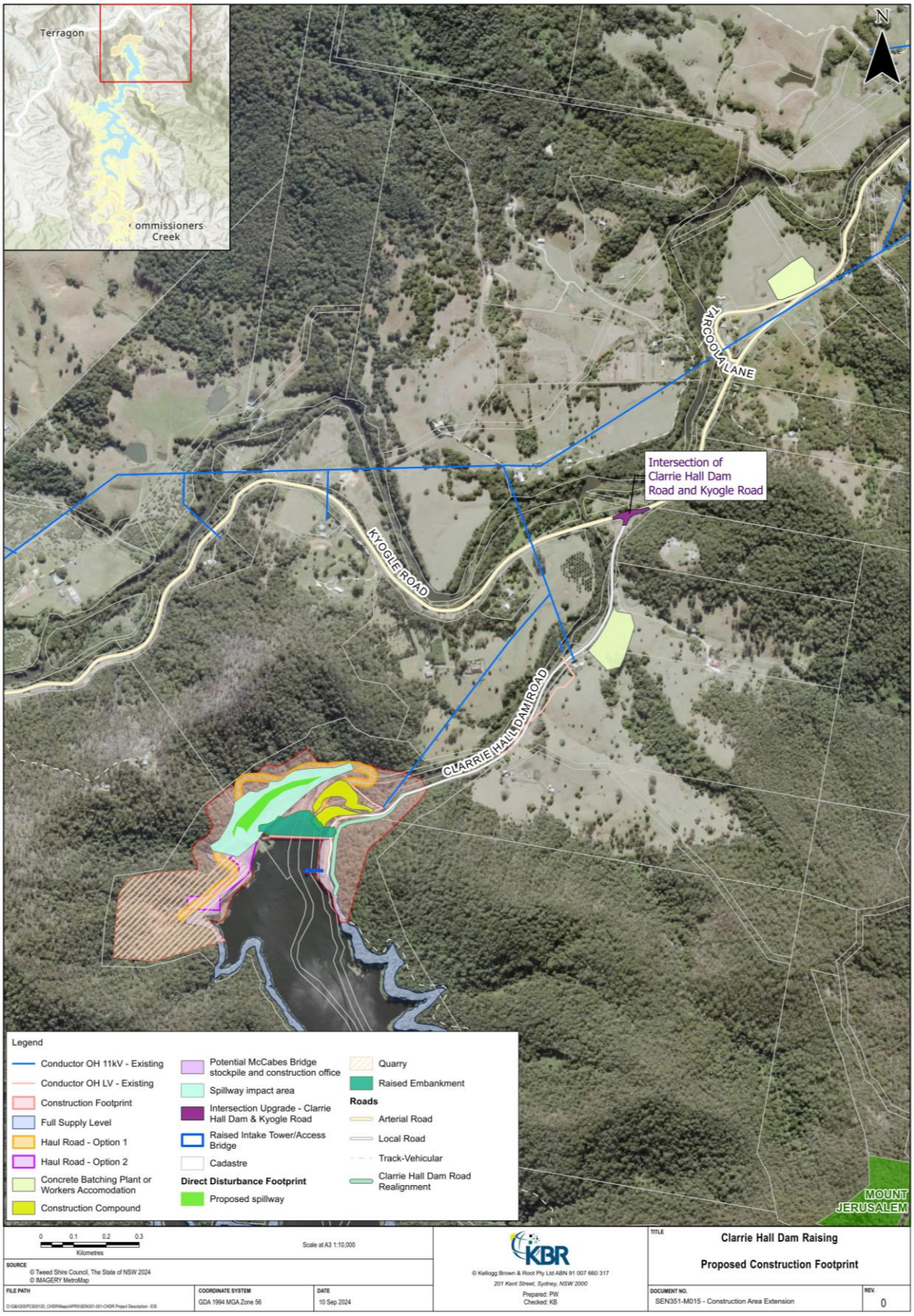


Figure 3-12 **Proposed locations of construction compounds, site offices, concrete batching plant, workers' accommodation and realignment of utilities at the southern end of the Proposal area**

3.4 PROJECT AREAS

The location of the Proposal is the existing Clarrie Hall Dam. The disturbance areas include the main construction area, ancillary works areas, FSL and areas where changes in upstream and downstream hydrology could potentially occur, including the area between the FSL and PMF. The types and extent of these disturbance areas are discussed below.

The area where direct impacts may occur during construction and/or operation of the Proposal is approximately 250.6 ha.

Approximately 49.6 ha would be impacted for construction and 209 ha for operation, including an overlap of 8 ha impacted during both construction and operation. During operation, approximately 248 ha may also be temporarily impacted in the area between the proposed FSL and the PMF which could be temporarily inundated due to flood events including the 5% Annual Exceedance Probability (AEP), 1% AEP, 0.5% AEP, 0.2% AEP and PMF.

The extent of the Proposal disturbance area includes all areas where direct impacts may occur due to construction and/or operation. These areas are the:

- construction activities disturbance area, comprising:
  - the raised dam wall, spillway, road realignments/upgrades, quarry, stockpile sites and construction compounds, intake tower and bridge and recreational areas
  - concrete batching plant
  - workers accommodation
  - upgrading the Kyogle Road and Clarrie Hall Dam Road intersection
  - replacement of McCabes Bridge and realignment of Commissioners Creek Road
  - removing or reconstructing impacted infrastructure and facilities at Crams Farm
  - utilities relocations
  - new recreation and operational facilities including an amenities block, public shelters, viewing areas, interpretation signage, paths, car parks, landscaping, security fences, lighting, monitoring equipment and boat ramp
  - removing and relocating the jetty at Crams Farm
- operational disturbance areas including the:
  - raised inundation area (RL 70 m contour), which is the waterline boundary at FSL
  - area between FSL and PMF
  - downstream areas, where there could be changes in flow.

The activities and disturbance area footprints of the Proposal provide the basis for assessing the extent of direct environmental impacts.

Further details are provided in sections 3.2 and 3.3.

3.4.1 Construction disturbance areas

The construction disturbance area and associated activities include the dam wall area and ancillary areas. The construction disturbance area is estimated to be approximately 49.6 ha. It is summarised in sections 3.2 and 3.3 and shown in Figure 3-1 to Figure 3-3.

Land title information for the proposed construction disturbance areas is shown in Table 3-3.

3.4.2 Construction disturbance areas

The construction disturbance area and associated activities include the dam wall area and ancillary areas. The construction disturbance area is estimated to be approximately 49.6 ha and is summarised in sections 3.2 and 3.3 and shown in Figure 3-1 to Figure 3-3. Land title information for the proposed construction disturbance areas is shown in Table 3-3.

Table 3-3 Lot and deposited plan information for the proposed construction disturbance area

Lot and deposited plan (DP) number	Proposed use
Lot 1 / DP260821 Lot 2 / DP1260635 Lot 14 / DP260821	Spillway construction area
Lot 2 / DP260821 Lot 6 / DP260821 Lot 1 / DP44745	Site offices and construction compounds at the dam wall
Lot 14 / DP260821 Lot 1 / DP260821 Lot 6 / DP260821 Lot 1 / DP44745	Raised embankment
Lot 1 / DP260821 Lot 2 / DP1260635 Lot 2 / DP260821 Lot 14/DP260821 Lot 6 / DP260821	Haul road option 1
Lot 2 / DP1260635 Lot 1 / DP260821	Haul road option 2
Lot 6 / DP260821 Lot 1 / DP44745 Lot 6 / DP260821 Lot 2 / DP260821	Realignment of Clarrie Hall Dam Road and associated works including the new boat ramp and raised tower and access bridge
Lot 2 / DP1260635	Quarry
Lot 76 / DP755730 Lot 8 / DP46078 Lot 9 / DP46078 Lot 10 / DP46078 Lot 11 / DP46078 Lot 29 / DP755730	Potential location for concrete batching plant or workers accommodation along Clarrie Hall Dam Road
Lot 5 / DP1130130 Lot 4 / DP1130130	Potential location for concrete batching plant or workers accommodation along Tarcoola Lane/Kyogle Road
Lot 7006 / DP92894	Clarrie Hall Dam Road and Kyogle Road intersection upgrade
Lot 1 / DP877100 Lot 1 / DP749031 Lot 2 / DP778141 Lot 2 / DP261681 Lot 3 / DP261681 Lot 2 / DP838936	Realignment of Commissioners Creek Road and the new McCabes Bridge

Lot and deposited plan (DP) number	Proposed use
Lot 2 / DP 631489 Lot 2 / DP229800 Lot 1 / DP1257191	
Lot 2 / DP838936	Potential location for McCabes Bridge stockpile and construction office complex
Lot 1 / DP716151	Potential location for McCabes Bridge stockpile and construction office complex
Lot 1 / DP1243701 Lot 4 / DP1243701 Lot 1 / DP 716151 Lot 1 / DP261582 Lot 2 / DP261582 Lot 1 / DP877100 Lot 1 / DP749031 Lot 1 / DP877100 Lot 1 / DP749031 Lot 1 / DP749031 Lot 2 / DP778141 Lot 2 / DP261681 Lot 3 / DP261681 Lot 2 / DP838936 Lot 1 / DP1257191 Lot 2 / DP1257191 Lot 3 / DP605354 Lot 32 / DP755743	Removing overhead cables
Lot 1 / DP716151 Lot 1 / DP877100 Lot 2 / DP261582 Lot 1 / DP877100 Lot 1 / DP749031 Lot 2 / DP778141 Lot 2 / DP261681 Lot 3 / DP261681 Lot 2 / DP838936 Lot 1 / DP1257191 Lot 2 / DP1257191 Lot 2 / DP229800 Lot 2 / DP631489 Lot 3 / DP605354 Lot 1 / DP240856 Lot 21 / DP840278 Lot 3 / DP240856 Lot 5 / DP240856 Lot 6 / DP240856 Lot 7 / DP240856 Lot 32 / DP755743	New overhead powerline cables

3.4.3 Operational disturbance areas

The operational disturbance area is estimated to include the following:

- area of inundation increased to the area below the RL 70 m contour, which is the FSL – approximately 209 ha
- area between FSL and PMF – approximately 248 ha which could be temporarily inundated due to flood events including the 5% Annual Exceedance Probability (AEP), 1% AEP, 0.5% AEP, 0.2% AEP and PMF (recent flood modelling has found minimal impacts above the FSL)
- downstream areas due to changes in flow (modelling has found limited downstream changes in hydrology) – negligible.

The land title information for the proposed operational FSL (Figure 2-2 to Figure 2-4) and PMF level (Figure 3-13) is shown in Table 3-4.

Table 3-4 Property information for the proposed operational disturbance area

Impact type	Lot and DP no.
Inundation at FSL	Lot 1 / DP260821; Lot 6 / DP260821; Lot 1 / DP44745; Lot 74 / DP755743; Lot 6 / DP261570; Lot 2 / DP716151; Lot 2 / DP261582; Lot 3 / DP605354;; Lot 32 / DP755743; Lot 6 / DP261681; Lot 1 / DP624073;; Lot 1 / DP261582; Lot 5 / DP261582; Lot 1 / DP261681; Lot 2 / DP261681; Lot 3 / DP261681; Lot 1 / DP261700; Lot 1 / DP716151; Lot 1 / DP749031; Lot 107 / DP755730; Lot 156 / DP755730; Lot 2 / DP814563; Lot 1 / DP814563; Lot 2 / DP838936; Lot 1 / DP877100; Lot 1 / DP628704; Lot 2 / DP628704; Lot 330 / DP1190205; Lot 2 / DP1243701; Lot 3 / DP1243701; Lot 4 / DP1243701; Lot 2 / DP1246411; Lot 2 / DP1257191; Lot 1 / DP1260635; Lot 8 / DP260821; Lot 9 / DP260821; Lot 10 / DP260821; Lot 11 / DP260821; Lot 12 / DP260821; Lot 13 / DP260821; Lot 1 / DP778141; Lot 2 / DP778141; Lot 13 / DP1266531
Inundation at PMF (RL 77 m) only	Lot 7003 / DP1052525; Lot 2 / DP776507; Lot 7004 / DP1052525; Lot 5 / DP1024097; Lot 21 / DP840278; Lot 1 / DP1243701; Lot 1 / DP1246411; Lot 1 / DP1257191; Lot 33 / DP755743; Lot 4 / DP605354; Lot 2 / DP631489; Lot 3 / DP240856; Lot 5 / DP240856; Lot 6 / DP240856; Lot 7 / DP240856

The operational footprint includes upstream and downstream changes in inundation and hydrology. Figure 3-1 to Figure 3-3 show the proposed inundation level at the FSL.

The PMF extent has been modelled and is shown in Figure 3-13.

Water Sharing Plan for Tweed River

The Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources Order 2023 (2023 No 335) (DCCEEW 2023a) under the *Water Management Act 2000* provides operational rules for managing water.

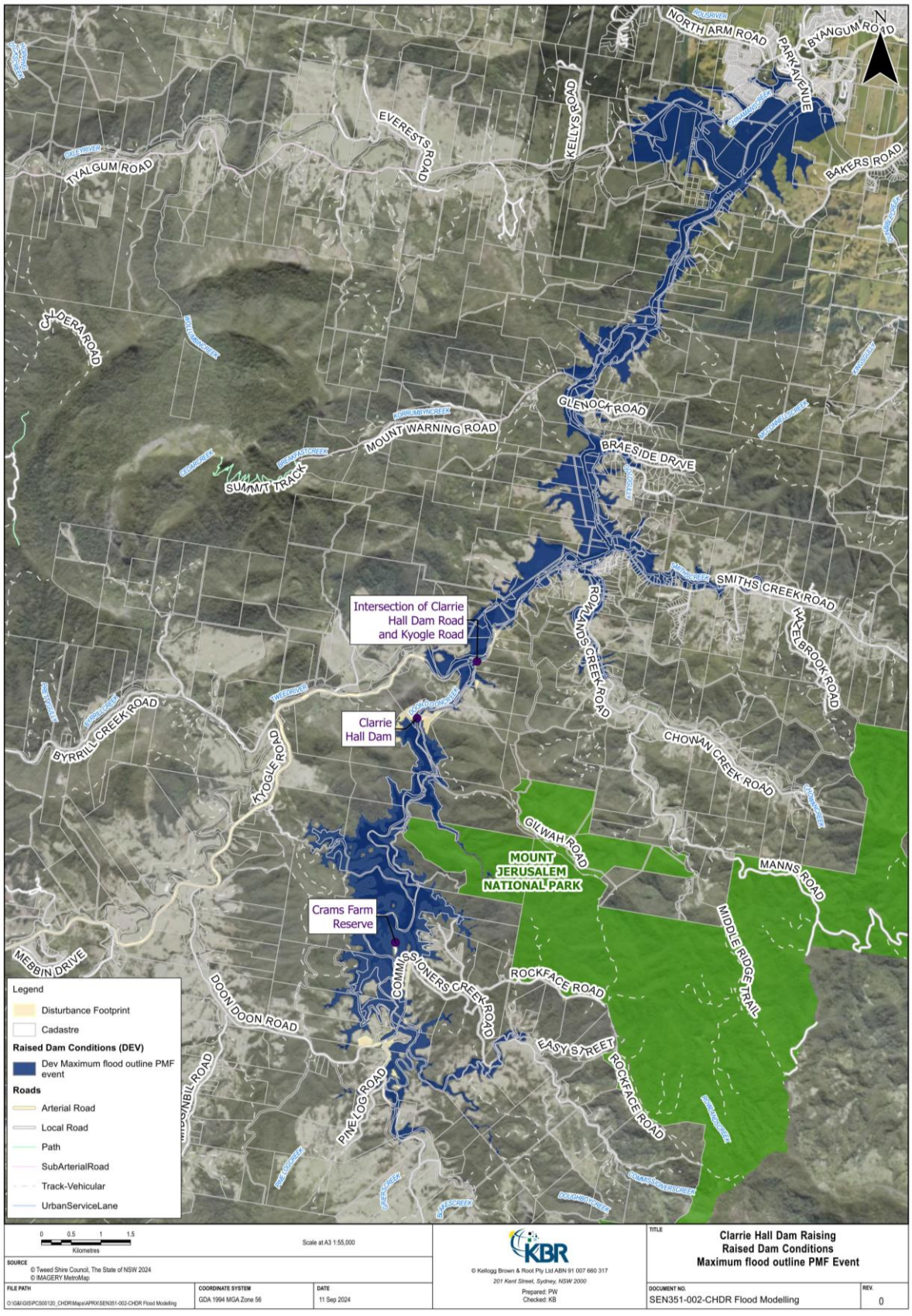


Figure 3-13 Probable maximum flood area for the proposed dam upgrade

3.5 CONSTRUCTION

The construction works for the Proposal, including construction infrastructure, methodology, sequencing, activities and materials are discussed in the following sections.

3.5.1 Cut and fill

The following cut and fill volumes have been estimated from the Concept Design Report (Appendix B).

The Proposal would require a minimum of 110,000 m^3 of high-quality rock for the embankment raising, which would be derived from the adjacent quarry due to the required rock quality properties.

Across the Proposal area, excluding the quarry, a minimum of 271,000 m^3 of cut material would be generated during the construction works. Major sources of cut material include the spillway, quarry haul road and the realigned Clarrie Hall Dam Road. Approximately 140,500 m^3 of fill material would be utilised across various areas of the Proposal during construction, including 7,500 m^3 of material that could be used for concrete aggregates.

A minimum surplus of 123,500 m^3 cut material would need to be deposited on site where suitable. Surplus fill could be used to satisfy most fill requirements for the realignment of Commissioners Creek Road, the new McCabes Bridge and backfilling the quarry.

3.5.2 Construction staging and sequencing

Contractor site facilities, workshops and material storage areas would be established before construction.

Some lowering of dam storage (approximately 300 mm below the current FSL) would be required to allow for construction of the raised embankment. Construction of the raised embankment would include the toe slab extension, grout curtain extension and upstream concrete face slab extension. Some diversion/dewatering works would be required to ensure flood-free construction, particularly for raised dam abutments.

Rock would be transported from the new spillway excavation to the stockpile (likely downstream) and/or to disposal (on- or offsite).

Rock would be delivered progressively to the dam site from the quarry along the haul roads through the left bank of the storage. Existing access routes to the site would have to be altered to allow for a new main access road higher in the right abutment and for construction access generally.

Sequencing of construction

The proposed stages and sequencing of construction are shown in Table 3-5.

Table 3-5 Proposed stages, approximate timing and sequencing of construction

Stage and approximate timing	Sub-stage	Works
1. Site establishment (Quarter 1 2026)	1-1	Environmental controls, including restriction of public access, traffic control and demarcation of project boundaries
	1-2	Establishing the site establishing, including clearing and grubbing
	1-3	Establishing site compounds, parking, offices and materials stockpile areas
	1-4	Clearing and construction access roads

Stage and approximate timing	Sub-stage	Works
2. Demolition (Quarter 1 2026)	2-1	Decommissioning the amenities block, viewing areas, recreation areas and other infrastructure, and electrical supply where required
	2-2	Removing the existing concrete parapet wall from the current dam embankment including removal and storage of the recyclable precast concrete panels
3. Embankment (Quarters 2, 3 and 4 2026)	3-1	Removing the crest pavement from the existing embankment to expose underlying rockfill
	3-2	Excavating the left and right abutments for the upstream concrete toe slab extension
	3-3	Stripping the foundation downstream of the existing embankment for the raised embankment footprint including removal of concrete gutter and seepage weir
4. Spillway (Quarters 2, 3 and 4 2026)	4-1	Demolishing the concrete walls at the existing spillway entrance and collection of waste for storage
	4-2	Excavating the new spillway channel higher in the left abutment (some blasting may be required in the lower downstream areas)
	4-3	Stockpiling suitable rock from the spillway excavation, and disposing of the remainder
5. Access and haul roads (Quarter 1 2026)	5-1	Excavating the new permanent access road higher in the right abutment
	5-2	Establishing haul routes between the old quarry and the dam site
6. Abutments (Quarter 1 2027)	6-1	Constructing the upstream concrete toe slab extension in both the left and right abutments
	6-2	Installing the grout curtain extension through the upstream toe slab extension on the left and right abutments (no blasting is envisaged, but slope correction may be required)
7. Quarry (Quarter 1 2026)	7-1	Stripping of the old quarry site and excavation of suitable rockfill (excavation of the quarry would probably require some blasting)
	7-2	Establishing a large crane or other means to transfer rock delivered from the quarry across the length of the raised embankment as required
8. Embankment – continuation (Quarter 1 2027)	8-1	Placing and compacting rockfill on the raised embankment (within configured zones as per the design)
	8-2	Extending the upstream concrete face slabs (possibly by slip forming)
9. Spillway – finalisation (Quarters 1 and 2 2027)	9-1	Constructing the concrete sill, floor and walls for the raised spillway (including anchors and drainage)
	9-2	installing large rock protection below the flip bucket downstream of the new spillway channel and entry to the creek

Stage and approximate timing	Sub-stage	Works
10. Embankment – completion (Quarter 2 2027)	10-1	Installing precast concrete parapet wall units obtained from the existing embankment on to the raised embankment, and connecting the parapet wall units to the raised upstream concrete face slabs
	10-2	Supplying and installing new precast concrete parapet walls on the ends of the raised embankment
11. Intake tower (Quarter 4 2026 and Quarter 1 2027)	11-1	Removing the existing intake tower house and tower access bridge deck
	11-2	Demolishing the existing intake tower deck
	11-3	Raising the concrete intake tower
12. Abutment support (Quarter 2 2027)	12-1	Raising the existing concrete pier, construction of a new concrete pier and construction of new concrete abutment support.
13. Tower (Quarter 2 2027)	13-1	Constructing the raised concrete tower deck
	13-2	Constructing the raised bridge deck
	13-3	Constructing a new tower house
	13-4	Installing all mechanical equipment including additional shutters, trash racks and the crane in the raised tower
	13-5	Reinstating electrical supply
14. Permanent access road (Quarters 3 and 4 2026)	14-1	Constructing a new permanent access road and seal on the right abutment to join the raised tower bridge and down to the new boat ramp location
15. Disestablishment (Quarter 3 2027)	15-1	Removing temporary access and haul roads
	15-2	Rehabilitating construction areas (including landscaping)
	15-3	Disestablishing.

It is expected that construction would commence in 2026 and would take approximately 70 weeks after the contract has been awarded.

An alternative construction sequence for the embankment raising requires drawdown of storage when raising the intake tower. The duration of the 300 mm drawdown is less than what is required for the original embankment works sequence. Major work elements including the intake tower raising, new access road and McCabes Bridge are minimally impacted by this change. The alternative construction sequence is described in Table 3-6.

Table 3-6 Alternative construction sequence

Stage	Sub-stage	Works
1. Site establishment (Quarter 1 2026)	1-1	Implementing environmental controls
	1-2	Clearing and grading
	1-3	Establishing quarry haul routes, access roads and constructions compounds and laydowns
2. Embankment – downstream raise (Quarters 2, 3 and 4	2-1	Excavating for new spillway channel in left abutment
	2-2	Stripping the quarry site and excavating suitable rockfill
	2-3	Stockpiling rock and wastes from the spillway excavation

Stage	Sub-stage	Works
2026 and Quarter 1 2027)	2-4	Stripping downstream foundation including removal of the concrete gutter and seepage weir
	2-5	Placing and compacting of rockfill on the raised embankment (within configured zones as per the design): Embankment Zone 3A complete from base to 64.5 m AHD (partial width only) Zone 3B concurrent with Zone 3A to 64.5 m AHD (partial width only) Remove PCC parapet wall unit and move to storage Excavate existing crest to allow tie-in of existing Zone 2 to new Zone 2 Robotic hydro-demolition of concrete facing below original wave wall and removal of the wave wall Zone 2, Zone 1 and Zone 3B complete to 73 m AHD (minimum) Excavate left and right abutments for upstream concrete toe slab extension Install grout curtain extension through the upstream toe slab extension on the left and right abutments Construct upstream concrete toe slab extension in both the left and right abutments Extend the upstream concrete face slabs (possibly by slip forming)
3. New spillway – reduced weir crest RL 67.3 m AHD (Quarters 2, 3 and 4 2026 and Quarters 1 and 2 2027)	3-1	Constructing new spillway training walls, apron, chute, flip bucket, etc.
	3-2	Constructing partial ogee (temporary weir height at RL 67.3 m AHD
	3-3	Constructing large rock protection below the flip bucket downstream of the new spillway channel and entry to the creek
	3-4	Commissioning new spillway to temporary weir height at RL 67.3 m AHD
4. Existing spillway – decommission (Quarter 1 2027)	4-1	Blocking off (mass concrete plug) existing spillway to 68 m AHD
	4-2	Demolishing existing spillway training walls
	4-3	Demolishing existing spillway chute
5. Embankment – completion (Quarter 2 2027)	5-1	Completing all embankment zones
	5-2	Installing precast concrete parapet wall units salvaged from step 2-5c
6. New spillway – finalisation (Quarter 2 2027)	6-1	Completing ogee to full crest height of RL 70 m AHD
7. Disestablishment (Quarter 3 2027)	7-1	Removing all temporary access and haul roads
	7-2	Rehabilitating construction areas (including landscaping)
	7-3	Disestablishing

3.5.3 Site establishment, construction compounds

Construction site offices, construction compounds, laydown areas and other facilities are proposed to be located as shown in Figure 3-12.

The construction compound area downstream of the embankment is a key access point to all the construction work sites. However, it is also the location of critical dam operational assets including the outlet tunnel, outlet control values and discharge valves.

This location is terraced and has a small usable footprint, requiring most of the area to be cleared and graded to support siting of office accommodation and welfare facilities (toilets, canteens, storerooms, etc.).

Workers accommodation

Considering a peak workforce of approximately 180 personnel, it is estimated that a temporary accommodation facility for 100 to 120 personnel would be required during construction.

An area of approximately 12,000 m^2 would be required for cabins, facilities and a car parking area.

Clearing and grading

The use of forestry equipment for clearing and grading may allow for the processing of timber logs, which may be able to be exported from the site for commercial use. Green waste from tree processing and clearing of scrub would be mulched onsite and stockpiled or spread.

Topsoils would be stripped and separately stockpiled at appropriate heights to a maximum of 3 m and then grassed to prevent erosion.

Subgrade would be stripped where unsuitable. Unsuitable materials that cannot be mixed with other materials so they can be used could be stockpiled for potential use as general fill.

Rock material would be sorted according to engineering properties and stockpiled for general fill or further processing via crushing and grading.

3.5.4 Upgrade to Kyogle Road and Clarrie Hall Dam Road intersection

The Kyogle Road and Clarrie Hall Dam Road intersection is the primary access road to the Proposal's construction site. An assessment of the intersection to accommodate access for the construction workforce and the transport of rockfill material required for the McCabes Bridge upgrade from the quarry has been conducted as part of the transport and traffic assessment. The assessment found that temporary treatment of the intersection may be suitable for construction. This will be reviewed during detailed design. The intersection is shown in Figure 3-10.

3.5.5 Clarrie Hall Dam Road realignment

The Clarrie Hall Dam Road realignment (see Figure 3-4) would require a vertical cut 8–10 m high, adjacent to the existing road. The boat ramp for operations and maintenance personnel would be relocated as part of the access road upgrade.

3.5.6 Quarry

Based on the elevation of the existing quarry, a review of geotechnical data, and the anticipated adequacy of rock volume supply, reopening the quarry used for the original dam construction was the only option considered by PWA for the dam wall raising (Appendix B).

Material sourced through the quarry expansion would be used in construction of the raised dam wall, new spillway, new access road and McCabes Bridge works. The expanded quarry would include an area required for the topsoil, overburden and rockfill stockpiles needed during the construction phase. Waste rock material from the new spillway construction area would be used to backfill the quarry void and develop the final landform. Haul roads suitable for heavy vehicles would be required to transport rockfill material between the quarry site and the dam wall embankment. Two haul route options are proposed, as shown in Figure 3-4.

The original quarry is bound to the north and south by gullies. Operations close to these drainage lines will require erosion and sediment controls due to the proximity to the dam storage.

The geotechnical cross-sections (extract shown in Figure 3-14) show sufficient volume of fresh rhyolite for supplying Zones 3A and 3B. These cross-sections also show significant overburden above the previously excavated benches. A 3D image of the quarry is shown in Figure 3-15.

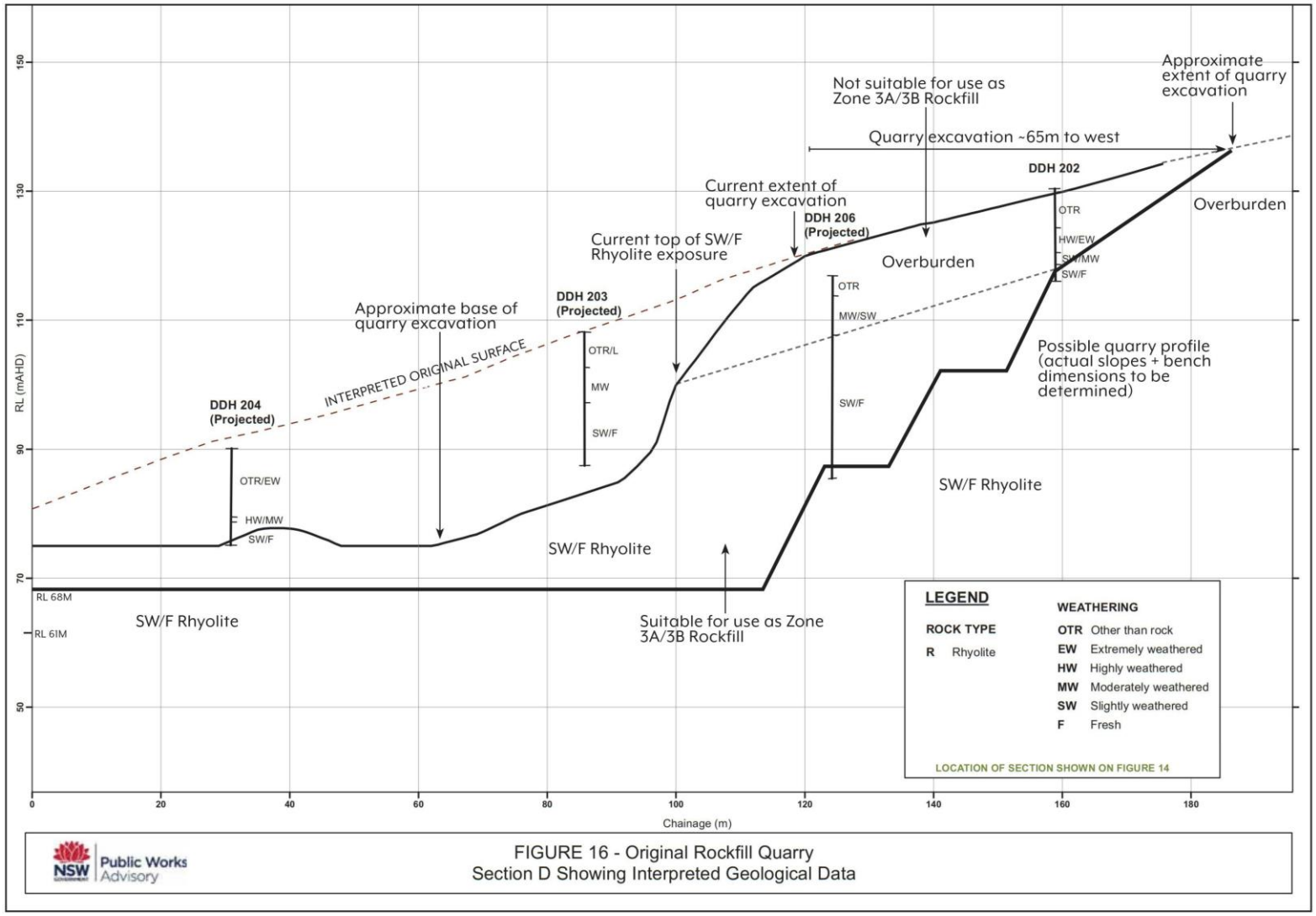


Figure 3-14 Extract of proposed quarry cross-section

Source: PWA 2018

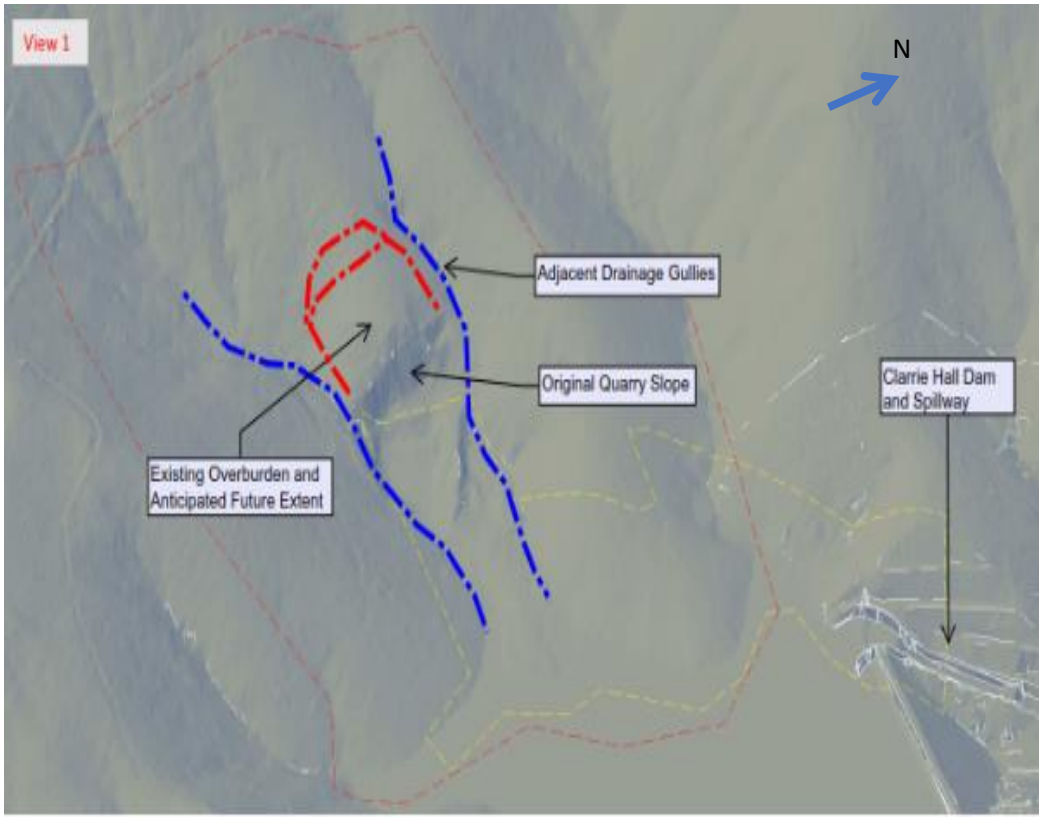


Figure 3-15 Existing quarry 3D image

Water supply

A raw water extract licence would be required to obtain water for quarry operations, including excavations and dust control.

Wastewater

Wastewater (sewage) will be collected via a plumbed storage tank for road tanker collection and exported to a centralised wastewater treatment facility by a commercial operator. Refer to section 3.9.1 for details of potential wastewater treatment facilities.

Wastewater from quarry operations such as dust control, the washing of products and the cleaning of equipment should be collected, settled and treated at the quarry site in accordance with environmental controls.

3.5.7 Haul roads

Haul roads will be required to accommodate the operating width of the largest vehicle regularly using the road. Different widths apply for various road types:

- single-lane roadways – 1.5 x vehicle operating width
- double-lane roadways – 3.5 x vehicle operating width.

Crossfall on haul roads should vary between 1.0% and 4.0%.

Haul roads would be designed and constructed with grades that conform to the following specifications:

- Grades should typically not exceed 10% (1:10).

- For large vehicles, a dual haul road including triangular safety berms (windrows) would be 26 m wide. This does not allow for road drainage or environmental controls.

Complexities of the terrain, and extensive cut and fill are constraints to constructing and operating a haul road from the quarry to the downstream face of the dam (see alternative below).

Haul road cut and fill volumes

The haul road route shown in Figure 3-4 requires:

- 105,000 m^3 of cut
- 81,000 m^3 of fill
- more than 24,000 m^3 of spoil (not allowing for bulking factors).

Based on the volume of cut and fill for a haul road, and other associated constraints to be considered, a haul route to the downstream face of the dam would be challenging to construct. An alternative is proposed below.

Rock material from cutting for haul road construction would be sorted according to engineering properties and stockpiled for general fill or further processing via crushing and grading. It is anticipated that most of the rock material and general fill materials would be placed and compacted in fill areas for the construction of haul roads and working platforms.

Alternative to the haul road

An alternative to the haul road discussed above and shown in Figure 3-16 is to create a new promontory, using spoil material, located in the valley west of the existing spillway training walls. Below the waterline at this location (RL 60 m) is the original construction stockpile area. This is a potentially flatter zone that may support material placement for the construction of the promontory and minimise potential for loading the upstream dam wall. The promontory would create a large laydown area with a short haul road connecting to the quarry and allow material stockpiling and processing from all sources including spillway excavation, the rock quarry and Clarrie Hall Dam Road. A further short haul route to the north of this promontory would allow connectivity to embankment and spillway zones. This is illustrated in Figure 3-16.

Belt conveyors can be used to move material to the embankment from the northern side of the promontory and should be able to be configured to manage grade changes between the two spillways allowing lift of material over the crest of the embankment of existing spillway walls.

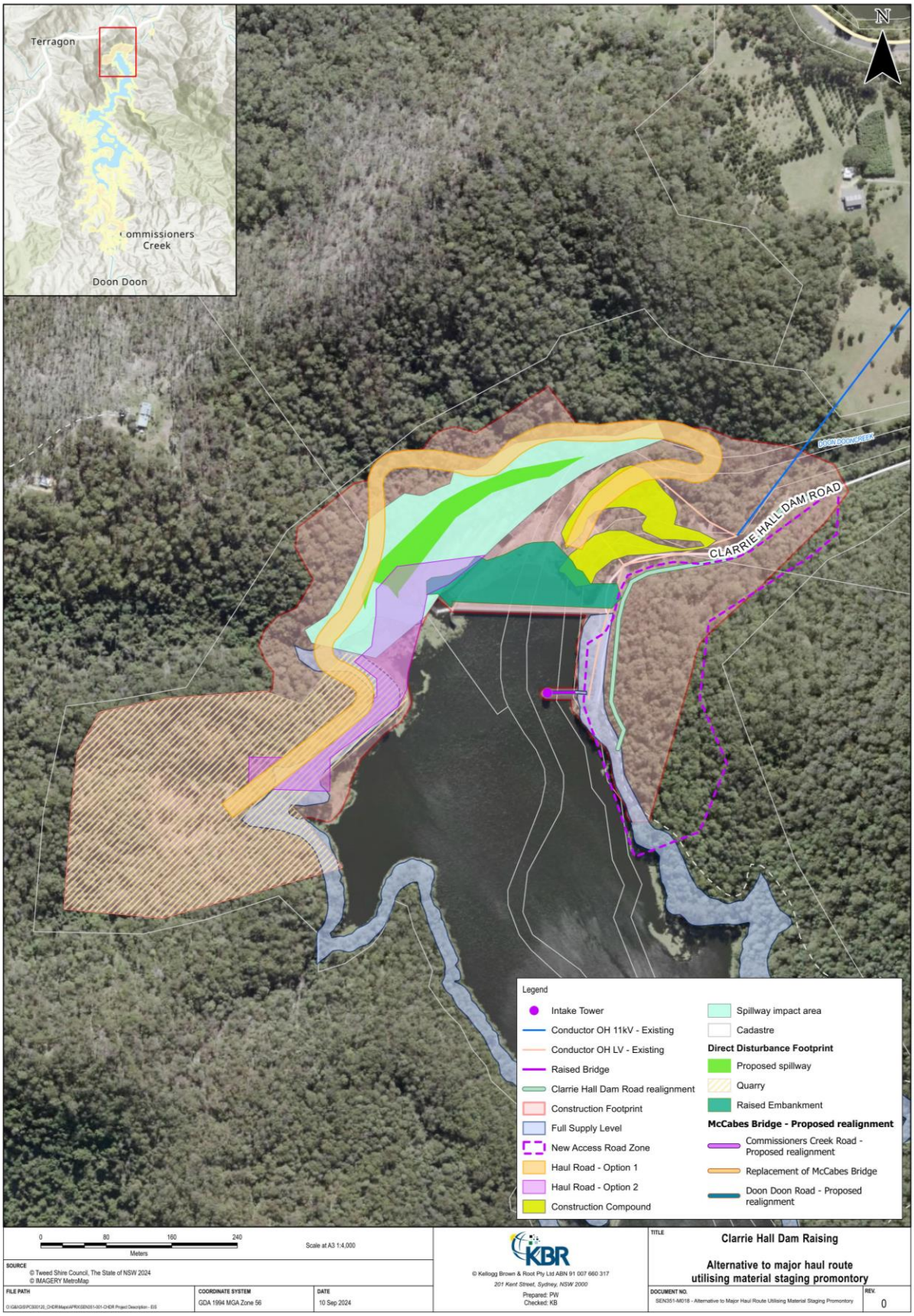


Figure 3-16 Alternative to the major haul route utilising a material staging promontory

3.5.8 Bulk material movement

There are various options for the movement of materials around the site.

Dozer

Dozers are used to push material from one location to another but are only effective over short distances. Dozers would be suited to clear and grade to move overburden laterally to clear access tracks. However, transportation of material by dozer pushing is not practicable because the terrain involves multiple changes in elevation and direction, and multiple materials would be processed and would need to meet stringent quality requirements.

Clearing and grading would likely utilise specialist forestry equipment to manage the felling and processing of trees and other vegetation. This specialist equipment allows for the complex terrain of the site.

Barge

Barges can allow vast volumes of materials to be moved across bodies of water. In this case, a loading wharf would be needed at the quarry source and at the embankment.

The option to use a barge was discounted due to the potential for variability in the stored water level, the additional infrastructure that would be needed (wharfs and moorings), and the short travel distance. The production rates and potential lost time were considered too great to progress this option.

Front loader

Front loaders allow materials to be lifted and placed from the ground to silos, bins and haulage trucks. These loaders would be required at each material source and placement location, the quarry, excavations, stockpiles, batching plant, and where rock material is processed.

However, the loaders are not practical for bulk transportation.

Hydraulic excavators

Hydraulic excavators would be utilised across all aspects of the site and would employ specialist attachments to rip, compact and place materials.

There is potential for excavators to walk or pass material via chain working to its placement location. This is likely to be employed on the embankment benches where the location at which the material would be deposited is established for each lift loaded at the point where the conveyor or haul truck offloads the material. An excavator then moves it, after which it is spread and compacted.

Belt conveyor

Belt conveyors allow long strings to be established, with successive conveyors added to form a chain. This flexibility also allows grade variations to be managed. Conveyor systems require detailed planning and do not support frequent reconfiguration or changes to source and deposit locations. Due to the site topography and constraints for haul route access, conveyor systems are likely to be utilised for bulk placement of material to the embankment, with final placement by hydraulic excavators.

The volume of material per lift, especially near the base of the embankment would require an extremely flexible and dynamic conveyor system to meet demands.

Off-highway trucks

Off-highway trucks allow larger payloads and can navigate unsealed haul routes with less downtime to both the truck and the road.

Various off-highway trucks are presented in Table 3-7, together with data about their key properties.

Table 3-7 Estimates of off-highway truck data

Item	CAT 735 Articulated	CAT 773G Rigid	CAT 777 Rigid
100% payload (tonne)	32	55.3	91.7
85% payload (tonne)	27.2	47.0	77.9
Capacity (50% heaped) m^3	18	31	50
Turn circle clearance dia. (min)	17	27	29
Truck width (m)	3.85	5.67	6.11
Dual haul road width (m)	18.1	24.4	25.9
No. of loads for Zone 3 Lift #25 (RL 60.0)	364	211	127
Days to load Zone 3 Lift #25	6.74	3.90	2.35
Will this production meet schedule?	No	No	Yes
'Design vehicle' for this assessment	No	No	Yes

Truck production is based on:

- 10 minutes load time (total)
- 600 m travel distance – quarry to dam
- 10 minutes unload time (total)
- 3 trucks on turn-around, working 9 hours per shift
- 54 trucks loaded/unloaded per shift.

Three was found to be the optimum number of trucks, but that would require a dual haul road, or separate segregated routes in and out.

Single-lane haul roads can be managed but require strict controls to manage safety. These issues would be compounded at this site due to the multiple steep grades, grade changes and tight curves minimising sight lines and stopping distances.

3.5.9 Rock excavation and quarrying

The rock fill for the embankment requires fresh rhyolite which is a high-quality, very hard rock. The rock that will be excavated for the new spillway is mostly unsuitable for use in the embankment as it is weathered and has low strength characteristics. The quarry therefore needs to be re-opened to source the fresh rhyolite.

Blasting

The Concept Design Geotechnical Investigation Report (Appendix B) states that slightly weathered and fresh rhyolite is extremely strong, and blasting will be required to extract the rock from the quarry and areas of spillway excavation (lower elevations) where fresh or slightly weathered rhyolite is found. The bulk of the spillway excavation is weathered rhyolite.

Multiple sensitive receivers are located near the area of the proposed rock quarry, spillway excavation and proposed alignment of the raised Clarrie Hall Dam Road, including private dwellings.

The impact to the existing dam wall, intake tower, outlet works and dam monitoring systems will be assessed for vibration transmission and magnitude.

Blasting requires detailed assessment based on the found rock conditions.

The major excavation locations are outlined below with an overview of likely rock excavation methods and frequency of blasting if required at that location:

- Clarrie Hall Dam Road – rock may be able to be ripped, sawn and hammered by excavator due to elevation and likely weathering; blasting may be required at a small scale; however, because the location is above the existing road and assets, use of rock sawing or chemical splitting should be considered
- spillway excavation – lower elevations closer to the downstream end of the spillway (flip bucket) are understood to have fresh rhyolite. explosive blasting events would likely be required at one blasting event per week (for an estimated 6-week duration). High reaches of the spillway cutting would use similar methods to Clarrie Hall Dam Road
- haul road and access tracks – intermittent hard rock encounters during clearing and grading are likely. Where sawing and chemical splitting are considered not viable; explosive blasting events would be required at approximately one blasting event per week
- rock quarry – explosive blasting events would be required at 2 per week from establishment of access to completion of the embankment raise (for an estimated 12-month period).

Alternatives to explosive blasting methods for hard rock extraction

There are other alternatives to blasting that should be considered during construction including:

- chemical splitting, where the expansive reaction of chemicals mixed and poured into drilled holes split the rock apart. This method:
  - requires close spacing and a high number of drilled holes for chemical placement to spilt high-strength rhyolite
  - has slow production rates due to drilling holes for chemical placement and slow reaction times
  - is expensive
  - is labour-intensive
  - would be useful for small-scale localised hard rock encounters
- hard rock cutting saws, which come in a large variety including cutting wheels, wires, and are often machine mounted. These methods:
  - have slow production
  - require expensive equipment
  - are ideal for jointed rock, but less so for rhyolite
  - create dust and require water spray suppression to manage the risk of silicosis (respiratory disease)
- excavator ripping, which uses the power of the hydraulic rams and arms of the machine to rip the rock and scrap or split the surface. Hardened steel points are used to focus the forces into the rock surface.

This method:

- likely has good production rates in weathered rock zones where rock strength is lower
- is ineffective for slightly weathered and fresh rhyolite zones due to high rock strength.

- excavator-driven hydraulic powered cutters and grinders, which are wheels and cutting blades mounted to excavator plant. This method:
  - has good production rates in weathered rocks zones
  - possibly has good production rates in slightly weathered zones where rock strength is lower, but may not yield useable size rock particles which requires extensive processing to allow use.
  - results in heavy dust creation, requiring water spray suppression to manage risk of silicosis
- dozer ripping, which uses the blade of the dozer to strip and rip the surface of the rock. Due to the strength of rhyolite, including weathered rhyolite, this method:
  - would likely meet refusal, where the machine can not clear the rock
  - is only viable for soils and subgrade overburden clearing.

3.5.10 Wastes and stockpiles

It is assumed that all site-won materials would be sorted and processed onsite to maximise site use. This requires a working area for stockpiling and processing. Further processing onsite would be a source of dust and slimes from crushing, grading and washing.

Storage lagoons and drying beds are not likely to be practicable because the terrain lacks suitable flat land with sufficient area. Also, there is a risk of contamination of the water supply within the dam if run-off in both dry and wet weather periods is not adequately controlled and drains and storage locations are not adequately sized. It is assumed that recycling of wash water via a series of storage tanks and lamella clarifiers would be needed due to the smaller footprint of these methods over open-storage lagoons. These systems are often ‘sealed’ and are therefore less susceptible to storm flows and overflow events, as long as they are suitably sized for throughflow capacity.

3.5.11 Concrete and materials

Concrete and cementitious products would be needed for most of the works including:

- site establishment
- temporary works
- enabling works
- main permanent works:
  - grout curtain
  - concrete facing
  - spillway
  - intake tower
  - other works and grouting activities.

An overview of key material quantities from the concept design is shown in Figure 3-17.

Item No	Description	Units	Qty
2	**EMBANKMENT**		
2.1	Precast Concrete Parapet Wall Units Removal	m^3	900
2.2	Excavation in Existing Embankment	m^3	4,200
2.3	Original RC Parapet Wall Removal	m^3	460
2.4	Foundation Excavation for Raised Embankment (incl Toe Slab)	m^3	20,000
2.5	Zone 1 Rockfill	m^3	8,000
2.6	Zone 2 Rockfill	m^3	30,000
2.7	Zone 3A Rockfill	m^3	75,000
2.8	Zone 3B Rockfill	m^2	20,000
2.9	Road Pavement	m^3	1,000
2.1	Demolition of Existing Spillway Entry RC Training Walls	m^3	400
2.11	Reinforced Concrete in Raised Face Slab	m^3	1,200
2.12	Raised Concrete Parapet Wall (on Embankment and Right Bank)	m^3	1,200
2.13	Reinforced Concrete in Toe/Foundation for Raised Embankment	m^3	600
2.14	Grout Curtain for Raised Embankment	m	200
2.15	Road Earthworks	m^3	240
3	**SPILLWAY**		
3.1	Clearing	ha	1.5
3.2	Stripping	m^3	10,000
3.3	Excavation in Rock	m^3	180,000
3.4	Reinforced Concrete in Crest Structure	m^3	1,000
3.5	Reinforced Concrete in Floor Downstream of Crest	m3	4,500
3.6	Reinforced Concrete in Wall	m^3	2,500
3.7	Reinforced Concrete in Flip Bucket	m^3	200
3.8	Reinforced Concrete Slab Upstream of Crest	m^3	600
3.8	Anchors	m	4,500
3.9	Drainage and Backfill	Item	1
3.1	Creek Rehabilitation and Drainage works	Item	1
4	**INTAKE TOWER**		
4.1	Deck and Bridge Removal	Item	1
4.2	Reinforced Concrete in Tower	m^3	40
4.3	Reinforced Concrete in Deck	m^3	50
4.4	Tower House Construction	Item	1
4.5	Additional Shutters and Trashracks	Item	1
4.6	Reinforced Concrete in Bridge Peirs & Abutment	m^3	160
4.7	New Bridge Construction	Item	1
5	**RIGHT ABUTMENT ACCESS ROAD**		
5.1	Excavation in Rock	m^3	11,300
5.2	Road embankment fill	m^3	10,000
5.3	Supply and construct 2 coat seal bitumen running surface	m^2	3,200
5.4	Supply and construct 100 mm DGS20 basecourse	m^2	3,200
5.5	Road marking and signage	Item	1

Figure 3-17 Concept Design key material quantities for the dam raising

Source: PWA 2018

The typical concrete mix design shown in Table 3-8 was used as a guide to estimate the overall quantity of the key constituents of structural concrete per square metre.

Table 3-8 Estimated quantities of key constituents of structural concrete

Constituent	Estimated quantity
Coarse aggregates	1160 kg
Coarse sand / fine aggregate	460 kg
Fine sands	80 kg
Blended cements	480 kg
Water	183 L

The works require a minimum of 17,500 m^3 of concrete, not allowing for blinding concrete, grouting activities and mass fill areas. Table 3-12 below provides an indicative breakdown of material volumes for the major concrete elements.

Whilst there are a number of suppliers in the local area, it is unclear whether the local Murwillumbah plant could meet the demand. There is significant risk to the quality of the works if supplies could not be met.

Several concrete batching plants are located in Tweed Heads. These are almost certain to be able to meet demand; however, the 50-minute minimum travel time brings complexity in mix design, delivery timing logistics, additional costs and potential for substandard quality. The plants could be requested to specify the retarding agents they use and to produce trial mixes to confirm that they are meeting the necessary specifications. Other factors to consider when designing mixes and additives are the summer heat and water loss due to evaporation.

Potential suppliers of bulk washed and screened sand within NSW and Queensland are shown in Table 3-9.

Table 3-9 Bulk sand suppliers

Sand supply / quarry	Distance	Travel time (one way)
Clutha Creek Sands (sand and concrete aggregate quarry)	120 km	2.0 hours
Holcim Australia – Dunloe Sands Quarry (sand soil & gravel supplier), Pottsville Rd, Pottsville NSW 2485	38 km	40 mins
Kingscliff Sands (concrete sand), 103 Altona Rd, Cudgen 2487	42 km	40 mins

Locations of the nearest concrete batching plants to Clarrie Hall Dam are shown in Table 3-10.

Table 3-10 Local concrete batching plants and ready-mix suppliers

Concrete batching plant locations	Distance	Travel time (one-way)
Holcim Australia – Murwillumbah	18 km	20 mins
Tweed Heads: • Boral Concrete • Hymix • Nucon • Holcim • Excel	50 km	50 mins
Burleigh Heads – Queensland	60 km	1 hour

The nearest cement manufacturing centres to Clarrie Hall Dam are shown in Table 3-11.

Table 3-11 Cement manufacturing centres

Concrete batching plant locations	Distance	Travel time (one way)
Gladstone – Cement Australia	700 km	8.25 hours
Berrima – Boral Australia	923 km	9.5 hours

Given the limitations, consideration for provision of an onsite batching plant may be preferred. Two options for a concrete batching plant have been considered in the EIS.

Table 3-12 includes an estimate of vehicle movements per day into the site (along Kyogle Road), including concrete agitator trucks with typical capacity of 6 m^3. Truck movements to service a typical 300 m^3 single pour are outlined below:

- using commercial batching plants – 50 deliveries (100 movements for 6 m^3 concrete agitator trucks)
- using onsite batching plants – 29 deliveries (58 movements for dry material trucks).

There are clear haulage advantages of an onsite batching plant as well as associated benefits to other road users because there are fewer heavy vehicle movements and therefore also less fatigue damage to the local public road network.

Coarse aggregates won on site need to be well screened and graded. This would require careful processing and possibly washing onsite. Washing water would require treatment including settlement and clarification before being reused or discharged to the environment.

The resulting slimes can typically be processed via settlement lagoons) onsite and local environmental controls managed accordingly. Due to the steep terrain of the location, there is a high risk of loss of containment during storms, which would result in pollution.

Alternatives include laminar screens, coagulants and other smaller-footprint equipment; however, these increase costs and onsite maintenance and management.

Medium coarse aggregates would also likely be required. Allowance for 30% importation has been used for to alleviate the amount of detailed site processing, washing and resulting treatments.

Coarse and fine sand should be imported to the site. Concrete grade sands are heavily washed, screened and processed. It is unlikely to be practicable to manage this onsite.

Cementitious materials including cement, fly ash, slags (ground granulated blast-furnace slag) and others will be imported to the site.

Site processing, crushing, washing and grading of coarse aggregates for concrete production can be eliminated if all concrete products are imported to the onsite batching plant, or concrete is procured from existing batching plants at Tweed Heads instead of the onsite batching plant.

Onsite concrete batching plant

There is potential for an onsite mobile concrete batching plant to be established for construction, and 2 location options have been considered.

Of the concrete produced, 70% would be used for the spillway, 25% for the raised embankment, 2% for the intake tower and 3% for McCabes Bridge.

Concrete supply will also require over 3 ML of water for concrete mix alone. Proximity to a suitable water source and approval for extraction are key considerations.

Because the concrete materials, sands and other cement components are coming from external sources, there will be truck movements related to external deliveries. The potential locations just outside of the main site allow these vehicles to deliver without needing to access the main works site.

Power

The concrete batching plant and associated conveyors, silos and other equipment may be powered by mains supply. A typical total estimate for power demand required for the mobile batching plant is in the order of 550 kW, 400 V, 50 Hz.

Capacity of the existing 11 kV supply, as shown in Figure 3-21 and Figure 3-22, and demand need to be fully investigated by the construction contractor in consultation with Essential Energy. Concrete transportation and material handling (front loader) is anticipated to be diesel powered.

Water supply

A raw water extract licence would be used for mobile batching plant operations, including use in mix and dust control. A small packaged filtration plant may be required to ensure the raw water is of suitable quality for concrete production.

Wastewater

Wastewater will be collected via a plumbed storage tank for road tanker collection and exported to a centralised wastewater treatment facility by a commercial operator. Refer to section 3.5.17 for details of potential wastewater treatment facilities.

Wastewater from batching plant operations, including dust control, washing pans and mixers, and cleaning of equipment would be collected, settled and treated in accordance with environmental controls documented in this EIS.

Table 3-12 Concrete volumes and mix constituent estimates

Concrete products		Concrete delivery trucks	Coarse agg 1.160 T/m³	Coarse sand 0.460 T/m³	Fine sand 0.080 T/m³	Cementitious materials (blend) 0.480 T/m³	Water 183 L/m³
Location	Total volume (m³)	6 m³	tonnes	tonnes	tonnes	Tonnes	L
Embankment							
Reinforced concrete in raised face slab	1,200	200	1,392	552	96	576	218,880
Raised concrete parapet wall (on embankment and right bank)	1,200	200	1,392	552	96	576	218,880
Reinforced concrete in toe/foundation for raised embankment	600	100	696	276	48	288	109,440
Grout curtain for raised embankment	200	34	232	92	16	96	36,480
Spillway							
Reinforced concrete in crest structure	1,000	167	1,160	460	80	480	182,400
Reinforced concrete in floor downstream of crest	4,500	750	5,220	2,070	360	2,160	820,800
Reinforced concrete in wall	2,500	417	2,900	1,150	200	1,200	456,000
Reinforced concrete in flip bucket	200	34	232	92	16	96	36,480
Reinforced concrete slab upstream of crest	600	100	696	276	48	288	109,440

Concrete products		Concrete delivery trucks	Coarse agg 1.160 T/m³	Coarse sand 0.460 T/m³	Fine sand 0.080 T/m³	Cementitious materials (blend) 0.480 T/m³	Water 183 L/m³
Intake tower							
Reinforced concrete in tower	40	7	46.4	18.4	3.2	19.2	7,296
Reinforced concrete in deck	50	9	58	23	4	24	9,120
Reinforced concrete in bridge piers and abutment	160	27	185.6	73.6	12.8	76.8	29,184
McCabes Bridge							
Reinforced concrete in deck	100	17	116	46	8	48	18,240
Reinforced concrete in bridge piers and abutment	320	54	371.2	147.2	25.6	153.6	58,368
Totals							
Total (base)	12,670.0	2,112	14,697.2	5,828.2	1,013.6	6,081.6	2,311,008
Total + allowance (+25%)	15,837.5	2,640	18,371.5	7,285.3	1,267.0	7,602.0	2,888,760
Overall total (inc. wastage +10%)	**17,421.3**	**2,904**	**20,208.7**	**8,013.8**	**1,393.7**	**8,362.2**	**3,177,636**
Truck capacity (estimated)	Site-won	6 m³	20	20	20	60	Site-won
Total truck deliveries	Site-won	2,904	1,010	400	70	140	Site-won
Est. movements per day	–	50	7	3	1	1	–

3.5.12 Embankment

The dam wall construction disturbance areas comprise the following activities:

- increasing the height of the existing concrete faced rockfill dam embankment
- applying curtain grouting within the extended toe slab area
- constructing a new intake tower and bridge
- constructing a new concrete lined spillway higher up in the west abutment
- excavating the quarry and haul roads
- establishing construction compounds and stockpile sites
- realigning Clarrie Hall Dam Road
- establishing new recreational areas, a boat ramp, operational facilities and amenities.

A temporary crossing at Doon Doon Creek is proposed downstream of the current dam embankment wall and stockpile areas to support the construction activities. The temporary crossing would be developed using rockfill material to enable construction equipment to travel between the dam wall construction site and the quarry. This crossing would need to be designed to facilitate the underflow of the operational releases from Clarrie Hall Dam to supplement Tweed River Flows for extraction at Bray Park Weir. This has been discussed with DPI-Fisheries, and mitigation measures are provided in section 6.1.

The concept design indicates the reuse of the existing precast concrete parapet walls. These would be removed and stored onsite for later reuse. Additional wall units may be required and are anticipated to be fabricated offsite. They can be delivered to the site as needed; therefore, they require no additional storage.

Materials

The raised embankment, as shown in Figure 3-18, is proposed to be constructed from the following materials:

- for a semi-permeable Zone 1 immediately under the upstream concrete face slabs –moderately weathered rhyolite
- for a permeable intermediate Zone 2 – slightly weathered to moderately weathered rhyolite
- for a permeable fresh rock Zone 3A/3B in the downstream part – slightly weathered rhyolite.

The volumes required for construction of the embankment include:

- Zone 1 – 8,000 m^3
- Zone 2 – 30,000 m^3
- Zone 3A/3B – 95,000 m^3.

Rockfill materials needed for construction would be sourced from the quarry and transported along the haul road to the proposed raised dam embankment wall, as well as along Clarrie Hall Dam Road, Kyogle Road and Doon Doon Road to the McCabes Bridge construction site. Additional sources for rockfill material include approximately 20% of the rock material from the raised spillway excavation for use for the raised embankment.

Rockfill would be stockpiled onsite, and any excess rockfill from the spillway excavation would be disposed of.

Properties of the material required for the embankment are summarised in Table 3-13.

Table 3-13 Summary of key material properties

Embankment zones	Description	Size d50 (mm)	Size d90 (mm)	Terrace thickness (mm)*
Facing	Comprising impermeable reinforced waterbar jointed concrete upstream facing	N/A	N/A	N/A
Zone 1	Semi permeable zone comprising moderately weathered rhyolite	16	90	330
Zone 2	Permeable intermediate zone comprising slightly weathered to moderately weathered rhyolite	80	300	1,000
Zone 3A	Permeable zone comprising fresh rhyolite	200	500	1,330
Zone 3B	Downstream face zone comprising selected fresh rhyolite	300	600	1,330

Note: Compaction levels would be achieved by progressing sublayer compaction as required by the design

Zones 3A and 3B

These zones are the main bulk mass for the raised embankment. The base of the existing embankment is formed of a reinforced Zone 3B. The original dam construction used this method to provide protection to the downstream rock face from overtopping flows during construction.

Once the dam reached a height where overtopping became infeasible (considering the cofferdam and bypass), the reinforcement was no longer required.

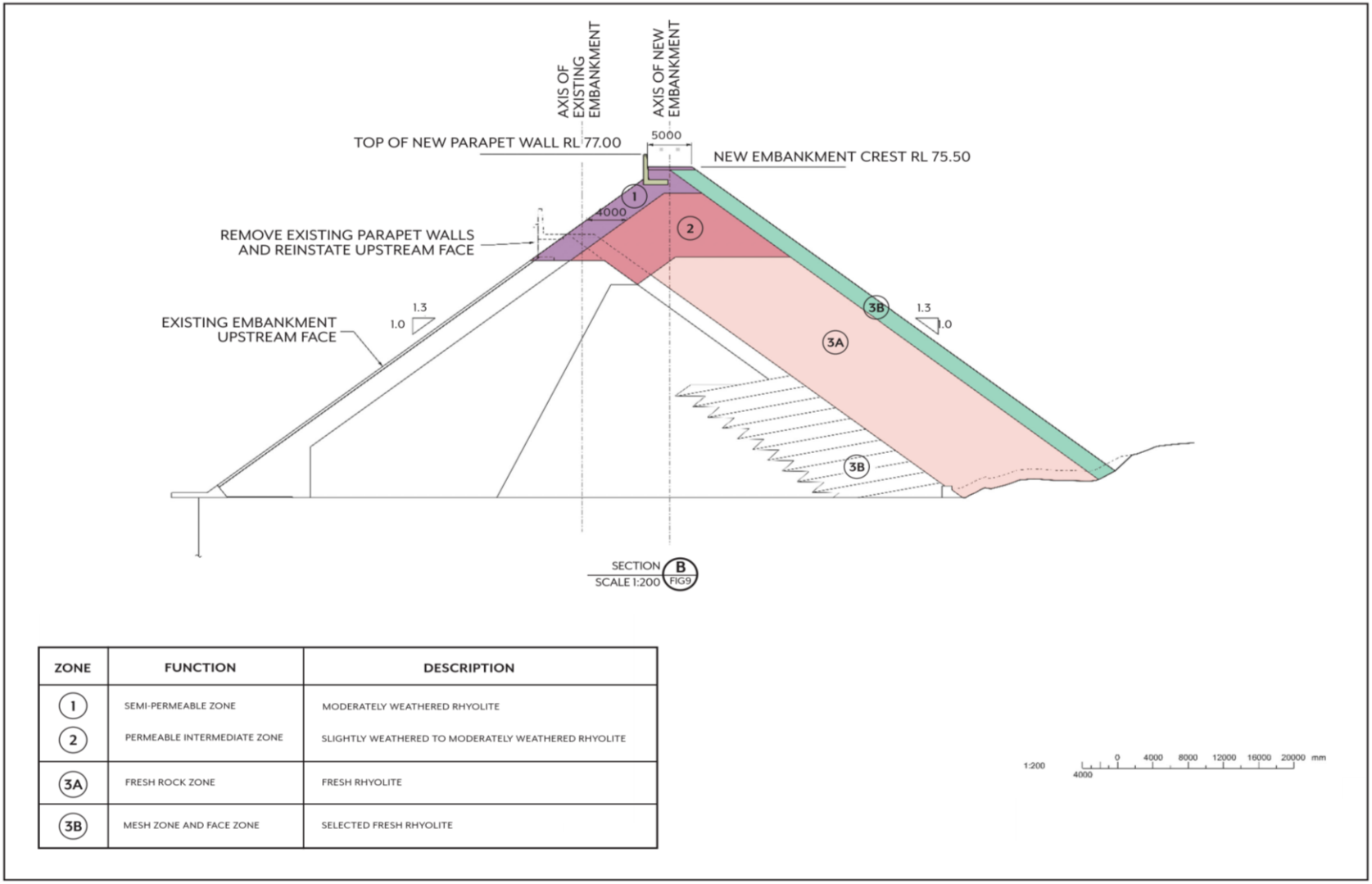
'Fresh' rhyolite will be sourced from the existing quarry, located approximately 300 m from the dam embankment. A haul road will be needed to transport this material to the upstream face of the embankment. The terrain of the site constrains the ability to construct a haul road to the downstream heel of the dam. This requires a local placement of the material onto the embankment from the upstream location.

The existing quarry is approximately 400 m from the upstream face of the dam.

Alternative options include:

- barge – conveyor loading at the quarry and offload and transport to a location at the embankment
- off-highway truck transport to a conveyor
- off-highway truck transport to a crane
- belt conveyor from the quarry to the placement location.

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ZONE	FUNCTION	DESCRIPTION
1	SEMI-PERMEABLE ZONE	MODERATELY WEATHERED RHYOLITE
2	PERMEABLE INTERMEDIATE ZONE	SLIGHTLY WEATHERED TO MODERATELY WEATHERED RHYOLITE
3A	FRESH ROCK ZONE	FRESH RHYOLITE
3B	MESH ZONE AND FACE ZONE	SELECTED FRESH RHYOLITE

Figure 3-18 Overview of raised embankment material zones

Source: PWA 2018

Zone 2

Zone 2 is a transitional zone acting as a filter between Zones 1 and 3. The material grading is coarser than Zone 1, but finer than Zone 3. Details include:

- Formation level – 61.2 m AHD
- Zone 3A step level –71.5 m AHD
- Layer/compaction thickness –1.00 m thick
- Quantity of terraces to be placed –10
- Zone 2 bench width– varies from 4 m to 25 m
- Zone 2 volume (m^3) – 30,000.

Slightly weathered to moderately weathered rhyolite is likely to be sourced from the spillway excavation zone, approximately 200 m from the quarry. Having crushers and grading equipment at this location as well as the quarry site will be advantageous to prevent additional transport of material for processing.

The stockpile and processing compound is proposed to be located at the base of the dam and spillways. An access road is required here to allow crossing of the creek and spillways.

Zone 1

Zone 1 is a carefully graded material consisting of finer particles allowing high compacted densities to achieve the semi-permeable zone. This also acts as the foundation to the impermeable concrete facing that will be extended up the upstream face of the dam wall.

Details of the material include:

- Formation level – 64 m AHD
- Zone 3A step level – 71.5 m AHD
- Layer/compaction thickness – 0.33 m thick
- Quantity of terraces to be placed –23
- Zone 1 bench width – 4 m
- Zone 1 volume (m^3) – 8,000.

Moderately weathered rhyolite is likely to be sourced from the spillway excavation zone. The distance from source to placement is 200 m.

The grading profiles for all zones require a small volume of small/fine particle material; however, this material is to be free of dusts. Crushing onsite will be required; however, this introduces dust to both the product and the environment. This dust would need to be removed by washing.

Onsite washing and processing of very fine graded material produces high levels of slimes. Slimes require careful control and processing, and this degree of processing onsite to produce very fine graded sands is not considered viable. Crushers and vibrating screens with dust extraction and secondary site dust management would be required and would need to be sufficient to manage the crushing required for Zone 1 material. Imported fine sands could be mixed with the crushed rock to achieve grading values, further minimising the need for fine crushing and extensive washing.

Fine graded materials for Zone 1 and concrete sands and aggregates could be sourced externally. This would significantly reduce the onsite processing required, resulting in lower dust emissions, siltation and other issues including worker respiratory health.

Externally sourcing this material would require between 400 and 500 truck journeys over the period of this activity, averaging 22 deliveries per day for a 4-week period.

Energy

The main electrical energy requirements would be to power the concrete batching plant and chilled water units. Electrical energy would be sourced from the local power network or from generators. Fuel (mainly diesel) would be used to power plant and equipment.

3.5.13 Parapet wave wall

The concept design indicates the reuse of the existing precast concrete parapet walls. These would be removed and stored onsite for later reuse. Additional wall units may be required and are anticipated to be fabricated offsite. These can be delivered to the site as needed, thereby requiring no additional storage.

3.5.14 Spillway

The spillway excavation zone is detailed in the concept design plans and geotechnical reports.

Spillway walls and the apron/base slab would be constructed from reinforced structural concrete, requiring good concrete properties. It is assumed a nominal 20 mm aggregate would be used.

Craneage

Figure 3-19 indicates possible craneage coverage for the spillway construction.

Two 70–75 m tower cranes can service the full spillway construction works. One is shown outside of the spillway footprint. This allows for finalisation of the ogee crest. The other one, shown within the chute envelope, would be demobilised before the spillway is commissioned.

Concrete transportation

Concrete would be transported from a batching plant via an agitator truck or tipper truck. To manage movement to elevated pour locations and also steep grades within the spillway, concrete could be moved to the location via a belt conveyor or concrete (stationary) pump.

Power

Tower cranes may be powered by mains supply. Each of the cranes illustrated in Figure 3-19 are based on JASO J300 Specifications for Tower Cranes. Each requires 132 kW, 400 V, 50 Hz. Local power poles from the mains site transformer can be installed as required.

Capacity of the existing 11 kV supply and demand needs to be fully investigated by the construction contractor in consultation with Essential Energy.

Concrete transportation and placement are anticipated to be diesel powered.

Rock excavation, crushing (cone or plate), screening and associated conveyors are anticipated to be diesel powered.

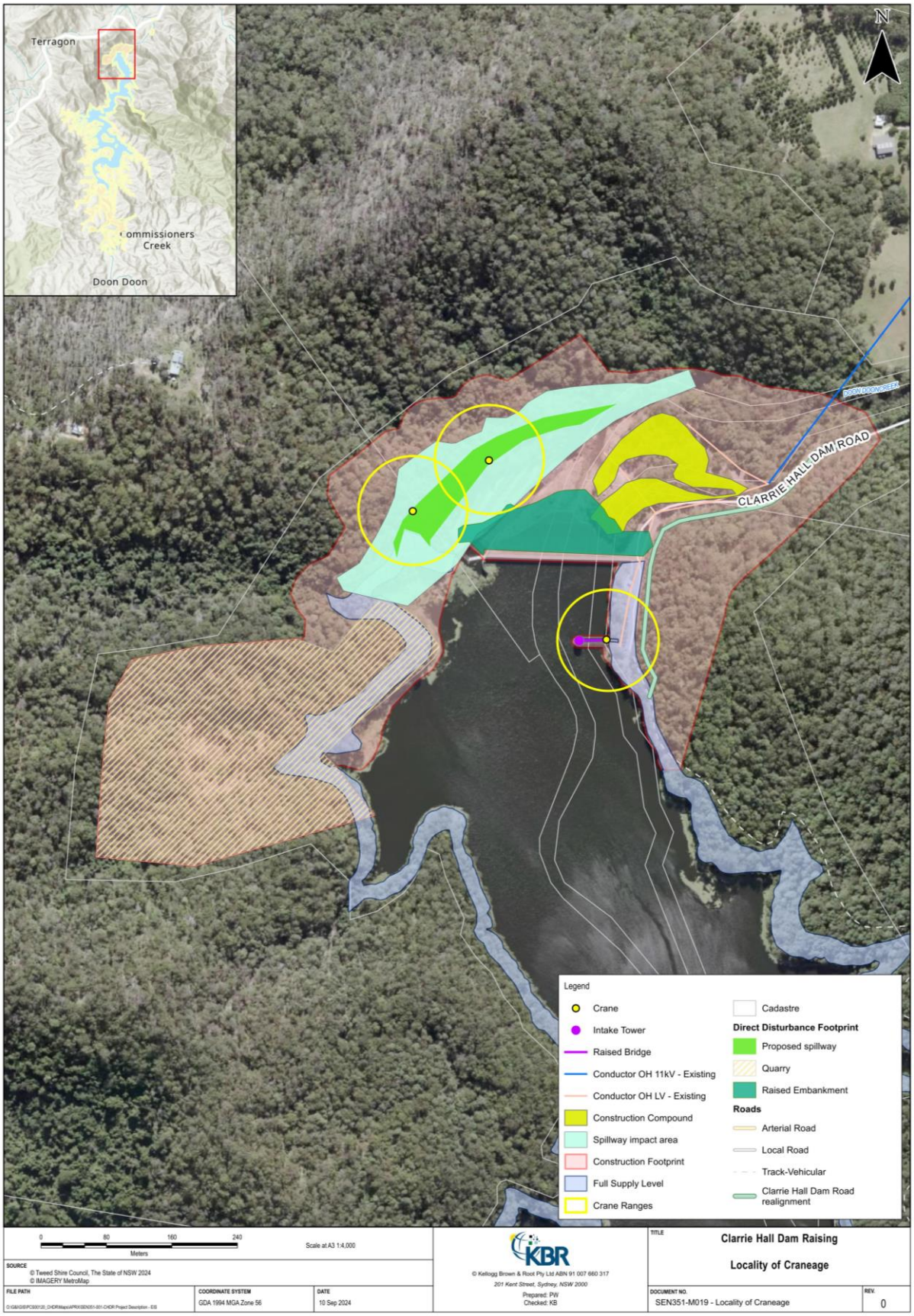


Figure 3-19 Spillway and intake tower craneage

Water supply

A raw water extract licence is assumed to be viable for all spillway operations, including excavations and dust control.

Wastewater

Wastewater will be collected via a plumbed storage tank for road tanker collection and exported to a centralised wastewater treatment facility by a commercial operator. Refer to section 6.9 for details of potential wastewater treatment facilities.

Wastewater from quarry/excavation operations, including dust control, the washing of products and the cleaning of equipment should be collected, settled and treated in accordance with environmental controls as documented in the EIS.

Footprint

Figure 3-20 indicates the potential impact footprint for the spillway excavation and construction area.

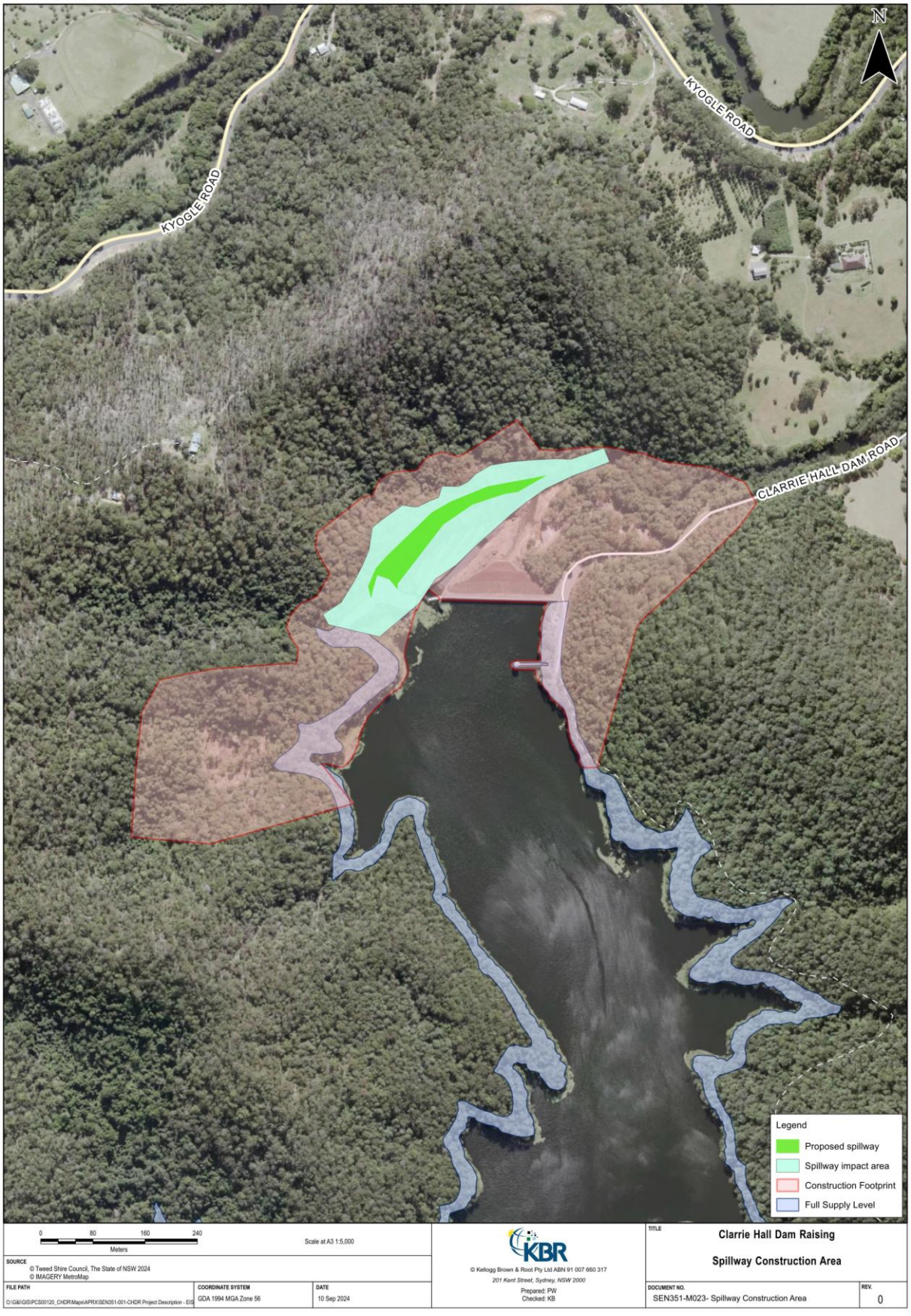


Figure 3-20 Spillway construction area

3.5.15 Ogee

The ogee surface would be reinforced, but the bulk centre would be mass concrete. It is assumed nominal 20 mm aggregate would be used for reinforced elements, and nominal 40 mm aggregate would be used for mass concrete.

3.5.16 Intake tower, access bridge and hoist house

A new hoist house similar to the existing hoist house is proposed to be constructed on top of the raised intake tower. The raised intake tower would have the radial beams built into its wall and a peripheral beam running on the outer edge of the radial beams (similar to the existing configuration) to support the floor and super structure. The existing compressed asbestos cement cladding would be replaced with other suitable material in the new hoist house.

Materials

It is assumed that nominal 20 mm aggregate would be used for the tower shaft, deck and bridge deck.

The bridge beam between spans 1 and 2 is assumed to be reused, and an additional beam between spans 2 and 3 is anticipated to be constructed externally and transported to the site from established pre-stressing concrete fabricators.

Craneage

Figure 3-19 indicates possible craneage coverage for the intake tower and bridge construction. Craneage here is considered for reinforcement placement, form- and falsework and general material movement. Crane capacity does not allow for placement of concrete or heavy lift of bridge elements. It is anticipated that a heavy lift crawler crane would be used for these elements.

With reconfiguration, the crawler may be able to undertake all aspects of this intake tower works.

To ensure continuity of service and supply control, it is assessed that this site craneage must also be suitable to support tower gate and screen duties following removal of the hoist room and crane.

The contractor would allow for access to and change of baulks and screens as required by Council.

Power

Due to the location of the intake tower site and likely need to disconnect existing power to the tower, all construction equipment for this works site would be diesel powered or sourced from diesel-powered generators. The advantage of using diesel is that there is flexibility in setting it up. This flexibility is also important when requirements change.

Water supply

The location is likely to be serviced by a satellite site setup with office and welfare facilities. Water may be piped from the main site set-up or existing site supply sources or brought in by water tank.

Wastewater

Wastewater would be collected via a plumbed storage tank for road tanker collection and exported to a centralised wastewater treatment facility by a commercial operator. Refer to section 6.9 for details of potential wastewater treatment facilities.

3.5.17 McCabes Bridge

A new McCabes Bridge is to be built approximately 40 m downstream of its current location. The bridge deck would be raised to 72.6 m AHD. A realignment of Commissioners Creek Road is also required to facilitate the bridge upgrade and approach roads.

The entire realignment is approximately 1,000 m to account for gullies and to reach the design level of RL 72.5 m.

There are 2 land parcels that could be used for construction compounds, laydown areas and stockpile locations close to the proposed new McCabes Bridge and road realignment. These are:

- lot 2 DP838936 –located at the southern end of the McCabes Bridge alignment works, with access off Doon Doon Road
- Crams Farm Reserve – lot 1 DP716151, which is located approximately 700 m north of the northern end of the McCabes Bridge alignment works, with sealed access from Commissioners Creek Road.

Both of these sites, as shown in Figure 3-11, are relatively flat and have open areas of grassland.

Materials for approach embankments will be primarily sourced from won materials from the dam site. McCabes Bridge would likely be an activity with a degree of flexibility in the construction schedule. Therefore, using either of the 2 sites above as a material stockpile location may be advantageous to allow movement and storage of these materials ahead of bridge/road construction. This would avoid the need to stockpile this material at the dam works site.

Concrete is expected to be provided by the dam site batching plant if required. Otherwise, careful consideration of mix design and transport durations will be required if concrete batching is sourced from existing commercial plants.

The proposed alignment also has some utility aspects (Telstra and Essential Energy) that need to be managed prior to clear and grade and subsequent site establishment.

Bridge precast beams are expected to be imported from third-party suppliers. It is considered that establishing onsite precasting may not be efficient, given the small quantity of units required.

Careful consideration of road construction sequencing will be required, as the proposed approach roads to the new bridge show raised embankments being constructed on the existing road alignment. This includes approximately 450 m of raised road on the existing alignment north of the new bridge, and 150 m of existing road alignment affected for the tie-ins at the intersection with Doon Doon Road. This has potentially significant implications for local access, as no other viable route appears to exist.

Upon completion of the approach road works, any elements of the existing bridge structure previously retained for construction stability would be removed. The complete earthworks would cut back the existing bridge abutment embankments as required.

Additional land impacts may eventuate from the development of temporary access routes alongside the approach road construction footprint, as alternative detour routes do not appear to exist, or are likely to be unacceptable due to the detour distance.

It is assumed nominal 20 mm aggregate would be used for the tower shaft, deck and bridge deck.

The bridge beam between spans 1 and 2 is assumed to be reused, and additional beam between spans 2 and 3 is anticipated to be constructed externally and transported to the site from established pre-stressing concrete fabricators.

Material for embankments is proposed to come from the main dam works site, transported via road haul trucks and the existing public road network (Kyogle Road and Doon Doon Road).

3.5.18 Utilities

Wastewater

Wastewater will be collected via a plumbed storage tank for road tanker collection and exported to a centralised wastewater treatment facility by a commercial operator.

Use of the natural terrain in this location will allow gravity drainage to the storage tanks. Tanks must be kept clear of the flow paths, flood inundation levels and tail water effects to ensure no discharge to river.

Wastewater management

Small-capacity facilities are assumed to be plumbed to storage tanks for regular tanker discharge and transport by road to a suitable treatment facility.

Workers accommodation would consider facilities and plumbing that would capture grey water for reuse (irrigation and toilet flushing). Sewage would be plumbed to storage tanks for tanker discharge and transport by road to a suitable treatment facility.

Reuse of grey water would likely be cost effective given the need for tanker transport of wastewater.

Tweed Shire Council operates multiple water and wastewater treatment facilities across the Tweed Shire. Tanker disposal of wastewater at the following facilities may be conducted during construction:

- Murwillumbah – capacity up to 3.8 megalitres per day, 16,000 Population Equivalent (PE) – 18 km (20 minutes)
- Banora Point – capacity up to 18 megalitres per day, 75,000 PE – 45 km (45 minutes)
- Kingscliff – capacity up to 6 megalitres per day, 25,000 PE – 45 km (45 minutes)
- Uki – capacity up to 190 kilolitres per day, 800 PE – 5 km (10 minutes).

The Uki plant is unlikely to be suitable for regular and significant tanker discharge. Both Murwillumbah and Banora Point wastewater treatment facilities are currently at capacity. It is recommended that wastewater be taken to Kingscliff Wastewater Treatment Plant.

The workers accommodation site has water requirements of approximately 150–200 L/p/d.

Water supply

Water abstraction from Clarrie Hall Dam and Doon Doon Creek is required for construction works. A water extraction licence may be required.

At workers accommodation and main work site compounds, potable water is to be processed onsite via portable packaged filtration units.

An alternative is to tanker water to onsite storage tanks.

Power

Essential Energy mapping shows that the key work areas and potential offsite compounds have the potential to be serviced from the existing overhead 11 kV network, as shown in Figure 3-21 and Figure 3-22.

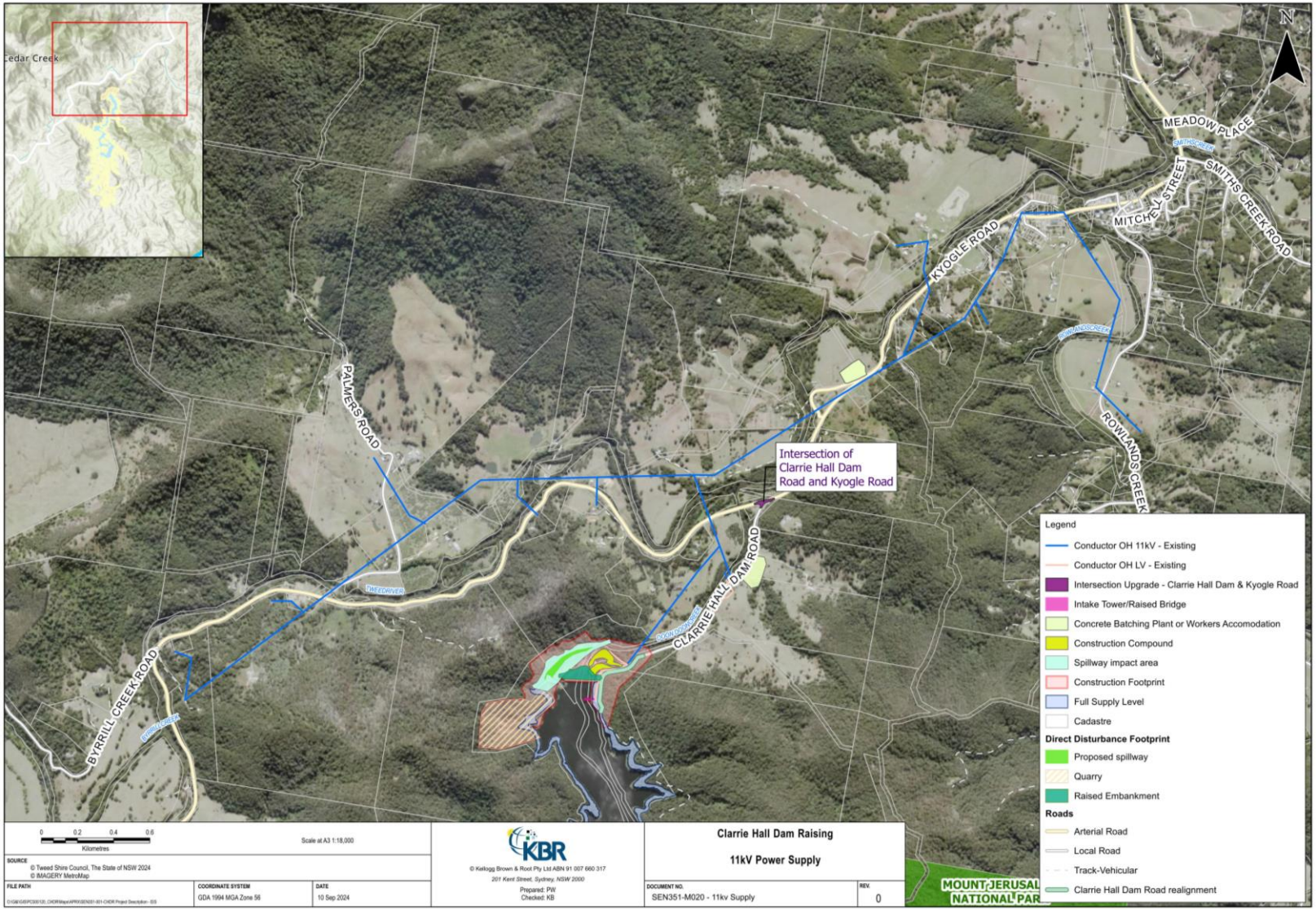


Figure 3-21 Electricity supply (11 kV) in the vicinity of Clarrie Hall Dam

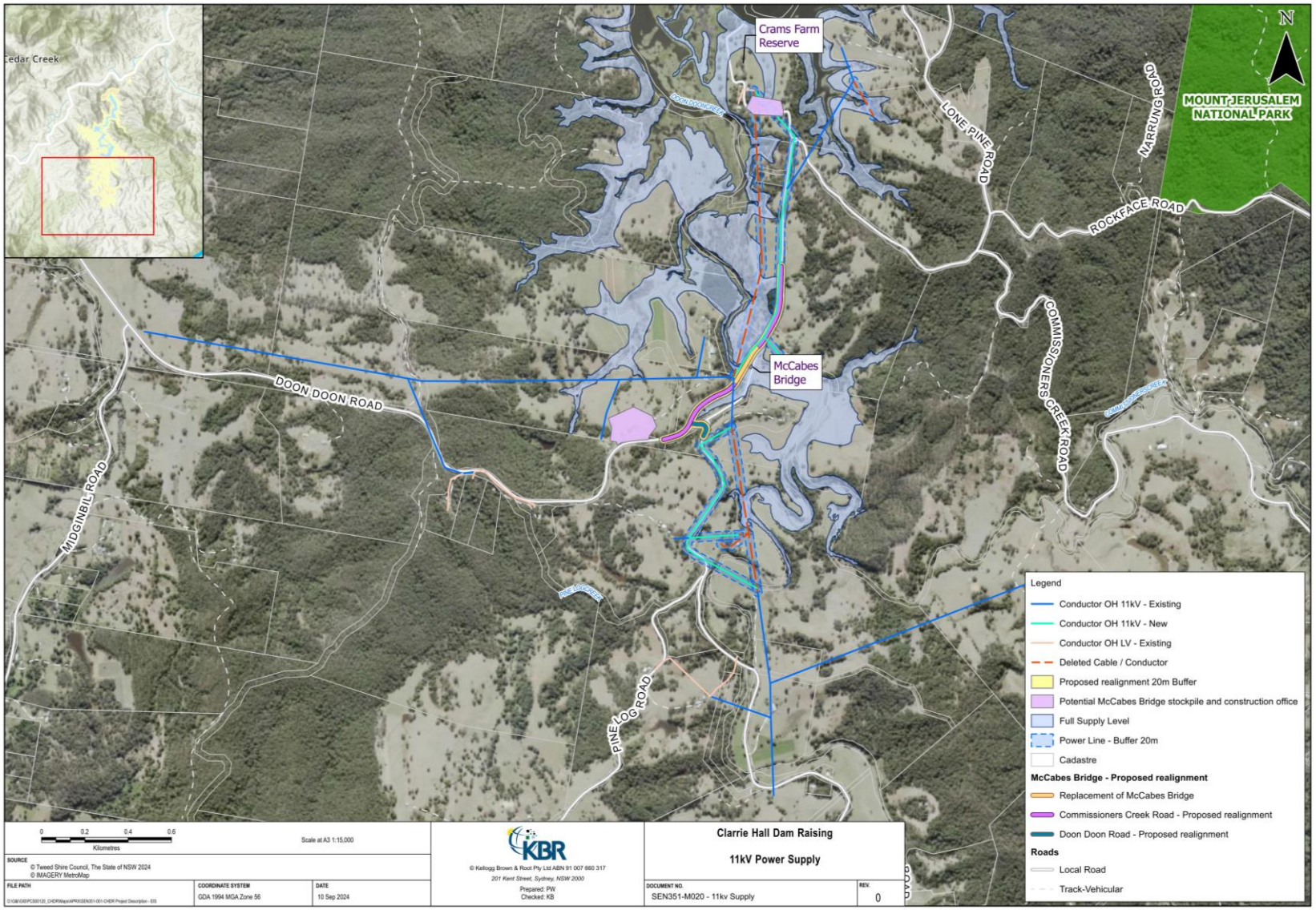


Figure 3-22 Electricity supply (11 kV) in the vicinity of McCabes Bridge work zone

3.5.19 Communications

According to the mobile phone coverage maps for Telstra and Optus, the area is generally well serviced however, in reality, there is only intermittent coverage around the dam wall.

This may be suitable for individual workers' personal communications, but specific high-capacity or high-speed infrastructure for construction may be required.

3.5.20 Recreational facilities near the dam wall

The existing recreational infrastructure located in downstream construction areas would be relocated or removed. Upon completion of the dam raising, the rockfill stockpile would no longer be required. Therefore, the area would be developed into a new recreational and operational facilities area including an amenities block, public shelters, viewing areas, interpretation signage, pathways, car parking, landscaping, security fencing and lighting. Dam operations monitoring equipment would be installed, and the boat ramp would be relocated to align with the new access road.

3.5.21 Existing property fences

Existing property fences located within the proposed FSL would be removed and replaced above FSL, where required.

3.5.22 Timber harvesting and areas of deeper water around the FSL

Timber harvesting of some existing plantation areas and some selected trees for fencing or other uses may occur in areas that would be inundated. Other areas of vegetation within the FSL may be cleared but stumps would be retained to assist with soil stabilisation and maintaining water quality, subject to management of biodiversity and land and soil risks as determined during detailed design.

It is also proposed that areas of deeper water be created around the new FSL to assist in algae growth mitigation.

3.5.23 Decommissioning and rehabilitation

Decommissioning of existing assets would be required.

3.6 PROJECT OPERATION AND WATER DELIVERY

3.6.1 Current operation of the dam

Clarrie Hall Dam is located on Doon Doon Creek, which is a generally north-flowing tributary of the Tweed River. Water is released down Doon Doon Creek to the Tweed River, where it is subsequently harvested at the Bray Park Weir.

The Tweed District water supply is currently a run-of-river supply augmented by releases from Clarrie Hall Dam. Raw water is drawn from upstream of Bray Park Weir, effectively a saltwater barrage, in the Tweed River. In periods of low flow in the river, flows are augmented by releases from Clarrie Hall Dam to ensure availability of water for the Tweed District water supply.

3.6.2 Dam structures

The spillway was upgraded in 2014, along with placement of precast concrete parapet wall units on the embankment crest, to pass the then probable maximum discharge of 1,355 m^3/s.

The intake tower consists of a 34 m high reinforced concrete tower with a 4 m outside diameter.

The tower is of the wet well type and is situated on a tower base structure at the head of the outlet tunnel, which is located under the right abutment. All releases from the intake tower are via

the tower's inlet ports through the tower's wet well to the connecting outlet works. Isolation of the intake tower is achieved with the aid of a circular horizontal bulkhead gate.

The installation and removal of the bulkhead gate, shutters, shutter spacers and trashracks are carried out under balanced head/no-flow conditions. The components are manoeuvred (raised and lowered) with the aid of the overhead gantry crane located above the operating deck of the intake tower.

The intake tower is designed for controlled variable withdrawal of water from the reservoir. Withdrawal of water occurs through a series of inlet ports 1.4 m wide by 1.5 m high (7 in total) located vertically in the face of the intake tower one above the other. An eighth low-level inlet (LLI) port is provided at the lowest point in the intake tower, for the purpose of emergency dewatering of the storage.

The LLI sits directly below the other 7 inlet ports and allows lowering the storage level to the lowest possible level in the event of an emergency. The LLI is located 5.85 m above the stream bed, allowing for anticipated siltation.

Trashracks are used to restrict debris entering the intake tower and outlet works. Selective withdrawal of water from the storage is achieved with the use of 6 shutters and 2 spacers. Shutters form a barrier at the inlet port that stops water entering the intake tower, while the spacers allow water to enter the intake tower and into the outlet works. Shutters are not designed to provide a watertight seal. The position of the shutters and spacers are interchangeable – the shutters are arranged as required to suit requirements related to the draw-off level. To facilitate the changeover of elements, an independent storage frame is located on the operating deck of the intake tower.

The trashracks may be operated for any of the following reasons:

- for exercising purposes
- to ascertain that the trashrack guide slots are free from silt and obstruction, which may prevent the trashrack from being manoeuvred in and out of the service guide slots
- to carry out inspection and/or maintenance activities
- to return to service after completion of an inspection and/or maintenance activities.

3.6.3 Conduits and monitors

An ultrasonic level sensor is installed on the operating deck of the intake tower to monitor the storage level. The level sensor is flange mounted on top of the removable grating panels that cover the trashrack service guide slots. Four fasteners are used to secure the sensor to the grating panel; in addition, the sensor sits within an aluminium enclosure for protection. The signal from the level sensor is transmitted back to the programmable logic controller of the outlet works control building via telemetry.

The outlet works consists of 2 interconnected conduits that each discharge into the downstream creek. The main conduit commences as a wet outlet tunnel at the base of the intake tower and converts at the tunnel plug into a 1,200 mm conduit within an accessible dry tunnel. This conduit operates during the emergency drawdown procedure. A 600 mm bypass outlet conduit commences at the base of the intake tower above the bulkhead gate and provides a second independent discharge to the creek.

Each outlet conduit is fitted with independent guard and control valves to assist with the release of water into the creek. The dam environmental releases are also able to be delivered via the 2 outlet conduits, allowing Council to fulfil its regulatory obligations.

A control building, constructed above the valve house, houses the electrical switch and control gear assembly (SCA) that provides power to outlet works equipment, and the hydraulic controls for the control valves.

Access into the valve house and dry tunnel is gained through the control building. A series of ladders, stairways and platforms provide access to various levels of the outlet works and equipment.

The main conduit has been designed to provide a normal operating flow of 1.55 m^3/s at FSL, and the bypass conduit can release a maximum flow of 10.6 m^3/s.

A second 1,200 mm diameter conduit was added through the downstream wall of the valve house to cater for a possible future upgrade of the system during the construction phase. At this stage, the second outlet is blanked off at both ends and is not connected to the main conduit.

The guard valve, complete with actuator, are designed to close under unbalanced head conditions in the event of an emergency. The valve is capable of closing against full flow that results from an inoperable control valve or from a burst penstock.

The end-of-line control (regulating) valves are a free discharge-type valve commonly referred to as a fixed dispersion cone valve (FDCV). A 400 mm diameter FDCV is located on the bypass conduit and a 900 mm diameter FDCV on the main conduit. The valves are intended to serve as flow-regulating valves and are designed to operate under unbalanced head conditions. The maximum discharge capacity for each valve with the storage at FSL is:

- 400 mm diameter FDCV – Q (flow rate) = 142.6 ML/day
- 900 mm diameter FDCV – Q (flow rate) = 865.7 ML/day.

However, as the storage level falls, the discharge capacity of the control valves reduces.

Information regarding the isolation valves is provided in Table 3-14.

Table 3-14 Valve information

Valve	Location	Valve type	Actuation type	Valve diameter	M flow	Working head	Rate pressure	Opening cycle	Closing cycle
1	Dry tunnel	Gate valve	Manual	600 mm	60 ML/day	60.0 m	100 bar		
2	Dry tunnel	Gate valve	Electric	600 mm	60 ML/day	60.0 m	100 bar	2.75 min	2.75 min
3	Dry outlet tunnel	Butterfly valve	Electric	1200 mm	220 ML/day	60.0 m	100 bar	3.0 min	3.0 min
4	Dry tunnel	Globe valve	Manual	100 mm					

3.6.4 Site services and facilities

Clarrie Hall Dam is operated using a number of site services. It also offers several public facilities.

Site services relate to:

- power – supplied by overhead mains to transformers
- non-potable water – supplied by the head of the dam via the 600 mm bypass conduit
- telephone – overhead cable to automatic telephone dialler in valve house control building
- effluent – Crams Farm cottage and public toilets flow to evapotranspiration beds.

The following public facilities are located on the right abutment overlooking the dam and areas immediately downstream of the embankment:

- public toilets at the dam wall – flow into holding tanks, which are then pumped out
- viewing platform
- picnic area.

The following monitoring equipment allows constant monitoring and measuring of the performance of the dam:

- v-notch weir – to measure embankment seepage
- flip buckets – one each side of the outlet tunnel
- spillway underdrains – one each side of the spillway
- storage level sensors – ultrasonic in inlet tower and a pressure transmitter in the outlet penstock
- rain gauge.

Survey pins on the upstream face, parapet wall and downstream face are used for deformation surveys.

A CCTV system with 4G connectivity is located on a 6 m high galvanized pole fixed to the right-hand spillway training wall. The system has 3 Hikvision Bullet, Darkfighter, 4MP, 8-32 mm (5A46) cameras that view:

- the dam crest and upstream face
- the spillway crest including level staff gauge
- the area downstream of the dam including the spillway flip bucket.

The system is powered by a 215 W solar panel on top of the mast and utilises 3 100 Ah lithium batteries that run the 60 W appliance (cameras and router switch) for 60 hours when the sun is less than 100%.

Clarrie Hall Dam is supplied electricity by the local electricity network operator, Essential Energy. An overhead high-voltage (HV) 11 kV feeder, originating from the zone substation at Murwillumbah, is reticulated through various villages on the way through to the dam site. At the entry road to the dam site, the voltage is transformed down to 400 V by an overhead substation. From this substation, a low-voltage (LV) 400 V overhead distribution mains network serves the various locations at the Clarrie Hall Dam, where LV electricity is used.

3.6.5 Destratification

A surface-mounted mechanical destratification system operated in the Clarrie Hall Dam between 2002 and 2015. It was upgraded in 2014. Over the 2014–2015 summer period, a destratification system trial identified that the upgraded mixer in operation was not able to prevent the dam from stratifying, which led to the mixer being decommissioned in 2016. Destratification of the dam is not currently performed.

The need for a destratification system and design is assessed in section 6.1.

3.6.6 Bray Park Weir

Bray Park Weir, built in 1960, is a critical component of the Tweed Shire Council infrastructure, as it provides in-stream storage for the Bray Park Water Treatment Plant. The weir comprises a sheetpile cut-off wall upstream core zone to minimise seepage through the joints and rockfill

zones for upstream and downstream erosion protection. A steel grillage founded on steel piles and connected to a concrete capping of the sheetpile helps to minimise erosion of the rockfill from the downstream slope of the weir.

3.6.7 Operation of flows

Council has a digital register of downstream users that may be affected by releases from the FCDVs. For all releases that will create a notable river rise (100 ML/day when dam storage is less than 100%), Council may choose to notify the downstream residents. Auditable and visual alarms at the outlet works also warn local users that the valve is about to operate.

Part 6 of the Water Sharing Plan requires environmental flows to be released from Clarrie Hall Dam into Doon Doon Creek as shown in Table 3-15. These flows are dependent on the dam level and the Palmers Road gauge level.

Table 3-15 Environmental flows from Clarrie Hall Dam

Volume released (ML/day)	Palmers Road flow (ML/day)	Palmers Road level (m)
1	≤ 3	≤ 0.262
2	3–13	0.262–0.400
4	≥ 13	≥ 0.400

A level of 20 mm over the spillway roughly equates to flows of 6 ML/day, so the only time additional releases are required to achieve the maximum environmental flows (4 ML/day) is when the dam level is less than 61.52 m AHD. To achieve the required additional flow, a 100 mm globe valve has been fitted to the dewatering line on the main outlet conduit. This valve can release up to 4.4 ML/day. Environmental releases can also be completed via the 600 mm bypass conduit.

Operators record the daily storage level as well as the average river gauge height for Palmers Road gauge. The data is used to establish the required volume released from the valve that is manually set via the valve hand wheel.

Council also needs to protect the water supplies available behind Bray Park Weir and the Uki extraction pool. License conditions for water extraction are also in place.

Therefore, certain steps must be followed to meet low flow requirements and maintain an appropriate water supply to Council's customers. For any release, the depth of the release at the intake tower needs to be selected first. The operator/engineer consults the depth profile sample information to obtain the layer of best quality water present in the dam. The tower shutters/spacers are adjusted to allow water to be extracted from this layer.

3.6.8 Maintenance

Maintenance is either preventative, corrective or emergency. The maintenance planning for Clarrie Hall Dam assets uses a risk-based approach as required by AS/ISO 55001 clause 6.1. A Failure Mode, Effects and Criticality Analysis has been developed for Clarrie Hall Dam to inform the maintenance planning.

Surveillance

An intermediate inspection by representatives of Council and Council's dam safety engineer is conducted annually. A major comprehensive surveillance inspection by representatives of Council and Council's dam safety engineer is also conducted 5-yearly.

Public access

Public access to the dam is restricted to:

- vehicles – no further than the area adjacent to the intake tower bridge
- pedestrians – no access to the intake tower, spillway, left abutment or the outlet valve house
- boats/canoes – no access north of the floating markers near intake tower.

Security gates are located at the entrance of Clarrie Hall Road and the entrance of Crams Farm. These gates are locked to the public each night and are open to the public between the following daylight hours:

- 7:00 am to 5:00 pm Australian Eastern Standard Time
- 7:00 am to 6:00 pm Australian Eastern Daylight Saving Time.

State Emergency Services (SES) personnel and Council's operational staff have key access to these gates.

Restricted access

Multiple signs at the 3 public car parks warn the public of the restrictions and dangers at Clarrie Hall Dam.

The intake tower is an operational area requiring restricted access.

The spillway has signage on the upstream and downstream ends that warn of the dangers and restriction to public access. A floating marker on the reservoir also warn the public of restricted access to the area in front of spillway. The spillway is hazardous due to steep slopes, high vertical walls, a plunge pool and excavated rock; therefore, it requires restricted access.

There is a security fence along the dam crest on the downstream side to restrict public access to the downstream face. Along the crest, multiple signs also inform the public of access restrictions and dangers.

Multiple signs are located at the outlet valve house to restrict public access and warn of danger related to releases from the outlet works. This area is restricted because it is an operational area, and reservoirs' releases through cone valves are hazardous to the public. A flashing light and alarm are used to warn the public at the excavated restricted area before a release is made.

Surrounding land management

The land surrounding the dam is identified as "Drinking Water Catchment" and Tweed Local Environmental Plan 2014.

The Clarrie Hall Dam Management Plan provides additional detail on permissible activities at Clarrie Hall Dam and Crams Farm. The main objectives of the Clarrie Hall Dam Management Plan are to ensure:

- acceptable water quality is maintained in accordance with public health standards for an off-stream regulation storage
- recreational use of the water and adjacent public land is appropriately controlled.

Management initiatives and activities described in the current plan would be reviewed to align with the Proposal. These include complying with the requirements of Part 7, Section 7.7 of the Tweed Local Environmental Plan 2014.

Fish stocking

Clarrie Hall Dam has been stocked with more than 300,000 Australian bass since 1991.

The following NSW Fisheries regulations apply to fishing at the dam:

- Two bass are allowed per person, with only one fish allowed to be longer than 35 cm.
- Catch and release is recommended in Clarrie Hall Dam.

In previous years, Council has participated in fish restocking as part of the DPI's Dollar for Dollar Native Fish Stocking Program. Council contributes to restocking when requested.

Recreation

Dam recreation area

The recreation area near the Clarrie Hall Dam wall is open to the public all year round, for day visits only. Access to the dam wall is via security gates on Clarrie Hall Dam Road, south-west of Uki.

The dam is surrounded by approximately 900 ha of Council-owned forested land and Mount Jerusalem National Park.

Recreational activities include photography, picnics, bushwalking and birdwatching. No overnight camping is allowed.

Facilities at Clarrie Hall Dam include toilets, picnic areas and electric barbecues. There is also a boat ramp that is used for operational purposes. Members of the public sometimes launch kayaks and canoes here, while private-owned trailer mounted boats are only permitted to be launched at Crams Farm.

Crams Farm recreation area

Crams Farm Reserve comprises 14 ha and is the main recreational area for the dam. Access to Cram's Farm is via security gates on Commissioners Creek Road, Doon Doon.

Facilities include:

- the Dairy sheltered picnic area with picnic tables and kitchenette (including power and water)
- the Piggery sheltered picnic area with electric barbecues and picnic tables
- Doon Doon Hall, which can be hired for weddings and events
- grassed area
- boat access
- toilet facilities.

Crams Farm Reserve is open from 7:30 am to 5:30 pm (6:30 pm during daylight saving). No swimming, overnight camping, livestock grazing, dogs or horses are allowed.

Boating

A concrete boat ramp is located at Crams Farm. Petrol and diesel motors are prohibited on the dam and must be removed from the boat before entering the water. Electric motors, sail boats, oared boats and kayaks are permitted.

Bushwalking

Fire trails and tracks around the dam are available for bushwalking (day visits only). No motorbikes or 4WDs are allowed.

3.6.9 Proposed dam operation

Tweed Shire Council does not propose any changes to the operation of the dam after the dam wall is raised. Water is to be released from the dam via the intake tower and outlet works to the downstream Doon Doon Creek and onto the Tweed River. Water is drawn for drinking water treatment at Uki (run-of-river system) and Bray Park (weir system).

The need for a stratification system was considered as part of the Surface Water Assessment (Appendix G1) which found that a stratification system is not required. Further details are provided in section 6.1 and Appendix G1

The CHD Operations and Maintenance Plan (revision 4.2, November 2022) (TSC 2022d) would be reviewed and updated to match the post-construction operation of the dam.



CHAPTER 4
Statutory context

4 Statutory context

This chapter describes how the Proposal meets the relevant statutory requirements, considering:

- the *Environmental Planning and Assessment Act 1979* (EP&A Act) and EP&A Regulation
- other relevant legislation
- environmental planning instruments and associated plans and guidance
- relevant approvals.

The SEARs state that the EIS must provide information on the statutory context. The relevant SEARs and where they are addressed in this EIS are shown in Table 4-1.

Table 4-1 SEARs for statutory and strategic context

SEARs for statutory and strategic context	Where addressed
1. Include consideration of how the project meets the provisions of the *Environmental Planning and Assessment Act 1979* (the EP&A Act) and the EP&A Regulation and a list of any approvals that must be obtained under any other Act or law before the project may lawfully be carried out.	Section 4.3 and Appendix C
2. Consider the provisions of relevant environmental planning instruments including: • *State Environmental Planning Policy (Planning Systems) 2021* • *State Environmental Planning Policy (Transport and Infrastructure) 2021* • *State Environmental Planning Policy (Primary Production) 2021* • *State Environmental Planning Policy (Biodiversity and Conservation) 2021* • *State Environmental Planning Policy (Resilience and Hazards) 2021* • Any other relevant State Environment Planning Policies (SEPPs), Regional Environmental Plans (REPs) Local Environmental Plans (LEPs), or draft SEPPs, REPs and LEPs.	Section 4.3 and Appendix C (Table C2) Chapter 2
3. Address the relevant planning provisions, goals and strategic planning objectives including but not limited to the following (or relevant draft documents that may supersede or supplement these): • Tweed Local Environmental Plan 2014 • Far North Coast Regional Water Strategy 2023 • Far North Coast – Implementation Plan Regional Water Strategy 2023 • North Coast Regional Plan 2041 • Relevant Tweed Shire Council policies plans and strategies, including: – Community Strategic Plan – Local Strategic Planning Statement – Integrated Water Cycle Management Plan – Water Supply Strategic Business Plan; and – Delivery Program and Operational Plan	Tweed Local Environmental Plan 2014 discussed in Sections 4.1 and 4.2 Other plans addressed in Chapter 2 and Chapter 3. Appendix C
4. Identify all approvals and licences required under environmental protection legislation including details of all scheduled activities, types of ancillary activities and types of discharges (to air, land and water).	Table 4-3 and Table 4-5 Appendix C

Table C-1 in Appendix C identifies how the relevant SEARs are addressed in the form of the EIS.

4.1 STATUTORY BACKGROUND

The Proposal has been progressed over a number of years. An overview of the statutory timeline is summarised in Table 4-2.

Table 4-2 Overview of the statutory background of the Proposal

Date	Status
2018	An application under Part 5, Division 5.2 (SSI) of the EP&A Act for the Proposal was submitted to the then NSW DPE
15 August 2018	SEARs issued for SSI 9458
27 February 2019	Referral decision that the Proposal is a controlled action under the EPBC Act (2018/8339)
23 April 2019	SEARs modified to include controlled action environmental assessment requirements
26 November 2021	Revised SEARs issued due to expiry of previous SEARs
30 June 2023	Request to vary the proposed controlled action accepted by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) to include: • upgrading the Kyogle Road and Clarrie Hall Dam Road intersection • replacing McCabes Bridge and realigning Commissioners Creek Road
22 November 2023	A new SSI application was submitted, as the revised SEARs were due to expire
22 December 2023	SEARs issued for SSI-65020460
31 May 2024	SEARs revised and re-issued for SSI-65020460

4.2 RELEVANT LEGISLATION

The following legislation has been identified as applicable to the Proposal when preparing an EIS under Division 5.2 of the EP&A Act:

- *Aboriginal Land Rights Act 1983*
- *Biodiversity Conservation Act 2016*
- *Biosecurity Act 2015*
- *Contaminated Land Management Act 1997*
- *Crown Land Management Act 2016*
- *Dams Safety Act 2015*
- *Dangerous Goods (Road and Rail Transport) Act 2008*
- *Electricity Supply Act 1995*
- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
- *Environmental Planning and Assessment Act 1979*
- *Fisheries Management Act 1994*
- *Heavy Vehicle (Adoption of National Law) Act 2013*
- *Heritage Act 1977*
- *Land Acquisition (Just Terms Compensation) Act 1991*
- *National Parks and Wildlife Act 1974*

- *Native Title Act 1993* (Commonwealth)
- *Protection of the Environment Operations Act 1997*
- *Roads Act 1993*
- *Rural Fires Act 1997*
- *Waste Avoidance and Resource Recovery Act 2001*
- *Water Management Act 2000*
- *Work Health and Safety Act 2011 and Work Health and Safety Regulation 2017*.

The application and relevance of the above legislation to the Proposal are provided in the detailed statutory compliance table in Appendix C (Table C-2).

The application of the following relevant environmental planning instruments is discussed in Table 4-3 or Appendix C (Table C-2). Land zoning information is shown in Figure 4-1.

Table 4-3 Identification of statutory requirements

Category	Details
Power to grant approval	The Proposal was declared State significant infrastructure by operation of Part 5, Division 5.2 of the EP&A Act, State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP), and State Environment Planning Policy (Transport and Infrastructure) 2021 (Transport and Infrastructure SEPP). Section 5.12(2) of the EP&A Act provides that a State environmental planning policy may declare any development, or any class or description of development, to be State significant infrastructure. The Planning Systems SEPP (section 2.13(1)) provides that development is State significant infrastructure if it is permissible without development consent under Part 4 of the EP&A Act and it is specified in the categories of development in Schedule 3 of the Planning Systems SEPP. The Proposal is permissible without consent as a result of the operation of the Transport and Infrastructure SEPP. Division 24, section 2.159 of the Transport and Infrastructure SEPP applies to development for the purpose of water supply systems and provides that development for the purpose of water storage facilities may be carried out by or on behalf of a public authority without consent on land in Zone RU1 Primary Production, Zone RU2 Rural Landscape, Zone SP1 Special Activities, Zone SP2 Infrastructure or an equivalent land use zone (discussed further under Permissibility below). As the Proposal is appropriately characterised as being for the purpose of a 'water storage facility' in accordance with the definitions provided in Schedule 3 of the Planning Systems SEPP, and is being undertaken by a public authority, the Proposal is permissible without consent. Schedule 3 (clause 1) of the Planning Systems SEPP defines State significant infrastructure as infrastructure that would be an activity for which the proponent is also the determining authority and would, in the opinion of the proponent, require an EIS to be prepared under Part 5 of the EP&A Act. Schedule 3 (clause 4) of the Planning Systems SEPP also defines State significant infrastructure as development for the purpose of water storage or water treatment facilities (not including desalination plants) carried out by or on behalf of a public authority that has a capital investment value of more than $30 million. The capital investment value (CIV) of the Proposal has been estimated by a Quantity Surveyor in accordance with the SEARs and Planning Circular PS 21-020: Calculation of capital investment value. The CIV is estimated at $304 million. As the Proposal is permissible without consent and meets clause 1 and 4 of Schedule 3 of the Planning Systems SEPP, it is declared State significant infrastructure. Therefore, the NSW Minister for Planning and Public Spaces is the approval authority for the Proposal under section 5.19 of the EP&A Act.

Category	Details
Permissibility	The Proposal is located on the following land use zones (see Figure 4-1) under the Tweed Local Environmental Plan 2014 (Tweed LEP 2014): SP2 – Infrastructure RU2 – Rural Landscape C1 – National Parks and Nature Reserves DM – Deferred Matter. The land use zoning is consistent with the zones identified in section 2.159(2)(a) of the Transport and Infrastructure SEPP with the exception of 'National Parks and Nature Reserves' and 'Deferred Matter' zoning. Clarrie Hall Dam encroaches on and contains catchment within Mount Jerusalem National Park. This is located to the east of the Proposal and is zoned C1 'National Parks and Nature Reserves'. Approximately 1.91 ha of Mount Jerusalem National Park has been revoked through the National Parks and Wildlife Legislation Amendment (Reservations) Bill 2020, which was passed by the NSW Government on 18 November 2020. The revoked land is vested in the Minister administering the *National Parks and Wildlife Act 1974* (NPW Act). In order to complete the transfer of the land to Council, Council is required to complete the necessary subdivision and title registration task. At the time of writing this EIS, the transfer is in progress. The 'Deferred Matter' zoning is a reference to Zone 7(I) 'Environmental Protection (Habitat) Public utility undertakings' in the Tweed LEP 2000. In this zone, development is permitted only with consent and must satisfy the provisions of clause 8(2) of the Tweed LEP 2000 (Consent Considerations). Council is conducting a review of the Deferred Matter zoning. Clarrie Hall Dam falls in stage 2 of Council's Deferred Matter zoning review area. The stage 1 review area, which is east of Pacific Highway (the coastal areas), is currently being finalised. Under Part 7, Section 7.7 of the Tweed LEP 2014, Clarrie Hall Dam is identified as "Drinking Water Catchment". The land is also identified as "Existing and Future Water Storage Facilities" and is marked on the Existing and Future Water Storage Facilities Map under 7.12 of Tweed LEP 2014.
Other approvals	
Approvals that should be substantially consistent with approved SSI	The Proposal may require the following additional approvals under section 5.24 of the EP&A Act: consent under section 138 of the *Roads Act 1993* for road upgrades to the public road network an environment protection licences (EPL) under the *Protection of the Environment Operations Act 1997* (POEO Act) approval under the *Dams Safety Act 2015* approval under the *Crown Lands Act 1989*. Refer to Table 4-5 for further information.
Approvals that are not required for approved SSI	Under section 5.23 of the EP&A Act, approvals and legislation that do not apply to SSI include: a permit under section 201, 205 or 219 of the *Fisheries Management Act 1994* an approval under Part 4, or an excavation permit under section 139, of the *Heritage Act 1977* an Aboriginal heritage impact permit under section 90 of the *National Parks and Wildlife Act 1974* a bushfire safety authority under section 100B of the *Rural Fires Act 1997* a water use approval under section 89, a water management work approval under section 90, or an activity approval (other than an aquifer interference approval) under section 91 of the *Water Management Act 2000*. In addition, Division 8 of Part 6 of the *Heritage Act* does not apply to prevent or interfere with the carrying out of approved SSI.

Category	Details
EPBC Act approval	The Proposal is being assessed under the bilateral agreement between the Australian and NSW governments, so a separate approval by the Commonwealth DCCEEW is not required.
Approvals that are not expressly integrated into the SSI assessment	Other approvals that are not expressly integrated into the SSI assessment include water access licences under the *Water Management Act 2000*, potential updates to the Tweed River Area Unregulated and Alluvial Water Sources WSP 2023 (refer to section 6.1) and possible leasing under the NPW Act. Water Sharing Plans (WSPs) are made under the Water Management Act 2000. WSPs set out the water management objectives for the relevant plan, establish environmental water, identify the requirements for water, and establish access licence dealing rules (trade rules). As discussed in section 6.01 (Hydrology), Clarrie Hall Dam is operated in accordance with the Tweed River Area Unregulated and Alluvial Water Sources WSP 2023.
Pre-conditions and mandatory matters	
Pre-conditions to exercising the power to grant approval	Section 5.22 of the EP&A Act confirms that: Part 4 and Division 5.1 of the EP&A Act do not apply to or in respect of SSI, except as expressly provided by Division 5.2 Part 3 of the EP&A Act and environmental planning instruments do not apply to or in respect of SSI except that they apply to the declaration of infrastructure as SSI or as CSSI, and to enabling infrastructure to be carried out in accordance with an approval granted under Part 5, Division 5.2 of the EP&A Act. Notwithstanding, relevant environmental planning instruments have been considered as part of this EIS in Appendix C (Table C-2) and include: State Environmental Planning Policy (Planning Systems) 2021 State Environmental Planning Policy (Transport and Infrastructure) 2021 State Environmental Planning Policy (Primary Production) 2021 State Environmental Planning Policy (Biodiversity and Conservation) 2021 State Environmental Planning Policy (Resilience and Hazards) 2021 Tweed Local Environmental Plan 2014. Refer to Table 4-4 for further information.
Mandatory matters for consideration	The matters that the Minister must consider when deciding whether to approve the carrying out of the Proposal are stated at section 5.19(2) of the EP&A Act. Part 3 (Planning Instruments) of the Act does not apply to or in relation to SSI except in limited circumstances. Refer to Table 4-4 for further information.

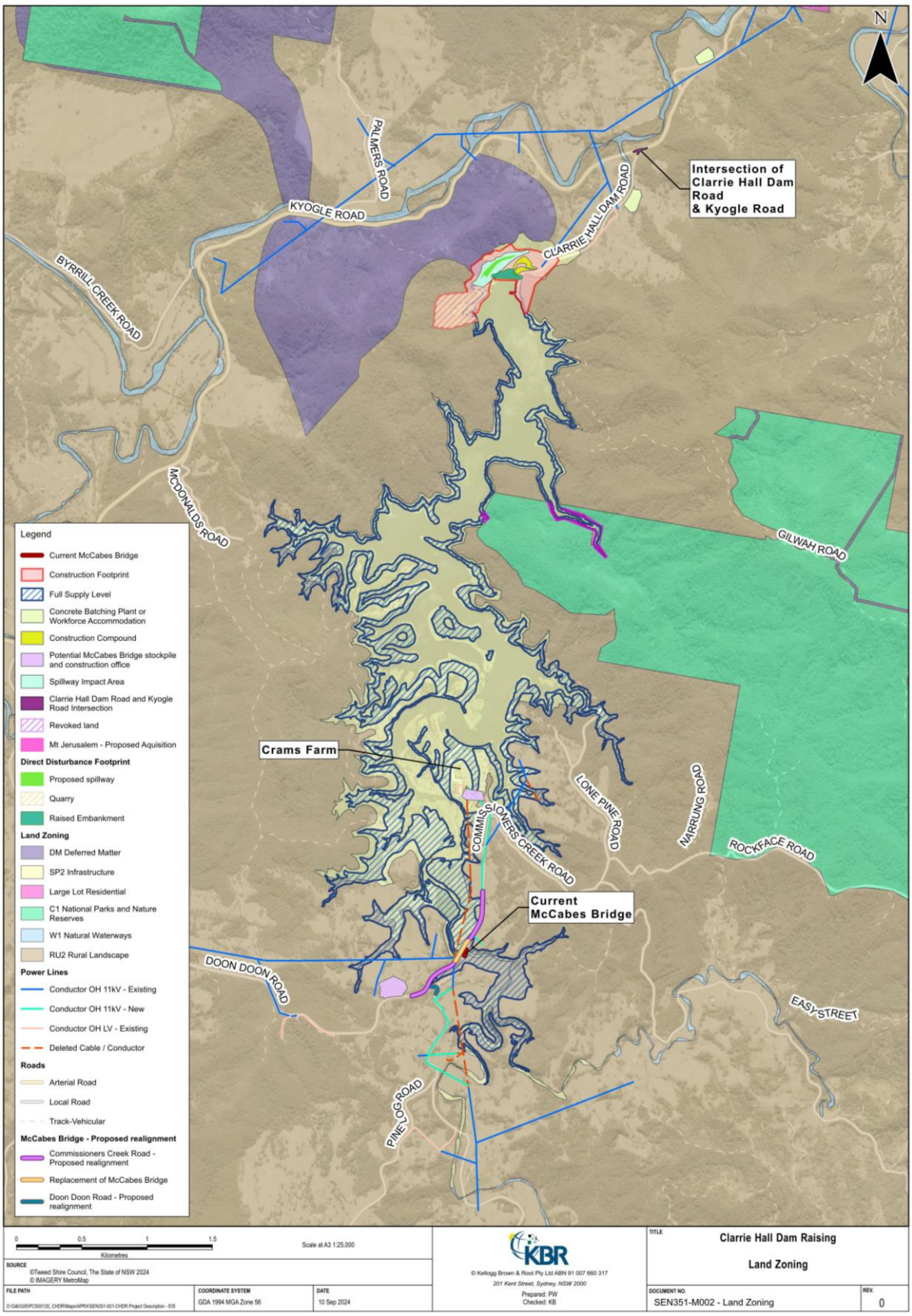


Figure 4-1 Land zoning of the Proposal area

Relevant and mandatory matters for consideration by the Minister, and any relevant pre-conditions, addressed in this EIS are identified in Table 4-4.

Table 4-4 Relevant and mandatory matters for consideration

Matters for consideration	Matter	Relevance/where considered
Pre-conditions to the Minister exercising the power to grant approval to the project	Under the EP&A Act, when an application is made for the Minister's approval for SSI, the Planning Secretary is to prepare environmental assessment requirements, or SEARs, in respect of the project. The EIS must address the SEARs for the project. All SSI projects require approval from the Minister for Planning (the Minister) or the Minister's delegate within the Department of Planning, Housing and Infrastructure under Division 5.2 of the EP&A Act before they may proceed. Prior to determination, they must go through comprehensive assessment with extensive community participation.	An SSI application for the Proposal was lodged in the required form on 22 November 2023. This EIS identifies how the SEARs are addressed.
	An EIS with respect to the infrastructure is made publicly available (s 5.26(2) of the EP&A Act).	This EIS for the Proposal will be publicly exhibited as per the minimum exhibition timeframe of 28 days. This period may be extended by the Minister for Planning and Public Spaces.
	The Planning Secretary must give their report on the SSI project to the Minister (s 5.19(1)(b) of the EP&A Act).	The Planning Secretary is responsible for providing the report to the Minster. Section 5.18 of the EP&A Act specifies what must be included in the Planning Secretary's report.
EP&A Act and consideration of biodiversity values	The EP&A Act has effect subject to the provisions of Part 7 of the *Biodiversity Conservation Act 2016* (NSW) (BC Act) (s 1.7 of the EP&A Act). Section 7.14 of the BC Act requires that the Minister, when determining an application for SSI that is required to be accompanied by a Biodiversity Development Assessment Report (BDAR) (which is the case for this Proposal), must consider the likely impact of the Proposal on biodiversity values as assessed in the BDAR. The Minister may (but is not required to) further consider under the EP&A Act, the likely impact of the Proposal on biodiversity values.	A BDAR for the Proposal has been completed and is provided in Appendix H. A summary has been provided in section 6.2 of this EIS.
Objects of the EP&A Act and ecologically sustainable development	When determining the project, the Minister must have regard to the objects of the EP&A Act, which includes the principles of ecologically sustainable development as specified at s 193 of the EP&A Regulation: (a) the precautionary principle (b) inter-generational equity (c) conservation of biological diversity and ecological integrity (d) improved valuation, pricing and incentive mechanisms.	This EIS has considered and addressed the principles of ecologically sustainable development (ESD) in the assessment of significance of biodiversity impacts (Appendix H and section 6.2), section 6.11 and Chapter 7.

Other approvals that may be required are identified in Table 4-5, and further details are provided in Appendix C (Table C-2).

Table 4-5 Other approvals required under NSW legislation

Act	Approval requirement	Relevance/where considered
Protection of the Environment Operations Act 1997	An EPL may be required for the construction phase of the Proposal in accordance with the following clauses of Schedule 1: • section 6 – cement or lime works • section 9 – chemical storage • section 16 – crushing, grinding or separating.	An environment protection licence may be required to construct the Proposal for one or more scheduled activities. Refer to Chapter 3 and section 6.13 for further information.
Roads Act 1993	Section 138 of the *Roads Act 1993* provides that consent from the relevant road authority is required to disturb, erect a structure, or carry out a work in, on or over a public road. Clause 5(1) of Schedule 2 exempts public authorities from this requirement, except in relation to works on or over classified and Crown roads.	Key roads subject to the Proposal include Kyogle Road, Doon Doon Road, Clarrie Hall Dam Road and Commissioners Creek Road, all local or rural roads. The Proposal involves works within public road reserves, therefore prior to those works being carried out, consent under section 138 of the *Roads Act 1993* will be obtained from Tweed Shire Council as the appropriate roads authority. Potential impacts to the road network are considered in section 6.14.
Dams Safety Act 2015	Dams Safety NSW has been, and will continue to be consulted on the design, construction and any changes in operation of the Proposal.	Section 6.13 (Health and safety) discusses compliance with Dams Safety NSW guidance
Crown Land Management Act 2016	This Act sets out the requirements for the management of Crown Land in NSW. This includes the permissions and authorisations needed when planning the development of activities on Crown Land as well as the process for the acquisition of Crown Land. The Proposal area includes 5 parcels of Crown Land, and Council have commenced discussions regarding acquiring this land.	Impacts to Crown Land are discussed in greater detail in section 6.7 (Social, land use and property).



CHAPTER 5
Engagement

5 Engagement

This chapter details the process and findings of the community and stakeholder engagement that was carried out for the Proposal and describes what further engagement will be conducted during exhibition of the EIS and if the project is approved.

Community and stakeholder engagement has been conducted to satisfy the relevant SEARs, as detailed in Table 5-1.

Table 5-1 Relevant SEARs - engagement

Relevant key issue requirements	Where addressed
1. During the preparation of the EIS, you must consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners. Ensure that all consultation undertaken is documented in the EIS. In particular you must consult with: (a) Australian Government Department of Climate Change Energy, the Environment and Water (b) NSW Department of Natural Resources Access Regulator (c) Department of Planning, Housing, and Infrastructure, specifically the: i. Crown Lands as applicable for consideration of any use or occupation of a Crown Reserve, road or waterway (d) NSW Department of Climate Change, Energy, the Environment and Water: i. NSW Climate and Energy Action ii. Environment and Heritage iii. DCCEEW Water iv. NPWS v. NSW Environment Protection Authority vi. NSW Biodiversity Conservation Trust vii. Adapt NSW (e) Department of Regional NSW, specifically: i. Department of Primary Industries - Fisheries ii. Regional NSW Group iii. Local Lands Services.	Section 5.2.4
2. The EIS must detail the engagement undertaken and demonstrate how it was consistent with the *Undertaking Engagement Guidelines for State Significant Projects* (DPE 2022c). The EIS must detail how issues raised and feedback provided have been considered and responded to in the project.	Chapter 5 Appendix D

The SEARs require the EIS consultation process to be documented and to demonstrate how the Proposal has responded to the inputs received. The following sections detail this process.

5.1 ENGAGEMENT PROCESS

Engagement has been conducted in accordance with: *Undertaking Engagement Guidelines for State Significant Projects* (DPE 2022d) which require engagement to be undertaken as early as possible including as part of site selection and scoping.

In accordance with the guidelines on undertaking engagement for state significant projects (DPE 2022d), the following process has been followed:.:

- plan early
- engage as early as possible
- ensure engagement is effective
- ensure engagement is proportionate to the scale and impact of the project
- be innovative
- be open and transparent about what can be influenced
- implement the community participation objectives.

This chapter demonstrates how the guidelines have been used to deliver community and stakeholder engagement for the Proposal.

A Communication and Engagement Plan (CEP) was developed by Council in 2015 following a resolution of Council to adopt Clarrie Hall Dam as the preferred option for future water security and to proceed with the land acquisition and planning approvals. The CEP was updated in 2017, 2019 and more recently in 2023.

To guide recent engagement activities and approach, the CEP was updated by KBR in 2023, in consultation with Council, to address the SEARs and Guidelines.

5.1.1 Overview

Council has informed and consulted with the community and stakeholders since 2009 on the need for long term water security solutions for the Tweed Shire, and specifically on this Proposal in relation to the need, design, and potential impacts. This has included engagement with landholders, local residents, members of the local Aboriginal community, government agencies, business and industry, and community groups.

The Community and Stakeholder Participation Report- Raising of Clarrie Hall Dam (Appendix D) provides a summary of community consultation undertaken between 2009 - 2022 and details of more recent consultation since November 2023.

The issues raised during the consultation activities and responses to consider and address these in the Proposal design and construction are provided in section 5.3.

5.1.2 Guiding policies and principles

The Communication and Engagement Plan (KBR 2023) expanded upon the Council's Communication and Engagement Plan to meet not only Council's requirements but also the NSW government requirements included in 'Undertaking Engagement Guidelines for State Significant Infrastructure (DPE 2022c).

The Proposal aligns with the following themes of Tweed Shire Council's Community Strategic Plan 2022- 2032:

- Living: We want to be safe at home and in the community with reliable essential services and infrastructure

- Goal 2.1: Provide safe, sustainable and affordable water supply and wastewater services as the foundations of a healthy community.

The engagement for the Clarrie Hall Dam raising was conducted in line with the Objectives and Principles outlined in the Tweed Shire Council Community Engagement and Participation Plan 2019-2024.

The Objectives are:

- Provide deliberative, early and broad-based engagement provides community-led recommendations to inform Council decision-making.
- Encourage the community to understand, be understood and learn from each other through a productive and inclusive exchange of views.
- Ensure that people receive timely information in plain language that is free of bias and easy to access.
- Be transparent and provide feedback on decisions, strengthen relationships and build mutual respect through ongoing engagement activities.
- Having the community partners value the professional staff for their guidance role in the engagement process.

The principles of community engagement and participation are:

- Engagement is based on social justice principles of access, equity, participation and rights.
- The community has a right and a responsibility to be informed and contribute to their community's future and matters that affect it.
- Information is in plain language, easily accessible and in a form that facilitates community participation.
- Council encourages effective and on-going partnerships with the community to provide meaningful opportunities for community participation in Council matters.
- Council engages with the community as early as possible to enable community views to be genuinely considered and to provide a framework for ongoing consultation.
- Community participation is inclusive, and Council actively seeks views that are representative of the community.
- Council uses appropriate methods of engagement with regard to a project's significance and likely impact.
- Decisions are based on evidence-based information and the representative views of the broader community.
- Decisions are made in an open and transparent way, and the community is provided with reasons where required for those decisions (including how community views have been considered).

This community and stakeholder engagement was conducted in accordance with NSW government guidance and it in line with the Objectives and Principles of Tweed Shire Council.

5.1.3 Objectives and engagement approach

The objectives of the engagement include those outlined below in Table 5-2, including actions that may meet the objectives.

Table 5-2 Objectives for the engagement and the resulting actions

Objective	Actions
Increase understanding of the reason the project is required in the context of water security	• Give details of the water consumption and calculations for the future water supply • Outline other ongoing actions to reduce water consumption in conjunction with this proposed dam raising.
Have people understand the planning approval process and when and how they can influence decisions	• Step out the plans for engagement through the various planning assessment stages. • Ask for input to aspects of the Proposal.
Take account of the community values, concerns, aspirations and expectations	• Articulate how Council and Council's actions align with the values and culture of the community. • Work with and meet with interested individuals to understand their values and what they want to see as part of the dam raising.
Build and maintain the trust of the community	• Continue to engage, acknowledge dissenting views and do not marginalise these stakeholders. • Seek consent and agreement from stakeholders when the Proposal would be impacting them directly.
Pre-empt potential concerns/ issues and address these before they are raised by stakeholders	• Provide information which highlights the potential risks, issues and impacts of the proposal. • Anticipate and understand community issues and communicate these.
Be responsive and open to changes	• Look for ways that the project might be able to mitigate or address the concerns of stakeholders and/or articulate what cannot be changed/ is non- negotiable.
Give the community confidence in the decision-making process	• Outline the role of the various authorities that will include DPHI, Council and other expertise that will contribute to the studies of the EIS.
Show respect to the community and their perspectives	• Acknowledge the community's valid concerns. • Continue dialogue with all.

5.1.4 Identification of Stakeholders

Stakeholders included those who might be either interested in and/or impacted by the Proposal. The focus of the consultation was to provide an opportunity to identify issues for consideration in the EIS.

The engagement aimed to encompass:

- surrounding landowners/neighbours
- recreational users of the dam and Crams Farm
- those within a larger radius of the dam site
- those who had engaged through previous project stages
- community organisations and groups.

A detailed list encompassing these groups was developed since 2015. This included over 500 stakeholders/stakeholder organisations. Of these, 250 provided email contact details. Others were contacted through other means outlined in section 5.2 of this chapter.

Council has led extensive consultation over many years with surrounding landholders whose properties would be directly affected due to inundation. Property owners were also consulted

regarding changes required to infrastructure including McCabes Bridge and Commissioners Creek Road, power lines and telecommunications services. More recent landholder consultation has been conducted to discuss potential locations for the concrete batching plant, construction workers accommodation and construction compounds.

Consultation with Registered Aboriginal Parties was conducted as part of the Aboriginal Cultural Heritage Assessment which is summarised in section 6.5.

Table 5-3 provides a list of stakeholders and their potential interest in the Proposal. This list was developed as part of the planning for the consultation. Some of these stakeholders were engaged through earlier consultation, others were contacted as part of the more recent consultation leading up to exhibition of the EIS.

Table 5-3 Stakeholder groups and their potential interest in the Proposal

Category	Stakeholder groups	Interest in the Proposal
Approvers/ key decision-makers	• Department of Planning, Housing, and Infrastructure (DPHI) • Department of Climate Change, Energy, the Environment and Water (DCCEEW) • Tweed Shire Council • Transport for NSW (roads) • Councillors	• Ensuring that all impacts are considered and mitigated in the public interest • Responsibly meeting the requirements for water supply to the community • Protecting the environment • Ensuring that there is adequate infrastructure to support the project • Ensuring that the project is delivered on time and budget
Other government	• Agencies requiring consultation as part of the EIS • State local members of Parliament – Lismore • Federal local member of Parliament – Richmond • NSW Rural Fire Service • Energy distributors/ utilities – Essential Energy	• Ensuring that the actions of decision makers are in the interest of the public • Protecting the environment, Aboriginal heritage and other matters • Ensuring construction and operation of the dam considers the need for continuation of the services to the community and in particular continuity of emergency services
Local affected residents	• Local residents (owners and occupiers) • Businesses (owners and operators) • Residents of Commissioners Creek and Doon Doon areas • Residents of Uki	• Uki and surrounds as the community closest to the site • Landowners whose properties would have water inundation at the full level of a raised dam or in Probable Maximum Flood • Residents of Commissioners Creek whose road access would be cut at McCabes Bridge at the full water level after the dam is raised • Landowners affected by the location of ancillary construction activities
Wider community interests	• Users of the Crams Farm Reserve • Special interest group and in particular environment groups i.e., Landcare and Team Koala • Community Reference Group (former members)	• Need to plan and provide for future generations • Being leaders of community group able to identify vulnerable and hard to reach people who need to be engaged • Protecting the environment and the wellbeing and amenity of the community

Category	Stakeholder groups	Interest in the Proposal
	• Resident, Environment, and Industry Group Roundtable (REIGR) • Tweed Shire residents and ratepayers • Tweed Shire Council water customers • Aboriginal Advisory Committee • Tweed River Committee • Council staff • Youth Council • Construction and other industry in Uki and Murwillumbah	• Communicating about the proposal and impacts • Being at risk of impact to the Shire on future water supply and potential impact on water rates • Protecting the environment and the current recreation resource • Undertaking additional interpretive and recreation activities in association with the dam
Other organisations	• Industry and farming associations • Growers/agriculturalists and other businesses using water • Land management groups i.e., local land care groups • Chamber of Commerce • Tweed Tourism Company • Real estate agencies in Uki and Murwillumbah • Rotary • Schools • Tweed Shire Parks and Active Communities • Sporting groups Tweed Shire Parks and Active Communities • Sporting groups	• Maintaining or enhancing business interests • Protecting the land and current uses • Protecting the environment and the current recreation resource • Undertaking additional interpretive and recreation activities in association with the Dam
Aboriginal Organisations	• Traditional owners and custodians	• Having Aboriginal land or heritage interests • Protecting heritage items and locations
Media	• Local press –online and print • Local and community radio and television • Council media department • Local social media groups	• Disseminating accurate information about the proposal • Interacting with the community about questions and concerns that they may have

5.2 ENGAGEMENT ACTIVITIES

Tweed Shire Council has consulted with the local community and key stakeholders to obtain input on the development of water security options and on the development of the preferred option, the raising of Clarrie Hall Dam.

5.2.1 Water security consultation

Considerable investigation and community consultation has been undertaken to date with respect to augmenting the Tweed water supply. Council has been engaging with stakeholders regarding water augmentation options since 2009.

In determining a preferred water augmentation option, input from the community was considered in a year-long community engagement process. The engagement also included the formation of a Community Working Group (CWG), which held 5 meetings from December 2009 to March 2010. The CWG was tasked with reviewing and commenting on the various options. It proposed Clarrie Hall Dam raising as the preferred option.

A Fine Screen assessment of the options was then carried out. The Fine Screen Assessment of Options report, completed by MWH in September 2010 was informed through detailed studies and information from a comprehensive Community Consultation process. The detailed information was sourced through:

- additional consultants reports focusing on environmental, cultural heritage, planning and costing issues;
- consultation with stakeholder groups including potentially affected landholders, the Aboriginal community, government agencies, and community groups;
- consultation with residents and the Tweed community through a comprehensive six month process;
- facilitation of the CWG; and
- feedback and submissions provided through a designated email address and Freecall 1800 number.

A Submission Report was prepared by Council in August 2010, consolidating all feedback on the Water Supply Augmentation project received by Council from the Tweed community between October 2009 and May 2010.

The Fine Screen assessment had narrowed the options to three. The CWG then considered and assessed the remaining options:

- Raise Clarrie Hall Dam
- New Byrrill Creek Dam
- Pipeline to SEQ Water

The options were assessed on the criteria of Environmental Impact and Social Impacts of the options. The CWG assessed the options on the rating of:

- I can live with this option
- I don't know / am not sure
- I cannot live with this option

The results showed that more people (15) could "live with" the raising of Clarrie Hall Dam than could "live with" New Byrrill Creek (4). Fewest (2) could "live with" Pipeline to SEQ Water.

Similarly, the results showed that the fewest people (2) "cannot live with" Raise Clarrie Hall Dam compared to fourteen (14) who "cannot live with" with Byrrill Creek Dam and five (5) who could not live with Pipeline to SEQ Water.

Subtracting "cannot live with" numbers from "can live with" ranks the options in order of preference were:

- Raise Clarrie Hall Dam (13)
- Pipeline to SEQ Water (-3)
- New Byrrill Creek Dam (-10).

Based on this assessment, and including additional comments by members of the CWG, a Recommendations report was prepared and put to Council. The report recommended that the preferred option for augmenting the Tweed District Water Supply was the raising of Clarrie Hall Dam.

In November 2015, a renewed assessment of the previously shortlisted options was undertaken by Council staff. Consistent with Council resolutions, the options of raising Clarrie Hall Dam and link to SEQ Water were considered in the new assessment. In addition, three different Byrrill Creek Dam options and a link to Gold Coast City Council were also considered. The options considered were:

- Raise Clarrie Hall Dam
- Build Small Byrrill Creek Dam
- Build Small Byrrill Creek Dam and raise it at a later date
- Build Large Byrrill Creek Dam
- Link to SEQ Water
- Link to Gold Coast City Council.

Council considered an analysis of various aspects and impacts of the options.

In December 2015, Council resolved to adopt the raising of Clarrie Hall Dam as the preferred option for future water security and proceed with the planning approval and land acquisitions phase for the Proposal, subject to Council continuing to undertake comprehensive investigations of Council's water supply–demand options.

In October 2016, Council approved the commencement of a range of investigations at Clarrie Hall Dam to further inform the project team, Councillors and the community on the potential impacts of the Proposal, and to further guide decision-making in relation to a preferred option.

Investigations into the biodiversity, heritage, hydrology and geology of the Proposal area were undertaken and informed the development of a concept design for the Proposal prepared by NSW PWA. Council is now progressing the preferred option to raise Clarrie Hall Dam, consistent with the 2015 resolution.

More recently, Council has participated in engagement activities with the NSW DPHI during preparation of the draft and final Far North Coast Regional Water Strategy, discussed in section 2.2.3.

5.2.2 Consultation with the local community

Overview

Consultation with the community has been conducted since 2015.

Community consultation for the Proposal after 2018 aimed to address the SEARs issued in 2018.

Engagement activities, conducted during the 2016–2024 period are outlined in Table 5-4. A summary of community views from the engagement activities is provided in Section 5.3.

Table 5-4 Timeline of consultation with the local community

Date	Audience / Purpose	Activity
13 January 2016	NSW Government agencies – were consulted with about Clarrie Hall Dam Raising Proposal	A letter was sent to Department of Planning, Office of Environment and Heritage, Office of Water, and Fisheries NSW about the commencement of planning for the Proposal.
April 2016	Impacted landholders – were informed of impacts and acquisitions	Face-to-face meetings with all directly impacted landowners started.
25 May 2016	NSW Government agencies – were consulted with about the Proposal to raise the Clarrie Hall Dam	A workshop on Environmental Flow Studies was attended by DPIE Water and DPI-Fisheries representatives.
20 July 2016	Local Aboriginal community – were consulted with about the Proposal to raise Clarrie Hall Dam	A preliminary cultural heritage workshop was undertaken. Attended by Office of Environment and Heritage representative, Tweed Shire Council, Tweed Aboriginal Co-Op, Tweed Byron Local Aboriginal Land Council, Joel Slabb, Kyle Slabb.
September 2016	Impacted landholders – were informed of the impacts of the dam raising	Letters were sent to all properties affected by access associated with the proposed inundation of McCabes Bridge.
11 October 2016	Public – the community was consulted with about the Proposal's impacts and assessment process	The first public meeting was held at Crams Farm. Landowners directly affected by the Proposal and other interested members of the public from the area attended. 24 properties were engaged and provided permission for flora and fauna surveys, with one landowner assisting by providing boat storage and access; another was the point of contact for emergencies.
21 February 2017	Public - Inform community about the Proposal progress	Article in *Tweed Link* issue 994 "Green Light for Clarrie Hall concept design phase" (TSC 2017a).
16 March 2017	Note	Council resolved to reconvene the Community Working Group (CWG) to review Tweed District water supply, demand management and drought management strategies and to develop the Terms of Reference for a Project Reference Group (PRG). This was called the Water Strategies Review PRG.
April 2017	Impacted landholders – were informed and consulted with regarding impacts of the Proposal and replacement bridge options	McCabes Bridge Replacement Options Report was sent to directly impacted landholders, including those affected by access, inviting comments. Council contacted all impacted residents to hold a series of workshops to discuss the optimal route and measures to ensure ongoing access to properties.
5 April 2017	Public – the community was informed about the Proposal's progress	TSC presentation on the Proposal to Murwillumbah Rotary.
21 June 2017	Impacted landholders – were informed and consulted with regarding impacts of the Proposal and replacement bridge options	An information session was held at Crams Farm where 5 options for replacement of the bridge were discussed. Two options were selected by the community for further investigation.

Date	Audience / Purpose	Activity
August 2017	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	The second Open Day was held during August 2017 at the dam wall area to inform interested residents, recreational users, and stakeholders on the Proposal and to provide the community with further information on various studies and assessments, including cultural heritage, flora and fauna, and engineering concept design elements through the use of pop-up stands and displays. There were more than 40 community attendees. A video presentation (TSC 2017c)of the day was uploaded on Council's YouTube channel. The event was also reported in an article in the *Tweed Link,* issue 1018 titled 'Clarrie Hall Dam insights pull a curious crowd' (8 August 2017) (TSC 2017b).
17 August 2017	Public – the community was informed about the Proposal's progress	Article in *The Echo* titled 'Local Aborigines invited to discuss dam-raising project' (The Echo 2017).
4 December 2017	Impacted landholders – were informed about replacement bridge options	Letter confirming two options for road access once McCabes Bridge is inundated by the Proposal: a higher bridge at the current location or a new road to link Doon Doon Road upstream of McCabes Bridge to Commissioners Creek Road. Sent to 58 directly impacted stakeholders.
7 December 2017	Note	Council resolved to establish the Water Strategies Review Project Reference Group (PRG) however, the PRG was not formed until March 2019.
30 January 2018	Public – the community was informed about the Proposal's progress	Article about the project in *Tweed Link* issue 1039 (TSC 2018a) and requesting nominations for Project Reference group.
February 2018	Impacted landholders – were informed about replacement bridge options	A revised Options Report, *Replacement of McCabe's Bridge, Doon Doon* (TSC 2018b) was prepared and sent to all interested stakeholders – those directly impacted by the inundation of the bridge and those who have previously expressed an interest at open days.
February - March 2018	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	Presentations at Chambers of Commerce for Murwillumbah, Tweed Heads and Kingscliff.
20 March 2018	Impacted landholders – were informed and consulted with regarding replacement bridge options	A meeting was held at Doon Doon Hall to discuss bridge replacement options. The local community selected the preferred access option for bridge replacement.
26 April 2018	Note	Council accepted the community's recommendation on the preferred access option for bridge replacement.
1 May 2018	Public – the community was informed about the Proposal's progress	Article in the *Tweed Link,* issue 1052 titled 'New Doon Doon bridge for dam raising' (TSC 2018c).

Date	Audience / Purpose	Activity
12 June 2018	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	Article in the *Tweed Link,* issue 1058 titled 'Protecting aquatic life' (TSC 2018d). It included a request for information, contact phone number and Your Say Tweed website address.
12 June 2018	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	Article in *The Echo* titled 'Understanding the impact of raising Clarrie Hall Dam' (The Echo 2018). It included an invitation to provide information via the website or phone.
3 July 2018	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	Article in the *Tweed Link,* issue 1061 titled 'Scientists surveying aquatic habitat' (TSC 2018e). It included a request for information, contact phone number and the Your Say Tweed website address.
17 July 2018	Public – the community was informed about the Proposal's progress	Article in the *Tweed Link,* issue 1063 titled 'Clarrie Hall Dam wall raising plans reach milestone' (TSC 2018f).
15 August 2018	Note	SEARs were issued for the Proposal
21 August 2018	Public – the community was informed about the Proposal progress	Article in the *Tweed Link,* issue 1068 titled 'Dam milestone' (TSC 2018g).
24 October 2018	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	An Uki public meeting took place to discuss the Tweed Shire Council Open Space Strategy and provide an update on the Proposal. It was attended by 24 local residents. Attendees at this information session explained they heard about the session through various means, including newspaper advertisements, posters (local post office), social media (Facebook), word of mouth and promotion by another group (Rail Trail).
18 February 2019	Note	Council selected the new McCabes Bridge Replacement alignment.
7 March 2019	Note	Council endorsed the proposed methodology and WSR PRG membership. Note the WSR PRG was set up in response to a Council resolution and Council's desire to check its water supply augmentation, demand management and drought management strategies.
19 March 2019	PRG – the community was consulted with and informed about water supply options, augmentation options, the Proposal's impacts and assessment process	The Water Strategies Review Project Reference Group was formed. This group consisted of the members from the 2009–2010 Community Working Group, representatives of key interest groups including Landcare, the farming community, service clubs, ratepayer and resident groups and the Caldera Environment Centre. It included one former councillor and two current councillors. This group considered the Proposal in the context of overall water strategies for the Tweed Shire.
23 April 2019	Note	SEARs for the Proposal were reissued as a controlled action under the EPBC Act.

Date	Audience / Purpose	Activity
21 May 2019	Public – the community was informed about the Proposal's progress	Article in the Tweed Link, issue 1104 titled 'Environmental impact statement process starts for proposed raising of Clarrie Hall Dam' (TSC 2019b).
16 July 2019	Public – the community was informed about the Proposal's progress	Article in the *Tweed Link*, issue 1112 titled 'What's happening with the Clarrie Hall Dam project' (TSC 2019c).
12 November 2019	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	The Clarrie Hall Dam Raising Council staff project team made a presentation to the Resident, Environment and Industry Group Roundtable forum on the Proposal.
20 December 2019	Public – the community was consulted with about the Proposal's impacts and assessment process	The Environmental Impact Statement process began.
4 February 2020	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	The communication plan was developed for the raising of the wall of Clarrie Hall Dam.
September and November 2020	Local community – was consulted with and informed about the Proposal's impacts and assessment process	Additional targeted consultation was conducted to review and refine the social values of the potentially impacted communities and stakeholders to inform the Social Baseline Assessment and Social Impact Assessment (Appendix L).
September 2020	Public – the community was consulted with and informed about	Council had a stand at the Sustainable Living Expo 2020 where information about the Proposal was provided.
8 September 2020	Public – the community was informed about the Proposal's impacts	Article in *The Echo* titled '19 archaeological sites to be inundated by dam' (The Echo 2020). Includes an invitation to make a submission via the Your Say Tweed website.
December 2020	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	Delivery of Tweed District Water Supply Augmentation Project Report Summary (Workplace Edge 2020) to Tweed Shire Council.
February 2021	Public – the community was informed about the Proposal	Publication of the draft EIS summary on the Your Say Tweed website.
Mid-February 2021	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	Promotion and development of online engagement through the Council Your Say Tweed engagement portal in response to EIS progress. Within this engagement, stakeholders could view a video, read an EIS summary and complete a survey.
3 March 2021	Public – the community was informed about the Proposal progress	Article in the *Tweed Link,* issue 1191 titled 'Have your say on raising wall of Clarrie Hall Dam' (TSC 2021a).
16 March 2021	Public – the community was consulted with and informed about the Proposal's impacts and assessment process	A presentation by Council officers was made to the Resident, Environment and Industry Group roundtable forum on the Proposal.

Date	Audience / Purpose	Activity
18 March 2021	Note	WSR PRG makes 19 recommendations to Council. Council resolves to adopt all 19 recommendations. Council resolved to the following: Integrated water management with adaptive pathways - Council adopts an integrated water management approach with adaptive pathways in the development of its future water strategies. Clarrie Hall Dam – Council proceeds with the raising of the Clarrie Hall Dam; and continues the work on planning and land acquisition, in accordance with the existing project schedule for this work which is consistent with Council's resolution. Concurrently, Council further investigates other options as recommended in this report that may be able to diversify water supply, be less reliant on rainfall dependent sources, and improve the security and longevity of the yield. Council disbanded the PRG.
26 March 2021	Note	The 3-week survey on Council's Your Say Tweed engagement portal for the Proposal closed and responses were collated.
February 2023	Public – the community was informed about the Proposal's progress	Update to the 'Environmental Impact Statement for raising Clarrie Hall Dam' page on the Your Say Tweed website to inform the community of the work KBR was to conduct for the first phase of the EIS.
8 May 2023	Public – the community was informed about the Proposal's progress	Tweed Shire Facebook page notification 'The Environmental Impact Statement (EIS) for the proposal to raise Clarrie Hall Dam is progressing, with KBR recently appointed to complete the EIS preparations.'
10 May 2023	Public – the community was informed about the Proposal's progress	Article in the Tweed Link, issue 1299 titled 'Work resumes on Environmental Impact Statement for raising Clarrie Hall Dam' (TSC 2023a).
15 - 19 January	Public – the community was informed about the Proposal's progress	A project update newsletter was distributed to local households and businesses.
17 January 2024	Public – the community was informed about the public information sessions	Article in the Tweed Link, issue 1331 titled 'Keep up with Clarrie Hall Dam raising EIS' (TSC 2024c).
18 January 2024	Public – the community was informed about the public information sessions	Tweed Shire Facebook page notification to inform the community of the upcoming information sessions.
29 and 31 January 2024	Public – the community was informed about the public information sessions	Article in the Tweed Link, issue 1333 (TSC 2024d)and an advertisement promoting the information sessions.
31 January 2024	Public – the community was informed about the public information sessions and the Proposal's progress	Tweed Shire Facebook page notification to inform the community of the upcoming information sessions and EIS.

Date	Audience / Purpose	Activity
28 February 2024	Public – the community was informed about the Proposal's progress	Article in the Tweed Link, issue 1337 titled 'The latest on raising Clarrie Hall Dam' (TSC 2024e). Post information session and inviting further input.
6-7 February 2024	Public – community information sessions were held	Two community information sessions were held across two days in the Uki and Murwillumbah townships respectively. Residents of the Tweed Shire were invited to drop in and ask questions or express any concerns regarding the Proposal. Questions and concerns were noted. Residents were provided with follow up information if required.
10 April 2024	Public – local association was informed about the Proposal, and members were consulted	Council presented the Proposal and conducted a Q&A session with Casuarina, Seaside and Salt Residents Association.
7 May 2024	Public – local association was informed about the proposal, and members were consulted	Council responded to communication sent to Minister Rose Jackson's office from the NSW Farmers Federation, Far North Coast Branch.
28 May 2024	Public – local association was informed about the proposal, and members were consulted with	Council met with a representative of the Uki Residents Association to provide information for an article in the Uki News.

Engagement methods

Council has engaged with the community through information displays at the Clarrie Hall Dam open days, social media channels and presentations at Service Clubs. Council has regularly provided the community with information through the Tweed Link newsletter which is Council's weekly newspaper that was previously mailed to all shire residents and is now included as an insert in the Tweed Valley Weekly. Multiple communication formats have been used to inform the community, including hardcopy and digital information materials, information stalls and open days. Feedback forms through the 'Your Say Tweed' Proposal website and Council's social media channels were also utilised as informal consultation avenues. People can also ask questions on the 'Your Say Tweed' Proposal website page and register their interest in the Proposal. Registrants receive updates and mailouts.

Recent consultation during the 2023 to 2024 period utilised methods of communication and engagement shown in Table 5-5 to provide the public with relevant information and opportunities to submit feedback.

Table 5-5 Methods used to communicate and engage with the public

Method	Description of activity
yoursay@tweed.nsw.gov.au	Email to everyone registered on 'Your Say Tweed', not just for this proposal, to express concerns and get responses to questions from Council staff.
Customer service phone number (02 6670 2460)	Callers were referred to a member of the project team to respond to questions and issues.
Your Say Tweed web page 'Raising Clarrie Hall Dam – Environmental Impact Assessment' http://www.yoursaytweed.com.au/clarriehalldameis	Council continued to provide information via a Your Say Tweed web page 'Raising Clarrie Hall Dam – Environmental Impact Statement' (TSC 2024f). People are able to register their interest in the project and will be sent future information about the EIS or can have their questions answered through the platform.

Method	Description of activity
	This page was updated with information in December 2023. Additions at this time were: • updated project timeline • information about the public information sessions held in Uki and Murwillumbah in February 2024 • updated information about the progress of the EIS • frequently asked questions and answers (FAQs). This site continues to be visible to all, describes the proposal, provides updates and invites input to the EIS preparation stage.
Tweed Link	Advertisements about the project and the 2024 information sessions were placed in the Council publication Tweed Link on the following dates: • 10 May 2023 – work resumes on Environmental Impact Statement for raising Clarrie Hall Dam • 17 January 2024 – keep up with Clarrie Hall Dam raising EIS - information sessions • 29 January 2024 and 31 January 2024 – editorial and advertisement promotion for information sessions • 28 February 2024 – the latest on raising Clarrie Hall Dam. posting information session and inviting further input
Two-page hard copy Project Update – January 2024 A copy of the newsletter and a map of the area that received the newsletter is provided in Appendix D.	A project update, or newsletter, was distributed via Australia Post to 11,364 households and businesses. The distribution was via letterboxes or post boxes using the Australia Post rounds identified as closest to the dam site. Every effort was made to ensure that the properties closest to the site were covered. The distribution occurred mostly during the 15 to the 19 January 2024 period. There were a few notifications that may have arrived in the week to follow 19 January due to Australia Post misplacement. The objectives were to make the community aware of the Proposal and invite them to discuss the Proposal and/or meet with the team through the community information sessions.
Targeted email notification	An email to notify about the information sessions, with a copy of the project update attached was distributed to 250 people/groups on the stakeholder data base list – that is, all those on the list that had email addresses (including those potentially affected and/or interested). The email was also sent to approximately 6,500 email addresses signed up to Your Say Tweed.
Public information sessions	There were two in-person community information sessions: one at Uki, the closest town to the dam site, and one at Murwillumbah, which is the larger regional town. These were held as follows: • Tuesday 6 February 2024, 4 pm – 6.30 pm – Holy Trinity Anglican Church, 1473 Kyogle Road, Uki • Wednesday 7 February 2024, 12 pm – 2 pm – CWA Hall, 20 Queen Street, Murwillumbah. Refer to Table 7.2 and section 8 for details. The sessions were held on two different days and times of the day to maximise potential access by a range of participants. The format for both was a drop-in session, where CHDR EIS and project team members were available to answer questions and to discuss issues. Some matters were addressed subsequent to the session through follow-up calls and emails; other matters to be addressed through the EIS. People could come and

Method	Description of activity
	go within the advertised session time. Written information was available along with maps of the site.
Media – newspaper articles/ ABC	The media releases from Council resulted in articles including in The Northern Rivers Times, Daily Telegraph, Tweed Shire Council Environmental & Sustainability Newsletter, ABC North Coast Radio, Big Volcano Visitor Guide, ABC news. The dates and topics of these articles are detailed in Appendix D.
Meetings with individuals and interest groups	Meetings were offered for stakeholders. There were some meetings with interest groups held as part of preparation of the Social Impact Assessment. There were one-on-one meetings and calls with stakeholders who might be directly impacted, as ancillary infrastructure would be on or near their property.
Media releases	Council regularly distributes media releases to a subscriber base of more than 2,450 people – made up of media, business and industry contacts and residents who have self-subscribed. Similar themes are the basis for social media such as Facebook, Instagram and LinkedIn. A list of media releases prepared and the dates that they were distributed are listed in Appendix D.
Tweed Shire Facebook	The following notifications were provided via the Tweed Shire Facebook page. • 8 May 2023 – the Environmental Impact Statement (EIS) for the proposal to raise Clarrie Hall Dam is progressing, with KBR recently appointed to complete the EIS • 18 January 2024 – information sessions • 31 January 2024 – information sessions and EIS.
Council digital marketing screens	From 15 January 2024, there was a promotion for Have Your Say in the form of a video on digital marketing screens in the customer service areas of Murwillumbah and Tweed Heads Council offices.

In addition to the above, signage providing information relevant to the Proposal has been erected at the dam wall area (Figure 5-1) and Crams Farm Recreation area (Figure 5-2).



Figure 5-1 Project information signage displayed at the dam wall



Figure 5-2 Project information signage displayed at Crams Farm

Landowner consultation

The proposed raising of Clarrie Hall Dam would require the acquisition of inundated land and would include a 7 m maintenance zone extending from the RL 77 m contour. All affected landholders have been approached to discuss property acquisitions or boundary adjustments, including fencing realignments and temporary leases.

The Proposal would also require ancillary infrastructure for both the construction and operation phase. Landowners that would be impacted by construction of ancillary infrastructure, such as the concrete batching plant, construction compounds and workers accommodation, have been approached to discuss the use of property during the construction phase. Landowners that would be impacted by the construction of McCabes Bridge and realignment of Commissioners Creek Road were also approached to discuss access and impacts to property from construction and operation of the ancillary infrastructure.

Consultation with landholders was undertaken utilising a variety of formats including letters, email, phone calls and face-to-face meetings. The preferred contact method for each landholder was considered and utilised where appropriate.

Recent community information sessions

The most recent community information sessions were held on 6 and 7 February 2024, inviting the local communities of Uki and Murwillumbah respectively to ask questions about the Proposal and voice any concerns. The community information sessions were attended by Council and the KBR project team to ensure accurate and relevant information was provided to stakeholders.

5.2.3 Consultation with Aboriginal stakeholders

Consultation with Aboriginal stakeholders commenced in 2010 when the Community Working Group consulted the Aboriginal community during fine screening of options (TSC 2010). A timeline of the consultation with the Aboriginal Community conducted from 2016 is outlined in Table 5-6. Details of the consultation is provided in the Aboriginal Cultural Heritage Assessment Report (ACHAR) for the Proposal in Appendix J and summarised in section 6.5.

Table 5-6 Timeline of consultation with the Aboriginal Community

Date	Who	What
11 February 2016	Letter to AAC explaining project background and justification for raising CHD. Note the overlap in Aboriginal Advisory Committee (AAC) members and RAPs	Discussion about the Proposal including the strategic need

Date	Who	What
3 June 2016	Presentation on the Clarrie Hall Dam Raising water supply augmentation to the AAC Meeting	Discussion about the Proposal including the strategic need
20 July 2016	Office of Environment and Heritage representatives, Tweed Shire Council, Tweed Aboriginal Co-Op, Tweed Byron Local Aboriginal Land Council, Joel Slabb, Kyle Slabb	Preliminary Cultural Heritage workshop was undertaken by Council
26 July 2017	Navin Officer Heritage Consultants (NOHC)	Advertisement in the Tweed Daily News
8 August 2017	NOHC	Article in Tweed Link
August 2017	Tweed Byron Local Aboriginal Land Council Aboriginal Advisory committee: Tweed Shire Council North Coast Local Land Services NSW Office of Environment and Heritage Native Title Services Corporation Ltd Office of the Registrar Aboriginal Land Rights Act 1983 Aaron Talbott and Natalene Mercy Banjalang Aboriginal Corporation Bundjalung Elders Council Aboriginal Corporation Burabi Aboriginal Corporation Burra: Waj: Ad Canowindra Tweed Byron Aged and Disabled Aboriginal Corporation Minjungbal Cultural Museum Tweed Aboriginal Co-operative Society Bundjalung Tribal Society Durahrwa Training and Development Aboriginal Corporation Jackie McDonald Jason McDonald	Letters from Navin Officer Heritage Consultants (NOHC) – notification of project and requesting registration of interest
28 August 2017	Registered Aboriginal Persons (RAPs): • Tweed Byron Local Aboriginal Land Council • Jackie McDonald • Jason McDonald • Kyle Slabb (c/o Tweed Byron Local Aboriginal Land Council) • Paul Buxton • Mleeka Hart (Tweed Aboriginal Co-operative Society Pty Ltd)	NOHC requested preliminary survey methodology and cultural information.
7 September 2017	RAPs	NOHC undertook a preliminary methodology workshop

Date	Who	What
19 September 2017	RAPs	NOHC sent out the revised survey methodology
9 October 2017	NOHC and RAPs	NOHC undertook a second workshop – seeking further comment on survey methodology and logistics of an upcoming archaeological survey field program
16-27 October 2019	Ian Fox, Des Williams and Warren Phillips (Tweed Byron Local Aboriginal Land Council); Jason McDonald, Paul Buxton and Adam Mazarella (Mc Donald Family); Mleeka Hart and Mark Rotumah (Tweed Co-op)	Workshop and site inspection with NOHC and RAP participants
15 March 2018	RAPs	NOHC completed the draft Aboriginal Cultural Heritage Assessment Report (ACHAR).
10 April 2018	RAPs	All RAPs were invited to a workshop held at the Tweed Heads Civic Centre, to discuss the Draft Aboriginal Cultural Heritage Assessment conducted by NOH and the broader Clarrie Hall Dam raising project, including the strategic need.
21 May 2018	RAPs	Written comments submitted to NOHC.
June 2018	NOHC	NOHC Clarrie Hall Dam Raising Archaeological Assessment and Aboriginal Cultural Heritage Assessment Report were finalised and shared with RAPs
26 September 2018	NOHC and RAPs	The community mapping workshop involved attending members of local Registered Aboriginal Parties (RAPs) to review the existing site mapping generated from the archaeological survey of the Clarrie Hall Dam study area. These maps were presented on large broadsheet formats, allowing individuals to outline and define expectations and parameters for the updating of the predictive mapping layers.
29 January 2020	EcoLogical Australia (ELA) and RAPs	ELA sent an introduction email
February 2020	ELA and RAPs	ELA responded to the introduction of RAPs
18 May 2020	ELA and RAPs	ELA supplied the proposed methodology submitted for review by RAPs
11 June 2020	RAPs	ELA issued an invitation to test excavation
29 June 2020	ELA and RAPs	9 week test excavation program begins
1 March 2021	Tweed Byron LALC	ACHMP review comments submitted to ELA
14 March 2021	Tweed Byron LALC	Letter responding to ACHMP review comments sent by ELA
29 March 2021	ELA	ELA invites to RAPs to participate in further surveys

Date	Who	What
19-22 April 2021	ELA and RAPs	ELA undertook an additional field survey
22 April 2021	RAPs	A meeting was held with the TBLALC and the RAPs where ELA updated the group on the progress of the EIS, reinforced the strategic need for the project and discussed comments received on the draft ACHMP. Potential impacts and management strategies at specific cultural heritage sites were also discussed.
20 May 2021	RAPs	ELA provided a revised ACHAMP to RAP for review
3 June 2021	RAP	A meeting with Tweed Council and ELA took place to review the ACHAMP
25 June 2021	Jackie McDonald	An objection letter was submitted to ELA
25 June 2021	TBLALC	The response to the ACHAMP was submitted to ELA
22 July 2021	RAPs	Tweed Shire Council held a meeting to provide a presentation on the Proposal background, strategic need to augment the water supply, options assessment and past and future demand management /water efficiency programs.
18 May 2023	Heritage NSW, NTS Corp, National Title Tribunal, Office of the Registrar, North Coast Local Land Services	Government agency pre-notification
1 June 2023	Tweed Shire Residents	Advertisement in *Tweed Valley Weekly* for registrations of interest
31 May 2023 - 14 June 2023	Potential Aboriginal stakeholders	Notification and registration of potential Aboriginal stakeholders
4 July 2023	Heritage NSW Tweed Byron LALC	Advising Heritage NSW and Tweed Byron LALC of RAPs
18 July 2023 - 14 August 2023	RAPs	Presentation of information about the proposed project and additional tasks
31 July 2023	RAPs	Cultural values mapping study invitation
14 - 15 August 2023	EMM and RAPs	Fieldwork – rockshelter management site visit
26 - 26 September 2023	EMM and RAPs	Fieldwork – cultural values mapping
17 - 18 January 2024	EMM and RAPs	Fieldwork – additional survey
17 June 2024 - 19 July 2024	EMM and RAPs	Review of the draft ACHAR report

5.2.4 Consultation with government agencies

Consultation with government agencies was undertaken at various stages of the Proposal to provide updates to the relevant agencies, discuss impacts of the Proposal and seek advice for mitigation of certain impacts.

An overview of the consultation undertaken to date with relevant government agencies for the Proposal is outlined in Table 5-7.

Table 5-7 Government agency consultation

Government agency	Details
Various agencies	A number of agencies were involved in preliminary workshops in 2016.
Various agencies	Letter sent to Department of Planning, National Parks and Wildlife Service NPWS), Office of Environment and Heritage, Office of Water, and Fisheries NSW on 13 January 2016 advising of the commencement of planning for the Proposal
DPIE Water, NPWS and DPI-Fisheries	Workshop on Environmental Flow Studies held on 25 May 2016
NSW Department of Planning and Environment (DPE)	Council and DPE (now Department of Planning, Housing and Infrastructure) representatives have had fortnightly meetings since March 2021.
DPE Water	A meeting was held with DPE Water on 17 February 2023 to discuss the Proposal.
DPI-Fisheries	Meetings with DPI-Fisheries were held on 16 February 2023 and 9 March 2023 to discuss the hydrology modelling and the aquatic ecology assessment. DPI-Fisheries provided comments on the proposed aquatic ecology assessment. Correspondence was received from DPI-Fisheries dated 14 July 2023 regarding the section 218 determination for the proposed raising of Clarrie Hall Dam. The correspondence advised that DPI-Fisheries has assessed the scope of the raising of the Clarrie Hall Dam project and has recommended the application of section 218, which requires the provision of suitable fish passage. As part of the determination, DPI-Fisheries proposed that section 218 fish passage requirements for Clarrie Hall Dam be transferred to the construction of suitable fish passage at Bray Park Weir. A meeting was held on 9 February 2024 to discuss the construction area around Doon Doon Creek downstream of dam wall and Aquatic offsets. A potential construction compound layout and constraints at the site was presented.
Biodiversity Conservation Directorate (BCD)	May 2020 – a survey strategy for the Biodiversity Assessment Method (BAM) was developed. September 2020 – advice was provided on the agreed approach for threatened flora surveys and amphibians, forest owls, brush-tailed phascogale and reptiles. Additional guidance, requirements and recommendations were provided for the assessment of koala habitat, bat surveys and glossy black-cockatoo. Updates on ecological findings were provided as surveys progressed and feedback was incorporated as work progressed (an advice record is available). June 2023 – biodiversity development assessment report (BDAR) gap analysis and a proposed methodology were submitted to BCD for comment and discussion. A meeting with BCD was held on 26 July 2023. August 2023 – a follow-up meeting with BCD was held on 9 August 2023 to clarify and discuss the survey methodology. Communication and correspondence with BCD have continued throughout BDAR survey planning, conducting the surveys and during preparation of the BDAR.

Government agency	Details
Biodiversity Conservation Trust (BCT)	BCT were contacted regarding a site meeting to look at potential offset sites. BCT advised that offsets are to be developed in accordance with the Biodiversity Offset Scheme.
Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW)	An EPBC referral was submitted in 2018. The proposed action was deemed a 'Controlled Action' under the EPBC Act (EPBC 2018/8339). A meeting was held with DCCEEW on 16 February 2023 to discuss varying the proposed action to increase the disturbance footprint by 3.5 ha, to facilitate: • upgrading of the intersection of Clarrie Hall Dam Road and Kyogle Road • realignment of Commissioners Creek Road, including replacement of McCabes Bridge. A letter requesting to vary the proposed action was subsequently submitted to DCCEEW, and a decision notice dated 30 June 2023 was received by Council, approving the variation to the proposed action.
National Parks and Wildlife Service (NPWS)	22 December 2016 – Council enquired regarding any reports or fauna data for Mount Jerusalem National Park. Council also organised a key to access eastern ridgeline of Mount Jerusalem National Park to assist in fauna surveys associated with the Proposal. February 2018 – Council liaison with Senior Policy Officer NSW NPWS and Regional Area Manager regarding revocation of land within Mount Jerusalem National Park for the proposed Clarrie Hall Dam raising. 24 September 2018 – Enquiry with NPWS regional staff regarding status of the Hinterland Trail project and opportunities to connect with land adjacent to Clarrie Hall Dam. 9 October 2019 – Council arranged a meeting with a Ranger - Tweed Byron Area, North Coast Region, NSW NPWS regarding offset options for revocation of land at Mount Jerusalem National Park. 29 January 2020 – Meeting with Council staff and Ranger - Tweed Byron Area, North Coast Region, NSW NPWS to discuss offset options for revocation of land at Mount Jerusalem National Park. 1 February 2020 to 17 November 2020 – Multiple emails over a 9 month period discussing and organising preparation of material for bill of parliament for revocation of portion of Mount Jerusalem National Park. November 2020 – 1.91 ha of land from the Mount Jerusalem National Park was identified and revoked for the Proposal. 18 November 2020 – Meeting with NPWS planning, biodiversity and Park management staff to discuss offset options for revocation of land at Mount Jerusalem National Park. 21 September 2021 – Correspondence sent to Tweed Byron Area, North Coast Region, NSW NPWS Regional Manager regarding consideration of Council's proposed offset strategy for the Clarrie Hall Dam raising proposal. 15 March 2024 – Email correspondence and confirmation from NSW NPWS A/Team Leader Ranger Tweed Byron Area for additional surveys within Mount Jerusalem National Park associated with Clarrie Hall Dam Raising EIS. 7 August 2024 – Correspondence sent to the Area Manager NPWS North Coast Branch providing a summary of a meeting held in July 2024 to discuss the potential for using land bordering Mount Jerusalem National Park to meet land compensation requirements under the revocation and also potential sites for the retirement of biodiversity credits.
NSW Rural Fire Service	The NSW RFS, Far North Coast Fire Control Centre (Murwillumbah) provided input on fire weather conditions, fire history and ignition factors.
State Emergency Service	December 2020 – consultation took place with NSW SES Hazard Planning branch via letter. Issues addressed included aspects of dam safety and flood emergency planning.

Government agency	Details
	1 August 2024 – consultation took place with NSW SES Risk Reduction Assessment branch via a meeting. Issues addressed included aspects of dam safety, future dam safety assessments and updated flood modelling.
Dams Safety NSW	Dams Safety NSW were consulted during development of the concept design and will be further involved during the development of the Dam Safety Emergency Plan for the Proposal.
DCCEEW and Department of Planning, Housing and Infrastructure (DPHI) Water Working Group DCCEEW Water	The Water Working Group met 3 times (7 March 2024, 8 April 2024 and 15 April 2024) with representatives from Council and the project team in attendance. Issues addressed included: • the methodology for hydrology modelling updates to address the Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2023 and Native Title water rights • Flood modelling updates in view of the proposed updates to the Climate Change Considerations chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation (Ball et al. 2019).
Crown Lands	A meeting was attended by representatives of Crown Lands and the project team on 15 December 2023 to discuss transfer of Crown Roads to Council for use in the Proposal and acquisition of other property for the Proposal.
Adapt NSW	Data was downloaded from the Adapt NSW web site during preparation of the climate change assessment for the hydrology and surface water assessment.
NSW Climate and Energy Action	Climate change is addressed in detail in the climate change risk assessment (section 6.10), sustainability assessment (section 6.11) and hydrology, flooding and surface water assessment (section 6.1). Consultation with NSW Climate and Energy Action will be conducted during detailed design.
NSW Environment Protection Authority	NSW EPA requirements have been addressed in section 6 and consultation with the NSW will be conducted during detailed design.
Regional NSW Group	Consultation with the Regional NSW Group will be conducted during detailed design.
Local lands Services.	Consultation with the Local Lands Services will be conducted during detailed design.

The outcomes of the agency consultation are included in the relevant sections of chapter 6.

5.3 COMMUNITY VIEWS

The numerous feedback pathways utilised to identify community views and categorise key issues raised during consultation with stakeholders is provided below.

5.3.1 Online survey responses

Consultation conducted between 2020 and 2021 did not allow for public meetings due to the COVID-19 pandemic. Due to this limitation, an online survey on the Council's 'Your Say Tweed' web page related to the Proposal was used. The online survey allowed participants to provide their responses to a range of questions, including questions about their understanding of the importance of water security for the Shire, and the raising of Clarrie Hall Dam as a preferred option as well as the alternatives.

A selection of the relevant questions and responses is provided below. Engagement with the various elements of the 'Your Say Tweed' – website is summarised in Table 5-8.

Table 5-8 Summary of engagement during 2021

Consultation method	Website visits	Video views	EIS summary downloads	Downloads of timeline	Survey responses	Questions posted	Request for call-back
Number of responses	897	210	91	41	66	5	5

Responding to the question of support for the Proposal to provide longer-term water security, 78% of respondents indicated they supported the Proposal. The responses are provided in Figure 5-3.

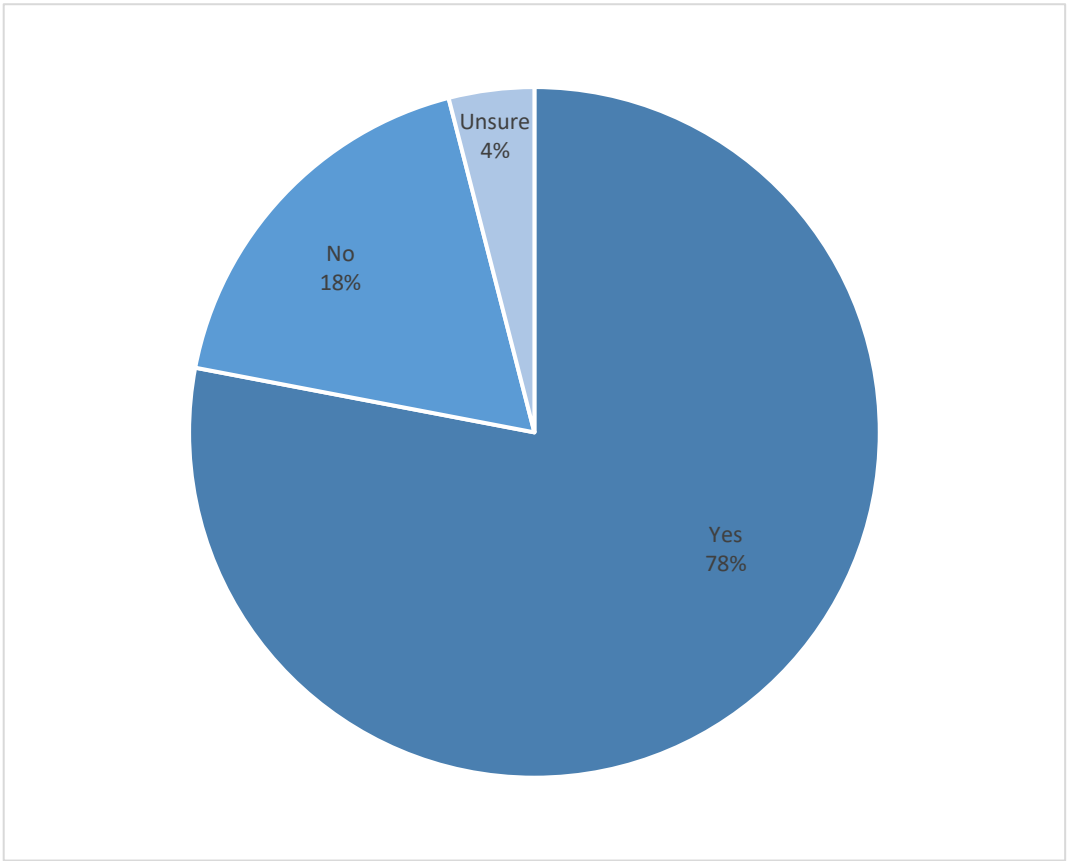


Figure 5-3 Responses to question asking about support of the Proposal

Respondents were also given the opportunity to provide their reasons for supporting, or not supporting, the Proposal. Multiple responses were allowed. The range of responses are provided in Figure 5-4. Water security was the most popular reason, while cost efficiency and growing population were also popular reasons.

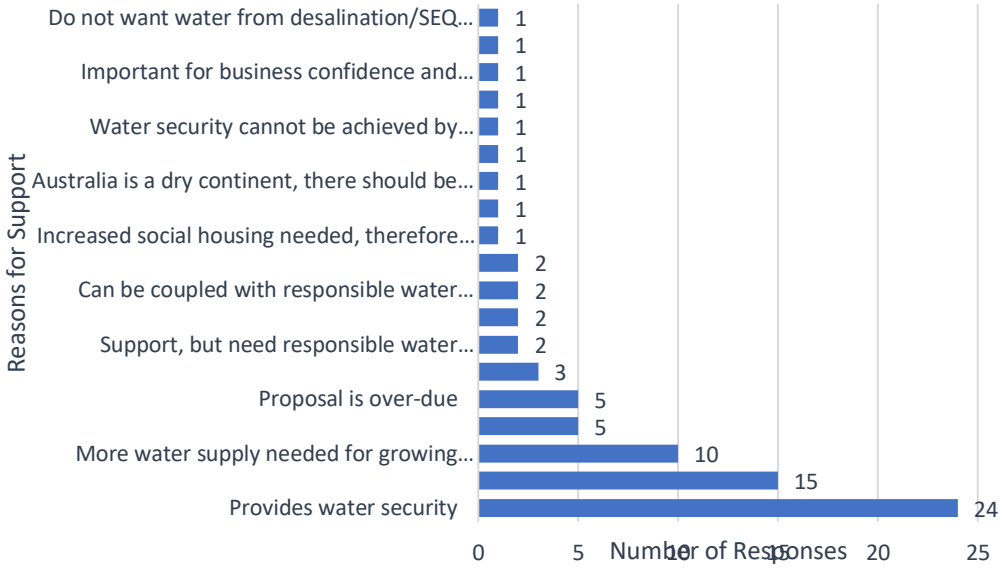


Figure 5-4 Reasons for supporting the Proposal

Participants who did not support the Proposal provided a range of responses, as shown in Figure 5-5.

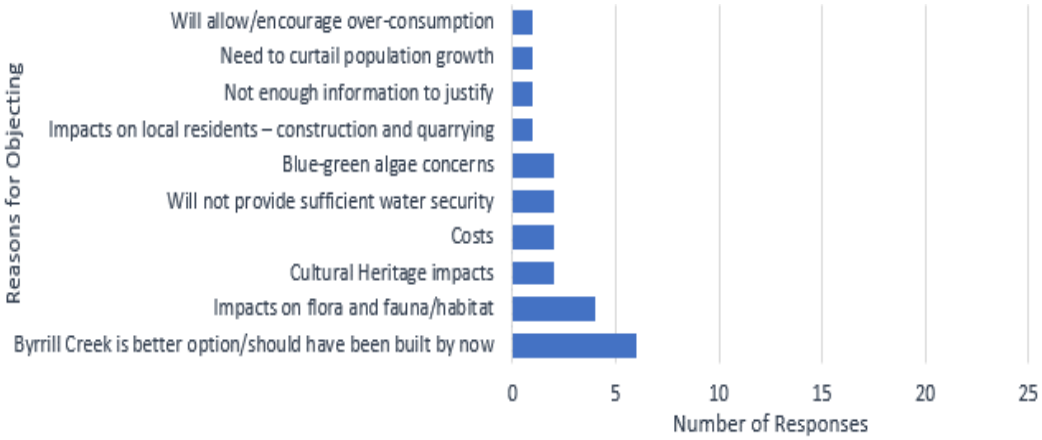


Figure 5-5 Reasons for not supporting the Proposal

Participants were also asked about their specific interests in the Proposal. Most respondents highlighted the issue of water security and being an interested resident. Responses are shown in Figure 5-6.

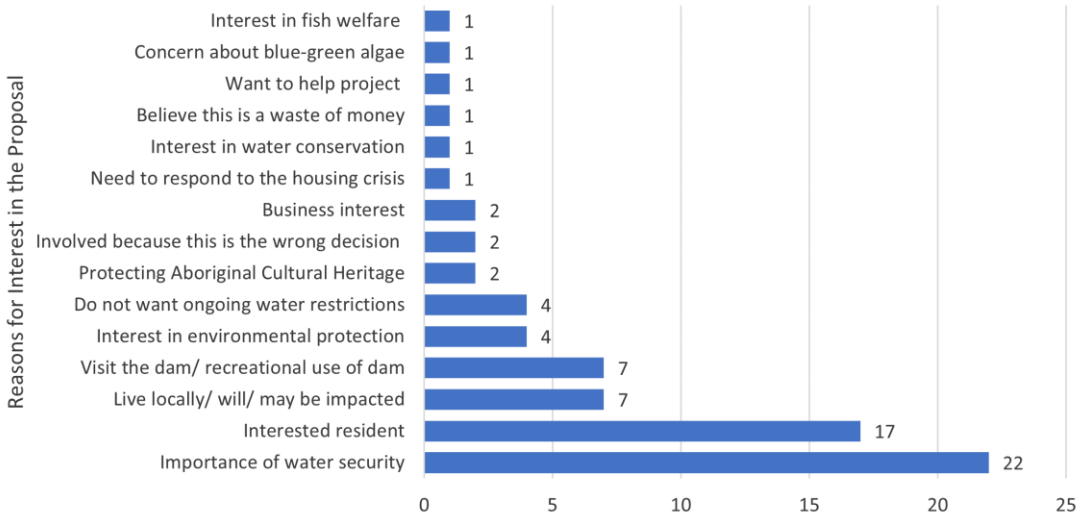


Figure 5-6 Reasons for interest in the Proposal

A summary of the matters raised throughout the consultation between 2009 and 2010 and from 2015 to 2021 is provided in Table 5-9, grouped by common themes. A summary response is provided for each matter.

Table 5-9 Summary of issues raised during consultation

Theme	Issue	Response from Council
Compensation	Compensation of inundation of property (through sale and fair dealings) and for properties impacted at the RL 77 m PMF level	The land acquisition process is underway between Council and owners of the properties identified. The land acquisition process and associated impacts are being addressed outside the scope of the EIS
Inundation / flooding	Definition of actual inundation footprint	The inundation footprint is shown and described in the Proposal description
	• Upstream flooding concerns - potential for water 'backing up' in high rainfall episodes/flooding • Potential collection of debris within the bridge structures, creating blockage and exacerbating upstream flooding • Ability of the new dam to mitigate downstream flooding	Upstream and downstream flood risks have been assessed and evaluated through detailed technical studies, including modelling of the PMF scenario to look at the maximum potential risk and impact profiles
	• Silt trap management • Width of the new spillway	Silt management and spillway features are described in the concept design document
Social	• Personal anxiety associated with uncertainty about dam construction and timing (i.e. potentially impacted property) • Increased anxiety due to perceived increased flood risks	Continuation of a consultation program with communities and key stakeholders to provide information on the Proposal and to communicate information specific to concerns raised - for example, demonstrating a reduced risk of flooding compared to the existing dam

Theme	Issue	Response from Council
	Increased housing costs	The proposed local procurement strategy would give preference to the local workforce and business during construction. The benefits resulting result from that can offset the potential increase in housing cost impacts
Access	Impact on access due to inundation of existing road	Community and directly impacted stakeholders were consulted on alternative access design options (for example, McCabes Bridge); a preferred option was nominated by the stakeholder group and passed by Council resolution during 2018
	Compensate the community for bearing the 'cost' of the raised dam with no direct benefit; for example, seal and improve the local road network	• Road upgrades have been proposed to address potential impacts associated with the Proposal • Rebuilding recreational areas, investigating options for recreational activities at the dam (walking and mountain bike tracks). This is discussed further below
Environment	Impact on fauna and flora from inundation	A terrestrial biodiversity impact assessment has been undertaken to identify a range of mitigation measures to minimise impacts on fauna and flora associated with inundation
	Management of weeds and lily mass	The terrestrial biodiversity impact assessment identified a range of mitigation measures to minimise impacts on fauna and flora associated with weeds
	Removal and beneficial use of trees before inundation	Trees would not be removed prior to inundation. Vegetation removal is to be minimised
Safety	• Residents' safety downstream from the dam • Dam failure scenarios under extreme events and earthquake	• The technical study conducted to assess flood risk associated with the Proposal concluded that the overall flood risk is reduced for the Clarrie Hall Dam (compared to the existing dam) • Dam safety and consideration of risks associated with seismic activity have been addressed in the Concept Design Report. The proposed upgrade is designed to be a 0.01% AEP earthquake event
Design	Whether there is need for new footings for the dam wall	Design considerations and specifications for the embankment and spillway are provided in the Concept Design Report (Appendix D)
	Whether Clarrie Hall Dam would need to be raised again (beyond this Proposal)	This Proposal is for the current upgrade plans. Council will maintain ongoing consultation regarding the Proposal and will continue to engage on feedback such as alternative options raised by stakeholders. Chapter 2 discusses alternative options to the Proposal that are considered for strategic water supply

Theme	Issue	Response from Council
	Whether a fish ladder is possible or needed	• The fish passage along Doon Doon Creek is currently impaired by the existing structure of Clarrie Hall Dam. There are no plans to install a fish ladder or lift on Clarrie Hall Dam, so the ability of fish to freely move between the upstream and downstream reaches would remain as it is now • Consultation with DPI-Fisheries has been conducted on potentially improving the fish passage at Bray Park Weir to offset impacts to the fish passage at Clarrie Hall Dam
	'Bigger vision for the Proposal' beyond water storage only, including recreational use and trails, and revegetation	Opportunities to further enhance recreational values associated with the Proposal area have been considered and described
Construction	Potential of water lowering during construction	Some lowering of the storage would be required to allow construction of the raised embankment, possibly an approximate lowering of 300 mm below FSL
	Use and location of spoil from construction	Most of the material required for use in the upgrade of the Clarrie Hall Dam wall is to be sourced from the existing rock quarry used in the original dam construction. Investigations indicated that the quarry holds sufficient volumes of reserve material
	Cumulative impacts of construction truck movements in addition to existing truck movements associated with the water extraction industry around Uki	A traffic impact assessment and an air quality and noise assessment have been conducted to assess potential impacts associated with construction truck movements. Primarily, impacts of truck movements are attributable to traffic flow and road user safety, for which mitigation measures such as upgrades to key intersections and potential road surface upgrades in certain sections of the truck routes may be required
General	Amenity	• Visual amenity is not anticipated to alter significantly from the existing visual amenity impacts as a result of the Proposal. Stakeholders will be consulted during the next planning stage in relation to the detailed plans for the recreation area that would be re-established as part of the Proposal • In relation to amenity for road and Uki village users, prior to construction Council would consult with stakeholders to communicate changes to the traffic environment and how they would be managed. Council would provide support for road users to change travel plans (if required) during the construction period
	Extent and type of boundary fencing (in relation to cattle)	The area surrounding the dam has limited points where livestock could potentially access the dam. Fencing required to manage livestock access would be established in consultation with the relevant adjoining landowners at locations where livestock could potentially have access to the dam

Theme	Issue	Response from Council
	Implications for rail trail	The proposed Northern Rivers Rail Trail route travels from Murwillumbah, via Stokers Siding and Burringbar in a south easterly direction. The proposed route is approximately 10 km away from Clarrie Hall Dam at the closest point. Further information about both projects is available on Council's 'Your Say Tweed' website
Other options	Necessity of the Proposal and alternative water supplies	Council commissioned technical studies to identify potential alternative options for securing water supply. The options were shortlisted to 4 alternatives, when targeted consultation was undertaken to involve the community in the process of identifying a preferred option to move forward into the design phase. The alternative options considered and the justification for the selection of the upgrade to Clarrie Hall Dam will be provided in the EIS
	Preference for Byrrill Dam (others against Byrrill Dam)/ build Byrrill Dam as well	
	Preference for household water tanks instead of dams	Council developed a Policy on Rainwater Tanks in areas with Reticulated Water. While rainwater tanks can assist in managing water demand, they are not considered a viable alternative to augmenting the water supply.

5.3.2 Summary of feedback received via various engagement methods

Feedback from the community received through methods other than the online survey is provided in Table 5-10. Feedback received at the community information sessions held in February 2024 is provided in Table 5-12.

Table 5-10 Summary of feedback received through various engagement methods

Feedback mechanism	Details
Questions through the Your Say Tweed, Facebook and to Council via Email	21 questions were responded to as follows: • 10 questions were posted via the Your Say Tweed Page and answered individually or via the page • 7 face book posts were responded to • 4 emails were received in response to the emails to those registered through Your Say Tweed or other information. Details of the responses provided by Council to questions asked are outlined in Table 5-11.
The online Your Say statistics	626 people engaged with the Your Say Tweed project page and of this 9 engaged by asking questions. There were 147 who are considered to be "informed visitors" including those asking questions and the following: • 88 who downloaded a document (40 accessed the Clarrie Hall Dam Raising Concept Design Report July 2018, 37 the Clarrie Hall Dam Raising EIS information sheet, 35 Community update 2024) • 41 who viewed the FAQs • 28 who viewed a video. *Noting that figures do not add up to the total of those "informed" as people will have taken multiple actions.*

Feedback mechanism	Details
Information sessions	Attendance recorded via the sign in sheet for the information sessions were: • 28 people in Uki • 23 people in Murwillumbah. Questions and issues raised were gathered and a summary of this information is outlined in Table 5-12.
Phone calls	One call was received asking about Clarrie Hall dam versus Byrrill Creek and requesting a copy of the 2009 SMEC report "Integrated Water Supply Options for North East New South Wales and South East Queensland"
Other communication	**10 April 2024** – Council presented to the **Casuarina, Seaside and Salt Residential Association (CASSRA)**, at their request. It was attended by 7 members. A PowerPoint presentation on the raising CHD project and EIS was followed by Q&A for about an hour. There was support for the CHDR project and no concerns raised. **7 May 2024** – Council responded to communication sent to Minister Rose Jacksons office from the NSW Farmers Federation, Far North Coast Branch. This questioned the decision-making process and wanted to revisit the Byrrill Creek option. Information about the decision-making process was provided by Council to the Ministers office. **28 May 2024** – Council met with a representative of the **Uki Residents Association.** The representative had attended the information session and wanted more people to know about the proposal. He was writing an article for the Association's newsletter, the Uki News, about the proposal. (About 1,000 copies of the Uki News are produced every 2–3 months and circulated to Uki and surrounds). An overview of the proposal and copies of maps to show the current and proposed inundation areas were provided. Questions included 'why not Byrrill Creek Dam instead' and flood mitigation. Council provided information about the Byrrill Creek Dam option and why raising Clarrie Hall Dam is Council's preferred option. A link to a Council video that explains that Clarrie Hall Dam is not a flood mitigation dam was also provided.

Table 5-11 Responses to feedback received via Your Say Tweed, Facebook and Email

Feedback	Response
Once the water height has been established, will there be an opportunity to create some nature trails around the circumference of the dam?	We're working on a catchment management plan for the dam and as part of that, we're considering low-impact recreational activities such as walking, hiking and bird watching. We need to wait until the environmental impact statement on raising the dam is released and reviewed by the NSW Government because recreational activities near the dam will need to be in keeping with the EIS and any conditions that the State Government attaches to it. If you haven't already, please consider subscribing to Tweed Link or our media releases so you can keep up to date by receiving Council news in your inbox.
More water tanks at people's homes would be a great start in securing water. So many people live outside of town that live solely on tank water and manage just fine.	Council encourages all dwellings to have rainwater tanks – if you're connected to town water, they are great for reducing your reliance on tap water and saving money on water bills. However, should we move into extended dry weather, tanks can quickly run out. Rainwater tank owners then need to get their tanks filled with water from the Tweed district water supply. During those times, the water will be sourced from our main water storage facility, the Clarrie Hall Dam. Raising the dam will allow us to meet the projected demand for town water from our community until 2065.
What is the point you never publish anything	Our goal is to keep the community informed, and we apologise if you feel otherwise. The Raising Clarrie Hall Dam EIS page at Raising Clarrie Hall Dam – Environmental Impact Assessment | Your Say Tweed already has a lot of information which you may find useful. There you can find a range of related documents as well as frequently asked questions about the proposal. Your feedback is valuable. I encourage you to share ideas or questions you may have about publishing information on the EIS for raising the dam. The upcoming information sessions are a great way to let us know. Please come along. If you would prefer that we have a chat, please let me know.
With regard to the proposal to raise Clarrie Hall Dam, Vehicular traffic impacts are a concern for me. Road works along Kyogle Road do not appear to be a priority. now or ever. Road works prioritised to address the additional vehicular traffic, to and from the dam during works, is a concern for me. Kyogle Road has many subsidence spots, post 2022 disaster and now many potholes from recent rains. Ensuring that the roads are maintained as a priority, is important for me, during a dam build and as a right as a citizen. keeping Uki safe for pedestrians also a concern. Traffic calming through the village of Uki would be a good idea as already a racetrack for some. Additional parking for the village would address much of the risk involved in visiting the amenities. Maybe it is time for an alternative route to avoid trucks traversing the centre of the village.	Thank you for your email. We will pass your comments to independent consultant KBR, which is completing the environmental impact assessment for raising the dam and developing the Environmental Impact Statement (EIS). As part of the EIS, the NSW Government requires a detailed traffic assessment, which we are working on. The traffic assessment is considering the impact of construction on local road networks including key intersections, proposed improvements to affected intersections, impacts on public transport and school bus routes, and impacts on road traffic noise among a range of other things. We're also exploring options to limit construction traffic on local roads by locating workers' accommodation and ancillary construction activities close to the dam. Once construction is completed, the traffic generated by construction is expected to return to existing levels, with no increase in traffic anticipated for the long-term. To find out more or to raise any further concerns you may have, please consider coming along to one of the upcoming community information sessions. Our team welcomes the opportunity to chat with you. Your input would help us with our assessments. Sincere regards

Feedback	Response
Should dam works commence without consideration of prioritising road infrastructure (repairs and maintenance), then council and rate payers will pay through delays to works. As the name implies, Northern Rivers sees much inclement weather. To maintain a schedule of works will necessitate an alternate access to Byangum Bridge. Bakers' road will require widening to accommodate trucks. Think about raising the road at the corner of Mistral and Stokers. My rural community is doing the heavy lifting for water security, but we are not a priority for transport. lack of transport holds back economic prosperity. A single, limited, private bus service Murwillumbah to Nimbin, ensures a heavy reliance on vehicular transport. Meanwhile maintaining Kyogle Road does not seem a priority. Plus very little consideration for planning alternate vehicle routes. BTW additional bridge at Murwillumbah also well overdue.	
What will happen to the water run off when the dam is full and there is a lot of rain forecast, will this cause flooding down the Tweed River as we live on the river and have been impacted before	Clarrie Hall Dam is built with an open, un-gated spillway - it's not built to mitigate against flooding. This is because the dam isn't in a suitable location for protecting our towns and villages from flooding - its catchment area takes in just 5.7% of the overall catchment area of the Tweed River and its upstream creeks and rivers. For more details and a video to explain how to dam operates, please go to tweed.nsw.gov.au/clarrie-hall-dam#operations. Also consider coming along to a community information session that we're holding in early February at Murwillumbah and Uki. Details are at yoursaytweed.com.au/clarriehalldameis. Sincerely, TSC
What areas of the proposed development can the community impact?	We're inviting the community to comment on anything to do with the proposal to raise the dam. Issues and concerns raised will be considered in the EIS. The EIS will look into relevant issues and consider mitigation measures or solutions that can be implemented as part of raising the dam. Please come along to one of the community information sessions at Murwillumbah and Uki next month to find out more about the project and to voice your thoughts. When the EIS is on exhibition mid this year, everyone will have another opportunity to raise issues. Sincerely, TSC
Who's paying for it?	Currently, the raising of the dam is fully funded from Council's Water Fund. However, we are exploring the possibility of NSW and Australian Government grants that may be available. The preparation of the EIS is also funded by Council, with part funding from the NSW Government under its Safe and Secure Water Program.
Is there any correlation between development and water usage?	Yes – as our population increases, more water is needed. However, climate change will also reduce the secure water yield of Clarrie Hall Dam. That's why we are planning to raise the dam and we're aiming to have it raised by 2028. That will provide us a secure source of water until about 2065.

Feedback	Response
Can you publish the reports on the old build. Wasn't there a problem with the strength of the bedrock.	Numerous geological investigations were completed as part of the original dam construction. More investigations have been undertaken for the raised dam and have consistently found the bedrock is suitable for foundations and construction of a raised dam. Access the NSW Public Works Clarrie Hall Dam Concept Design Report at yoursaytweed.com.au/90358/widgets/422769/documents/274421, which features a geotechnical investigations section.
All the impacted land around there has been acquired by council in preparation for the raising of the dam. Why then ask the community now?	Council has purchased or is in the process of purchasing all parcels of land or portions that will be impacted by the raised water level. But acquiring the land is only one part of the work required to plan and gain approval for a proposal this extensive. For example, planning for the relocation of power and telephone services is another body of work. A range of environmental, social and economic studies have been done as part of the EIS and we have been keeping the community informed along the way. Now that the EIS will be completed by mid-2024, the community has a further opportunity now to ask questions about the proposal and raise any concerns before the EIS is completed.
How would you go about it? What areas will need to be built up and which areas are you willing to lose to becoming new dam water holdings? Is there an estimate of how much more water could be held within the new level and how did you come to the extra height of 8.5 m and not more or less?	Before we started work on the EIS, NSW Public Works prepared a concept design for raising the dam. That design determined how high the dam could be raised and 8.5 metres was the result due to the topography. The concept design is what the EIS is based on. Raising the dam higher than 8.5 metres would cause water to overtop an upstream spur in the catchment. By limiting the height increase to 8.5 metres, no areas will need to be built up other than the dam wall itself. Raising the dam by 8.5 metres would increase its capacity from 16,000 to 42,300 ML, doubling its footprint and securing the Tweed's water supply until at least 2065. Have a look at this media release for a graphic comparing the dam's current inundation area (in light green) with the area that would be inundated should the 8.5 metres raising be approved by the NSW Government (in dark green). www.tweed.nsw.gov.au/council/news-updates/latest-news/media-releases/1454887-keep-up-with-the-latest-on-raising-clarrie-hall-dam council has been working for a number of years with landowners whose properties would be wholly or partly inundated due to the new water level. By the time the dam is being built, Council will have purchased all affected land.
Hello, Could you advise if the raising of the dam will increase flooding risk to residents of Uki or further downstream? Thank you.	There will be no 'release' of water from the dam in times of high rainfall. In a high rainfall event, when the dam fills, water will overtop the spillway and flows in Doon Doon Creek and the Tweed River will be similar to flows that would occur if the dam did not exist. Clarrie Hall Dam is not a flood-mitigation dam. For more details and a video to explain how to dam operates, please go to tweed.nsw.gov.au/clarrie-hall-dam#operations. Also consider coming along to a community information session that we're holding this week at Murwillumbah and Uki. Details are at yoursaytweed.com.au/clarriehalldameis. Sincerely, TSC
I am planning to attend the information at the Anglican Church in Kyogle Road on Tuesday, but wanted a bit more information on the reasons for not going ahead with the Byrrill Creek Dam. I know the Council was divided, and we will lose water in the Clarrie Dam while you are raising the wall, but it would seem prudent to build other dam first,	The source of water for most of the Tweed is the Tweed River, with water drawn from the Bray Park Weir. Most of the time, the river's flow meets the demands of our population. In drier times when there are low river flows, stored water (stored in Clarrie Hall Dam) is released to supplement the river flow. To augment the water supply, what is needed is more stored water to get us through future low-flow periods when there is higher demand. It does not matter where that water is stored, as long as it is an efficient storage and cost effective. Comparing raising Clarrie Hall Dam with a dam at Byrrill Creek: Environmental releases: There is an environmental release

Feedback	Response
especially to have some flood prevention strategies in place which Clarrie Dam will do nothing to provide. Also interested to know that there will be a Parliamentary Enquiry into Mt Warning and the access of the public. Can you send me some information on Birrell Creek options….	from Clarrie Hall Dam and if a Byrrill Creek dam was built, there would be a requirement for an environmental release from that dam. This means of total stored water, more would be lost if we had two dams. This makes a Byrrill Creek dam less efficient than raising Clarrie Hall Dam, as it would not increase our secure yield as much as raising Clarrie Hall. Cost: To provide similar secure-yield outcomes, a Byrrill Creek dam would be significantly more expensive than raising Clarrie Hall Dam. Cultural heritage: Consultation with First Nations peoples have informed Council the area around the location of a Byrrill Creek dam contains items and areas of significant cultural heritage, more so than the area that would be inundated by raising Clarrie Hall Dam. Ecology: Ecological studies have informed Council the area around the location of a Byrrill Creek dam contains areas of ecological significance, more so than the area that will be inundated by raising Clarrie Hall Dam. Community consultation: Community consultation in 2010 and more in 2019–20 indicated the community prefers the raising Clarrie Hall Dam to augment the Tweed District water supply. Based on these matters, Council resolved to raise Clarrie Hall Dam.
Thank you for the information provided at the recent community sessions. I have a question about the commitment of Tweed Shire Council to upgrade the road from Uki to Clarrie Hall Dam. There are a number of areas with tracks of potholes that would only get worse with significant truck traffic required for dam construction. Can you add in the engagement report community questions about road upgrade works to support truck movements and consideration of traffic calming measures around villages along Kyogle Road on the way to Clarrie Hall Dam. Thank you.	You're very welcome. The many discussions we had with members of the community during the information sessions have been documented as part of our work to prepare the Environmental Impact Statement. Thank you for raising the issue of road impacts during construction. We will definitely incorporate community concerns into the relevant report.
How do I find out more information on the Clarrie Hall Dam? How do I find out the contractors involved who will complete the Project? Or how do I become on the mailing list? Thank you	Thank you for your email on 13 February 2024, seeking more information about the Clarrie Hall Dam Raising project, the contractors involved and how to receive updates about the project. Our goal is to keep the community informed as much as possible about the project. The Raising Clarrie Hall Dam EIS page at Raising Clarrie Hall Dam - Environmental Impact Assessment | Your Say Tweed has a lot of information which you may find useful. There you can find a range of related documents as well as frequently asked questions about the project. You can also choose to 'Stay Informed' by registering your email address. This way you will be added to our mailing list and receive updates about the project as it progresses. Your feedback is valuable and I encourage you to share your ideas or questions on the page. With regards to contractors involved with the project, the original concept design for the project was prepared by NSW Public Works Advisory. The EIS is being prepared by Kellogg Brown and Root Pty Ltd (KBR) and is expected to be completed by mid-2024. KBR has engaged several sub-contractors who are preparing the various technical reports. Contractors for the detailed design and construction of the project have not been determined yet. Tenders for this work will not be called until (and if) the project is approved by the Minister and Council.

Feedback	Response
Bottled Water is Crap. So why is there still over 60 water tankers with 28,000 litres of water in each leaving Tweed Shire every week!!!!!!!!	The NSW Government has regulatory responsibility over groundwater extraction throughout the State, including the Tweed. When it comes to groundwater extraction and bottling, Council's only influence is through planning controls. To that end, in 2020 we worked with the community to amend a clause in the Tweed Local Environmental Plan 2014 that allowed water bottling facilities in the RU2 Rural Landscape Zone. This has prohibited new water bottling facilities in rural areas of the Tweed.
The construction method for raising the Clarrie Hall Dam appears flawed given recent advice from the council and the current budget of $100 million. What would be the environmental effect of an entire dam failure occurring during a heavy rainfall event when the dam's spillway is not functional which current methodology dictates will occur for a period of many months?	The construction methodology as presently proposed is indicative only. The actual construction methodology will be determined after the detailed design by the contractor engaged to raise the dam. That detailed construction methodology will consider the risk of extreme rainfall events during construction and how the impact of those event may be mitigated. As an example, the contractor may construct the raised embankment and the new spillway before 'closing' the original spillway. This will be a matter for detailed design and construction methodology.
On 24 Feb 2024 I asked what would be the Environmental Impact if the Clarrie Hall Dam wall was to fail during construction of the wall raising which is likely if the contractor uses the Councils currently stated construction method. You did not answer this question and reply included the statement "As an example, the contractor may construct the raised embankment and new spillway before "closing" the original spillway". To be clear, the new embankment is to be built over the top of the existing spillway and will require significant modification to the existing spillway to attain the new dam wall and concrete membrane. Could someone the original question and someone who is has an engineering background please explain to the original responder what has to happen to build the new dam wall?	Thank you for your follow-up questions about dam safety during construction to raise the dam. If there was a failure of the dam during construction, it would be a 'sunny day' failure or a failure due to overtopping. When there is no construction the events that could cause a sunny day failure are seismic activity or a piping failure. The probability of this has been assessed and will be reassessed after the determination of the EIS as part of the design of the raised dam. The probability is extremely low. The probability of failure of the dam due to overtopping is also extremely low and is managed by the spillway. In respect to failure during construction the probability of a sunny day failure remains extremely low, as it is now. The probability of failure due to overtopping might increase for a period, depending on the construction methodology used by the contractor. To suggest that a dam failure is likely to occur, due to overtopping during construction, is incorrect as it would require the combined events of an extreme rainfall event occurring at the same time as specific construction works and the risk of these two events coinciding is extremely low. It should also be noted as previously advised the method of construction presently proposed is a proposal only and it will be up to the contractor to develop a method to minimise this risk. If you have suggestions on the construction methods that should be used to mitigate risk please forward them to Council at WaterAdmin@tweed.nsw.gov.au so that Council may consider them and will pass those onto the designers and contractors
Clearly building a second dam is preferable as then there are two water sources. This has become even more apparent since our current water source has blue green algae. What is the environmental impact assessment of the new dam versus raising Clarrie Hall Dam?	Thank you for raising the question about whether having two dams would be better than one, particularly in light of the occasional outbreaks of blue green algae in Clarrie Hall Dam. So why not Byrrill Creek? Isn't it wiser to have some contingency in a second dam? While you might expect that a second dam would provide greater drought security, it's not that simple. The bulk of the water supplying the Tweed comes from Bray Park weir, which is fed by the Tweed River, which has both Byrrill Creek and Doon Doon Creek as tributaries. While ever there is adequate water flowing to Bray Park, the water stored in the dams is not needed. It is only when there is insufficient flow in the Tweed River that water from the dam/s would be released. So without consideration of issues like environmental flows or evaporation it doesn't matter where the water is stored. However, we do need to consider issues like evaporation and environmental flows. A second dam at Byrrill Creek would require

Feedback	Response
	releases of water over and above that required from a raised Clarrie Hall Dam, thereby reducing the amount of water available to Tweed residents. Further, two dams have a much larger surface area than one dam and hence there would be greater evaporation losses, also reducing the amount of water available to Tweed residents. Lastly, the environmental impact of a second and new dam at Byrrill Creek would be considerably greater than that of raising the existing Clarrie Hall Dam. Overall, in the case of Tweed, one dam is preferable to two. With regards to the risks of aquatic weeds and blue-green algae in the raised dam, these risks may be slightly reduced due to a bigger and deeper water body. A dam operations management plan will be developed to control aquatic weeds and blue green algae. Some ideas being considered include the profiling of the ground at the top water level of the dam so that the land falls steeply away and the area for aquatic weeds to propagate is reduced. Further, if it is found that there is a propensity for blue-green algae, Council will consider the four factors precipitating blooms, being nutrient presence, high water temperature, time and sunlight, to determine the most appropriate control measures. Typically, where required, the most common control measure is to mix the water to reduce the time water stays in a high temperature and sunny environment, limiting and / or preventing algal blooms.

Table 5-12 Issues raised during the community information sessions and responses

Issue /Topic	Detail	Response – where provided during or after the information session (or recorded)
UKI 6 February 2024		
Maps	Many wanted copies of the inundation area and ownership	Maps have now been posted on the Raising Clarrie Hall Dam - Environmental Impact Assessment Your Say page at https://www.yoursaytweed.com.au/clarriehalldameis and copies were provided to community members requesting them.
Recreation facilities	• Desire for walking tracks, canoeing and cycling around the dam. • Is the toilet block at the dam wall moved or is it new? • More comfortable and attractive facilities and rain cover • Access to all public lands for cycling, walking swimming • Wants trail (cycling) beside the dam to be accessible – cycling loop. • Cross country mountain like connection to rail trail 5 to 10 kilometres connect to Gilwire Rd. • Recreation is good for local business. Council previously had a grant to build a local trail.	This is being considered by Council and will be addressed in the EIS. Council will be developing a catchment management plan which will incorporate recreational activities. Specific community engagement will be part of the development of this catchment plan.

Issue /Topic	Detail	Response – where provided during or after the information session (or recorded)
	• People come to Uki markets and ask where they can walk. Perhaps linked to other walks including new three day walk in the national park from Unicorn Falls • Crams Farm is underutilised and is the jewel in the crown of Tweed Shire. It's a shame to increase the water level here.	
Future water security	• Need for water efficiency measures • Concerns water security will be an ongoing issue, and the current solution does not address water needs.	Information was provided by Council staff about the current water security measures that were being undertaken by Council.
Traffic	• Excess traffic and Conditions	Traffic study is to be prepared in addition to a traffic management plan as part of the construction stage.
Funding	• Use of Council funds and Affordability • Where is the money coming from	Informed that revenue is generated from the dam. Money from Council Water Fund.
Alternative options	• Byrrill Creek – Preference that this is the future site • Dredging the dam as an option	Information provided about previous studies that determined this is the preferred option and why.
Quarry	• Lack of quarry material and not enough investigation into this • Fear of extension of existing quarry into private land	Concern of a particular land holder - Council spoke to them to answer any questions.
Water Quality	• Concern about the project risk to water quality • Concern construction will impact access for monitoring • Option to stock the dam with bass or alternative opportunities to use other species • If a fire occurs in the catchment all of the water will be rank • Problems with siltation affecting water quality	Water will go to Bray Park Weir and the WTP prior to distribution.
Safety and security of dam	• Concern about stability of the dam • Risk of dam failure • Seepage from the dam in the wider area • Concerns about the foundation	The dam is built on a strong rhyolite foundation and was designed to be raised. The risk of dam failure and dam failure mechanisms are considered in the design of the dam. This will be reviewed by the Dam Safety Committee. The risk of flooding during construction will be managed by the construction contractor in conjunction with Council.

Issue /Topic	Detail	Response – where provided during or after the information session (or recorded)
	• Construction impact on existing structure • Concern that there is a flood risk during the construction	
Impact on Infrastructure	• Clarification on McCabes Bridge alignment road • Need to upgrade Kyogle Road in advance of construction • Question regarding the intersection of Doon Doon Road and extent of impacts	The new McCabes Bridge will be generally parallel to the existing bridge. There will be some road realignment. Plans were provided and are available.
Ground water	• Concern about water mining activities	The issue of water mining is beyond Council's jurisdiction. The State Government regulates extraction of groundwater. Council has amended its LEP so that new water bottling / water mining activities are not permitted in the Tweed Shire.
Biodiversity	• Impact to the koala feed tree/s at Crams Farm. Want this tree protected. • Future of vegetation in inundation area • Use of existing trees –trees to impact amenity of Crams Farm • Compensatory revegetation	Council/consultants to investigate and determine whether tree will be impacted
Process of decision making	• 28 – day response period and when is it being exhibited • Concern this is not enough time for response/ submission/research	Timelines were discussed.
MURWILLUMBAH 7 February 2024		
Maps	• Area of impact and inundation and mapping of the area and impact on private property including acquisitions • Request for colour PDFs of maps	Maps of inundation area were available at the session and copies made available most the information session.
Recreation	• Walking tracks/ Canoeing – post development of the dam • Current recreation access • Protection of Crams Farm as recreation resource • Looking for improved recreation – walking tracks around dam circumference	Council discussed recreation opportunities that might be looked at post EIS. Discussion by Council about doing a master plan for catchment associated with raised dam – will consider recreation as part of that plan.

Issue /Topic	Detail	Response – where provided during or after the information session (or recorded)
	• Improving cycleway • Difficult to pass canoes/kayaks over fences to get to water at the dam wall • Can't launch a sailboat at dam wall area – only with difficulty at Crams Farm	
Flooding downstream	• Concern that there will be flooding	The dam will have little or no impact on flooding downstream. In flood events the dam is "transparent". Flows into the dam will pass through the dam and any impact will be a very slight reduction in flood levels down stream.
Groundwater mining	• Concern that water is being removed for bottling and impact on water available • How much water taken for bottling? Will that affect the dam.	WaterNSW regulates groundwater extraction so Council has no data on water mining. The dam will not be affected.
Construction	• Duration of construction and impacts including safety and access • Questions about the construction process	Information provided about the planned construction duration.
Water security	• Fear that Queensland will source the water created through the dam and this will be taken from the Tweed • Need to look at wider impact including Gold Coast • The newsletters are written poorly - fearmongering	Referred to the EIS that will consider the broader impact assessment to Queensland including social and water use issues.
Alternatives	• Desire to revisit Byrrill Creek	Noted as an interest of some participants
Roads, traffic and Safety	• Desire that Council fix Kyogle Road potholes • Traffic and road safety • Safety for Uki residents from construction traffic • Impact on parking in Uki • Need to maintaining resident access on Clarrie Hall Dam Road during construction • Having access through the Clarrie Hall Dam gate	Discussed traffic assessment that will consider traffic routes, impacts to bus routes, schools, peak hour traffic.

Issue /Topic	Detail	Response – where provided during or after the information session (or recorded)
Flooding	• Concerns about impact to an individual property • Concerned about impact of flooding on downstream communities • Have bought land and wants to know the impacts. Architect is waiting on hydrology report.	Discussed minimal downstream impact changes currently known and that this will be outlined as part of the reports of the EIS. Not intended for flood mitigation. Maps of flooding were provided.
Property impacts	• Acquisition • Question of how many properties are impacted	16 properties will be impacted. Council is working with property owners to purchase all or part of the impacted properties through private treaty. Of the 16 purchases, 14 are complete.
Alternatives	• Why not Byrrill Creek Dam instead? • What about flooding at Green Hills? • Preference to Byrrill Creek option to decrease impacts on Crams Farm.	Responses regarding Byrrill Creek dam option were consistent with those provided in Appendix D of this report. The CHDR proposal will not result in changes to existing flood impacts in Murwillumbah.

5.4 FUTURE ENGAGEMENT

Consultation will continue leading up to and during the exhibition period for the EIS. Council has prepared an updated Communication and Engagement Plan for this phase. Beyond this, consultation will continue through the detailed design and construction stages.

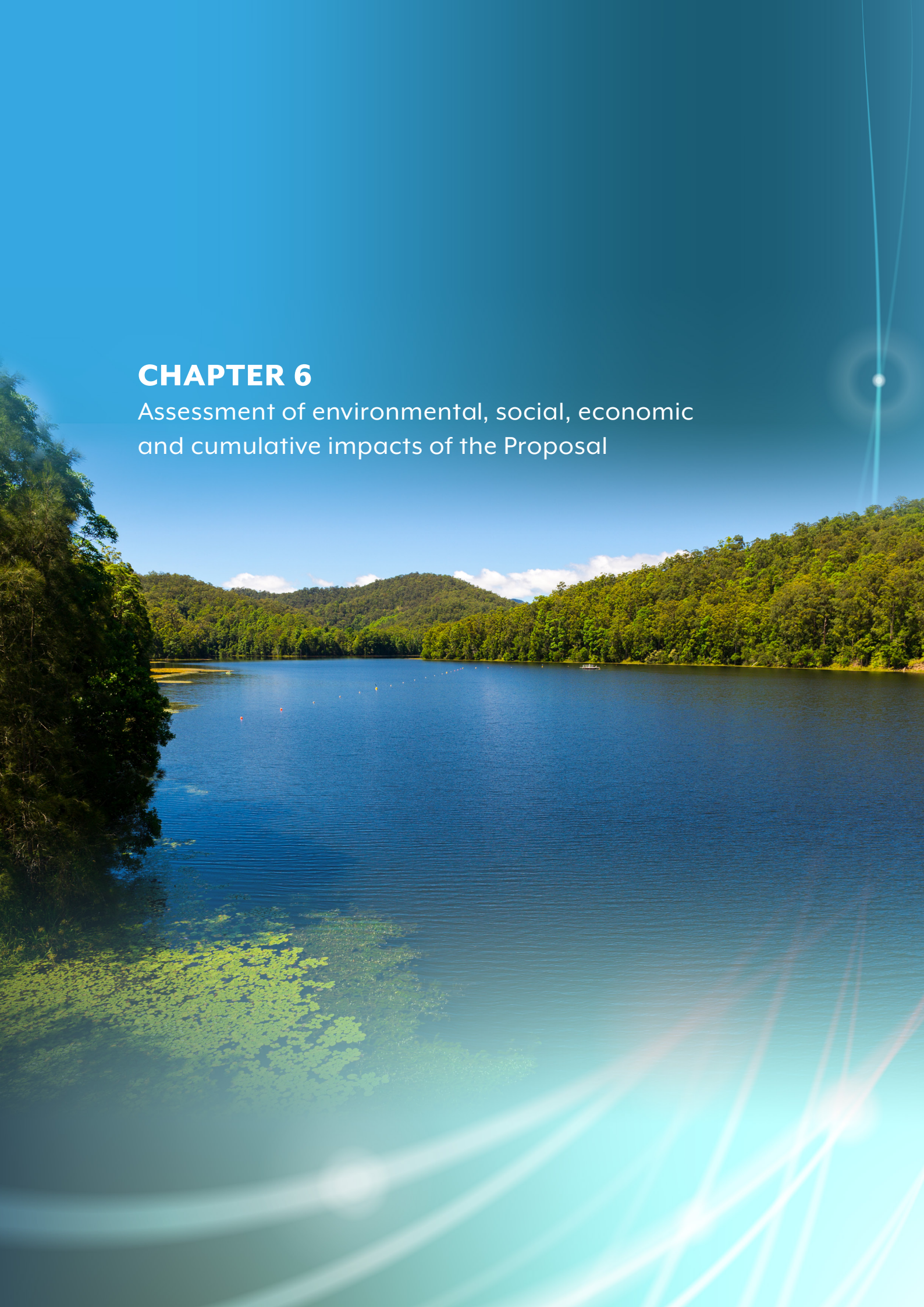
The mechanisms for people to receive information or to ask questions will continue as detailed in section 5.2.

This includes the following:

- Email address and phone contact number – which will be directed to Council project staff.
- The Your Say Tweed website – the Raising Clarrie Hall Dam – the Environmental Impact Assessment web page will be updated with links to the EIS and information about where and how to make submissions to DPHI. People will be able to continue to register their interest in the project and will be sent information as the project moves through the assessment stages. All information as it becomes available will be uploaded to the site.
- Council's *Tweed Link* – advertising and information will be provided using this publication (insert in 50,000 copies of Tweed Valley Weekly and 4115 email subscribers).
- A newsletter/project update – the update will be prepared and distributed using the same Australia Post distribution area as for the publication distributed in January 2024 (11,000 households).
- Emails to past contacts – emails will be sent to all those contacted in the past and the additional people registering interest as result of this consultation.
- Public information sessions – these are planned to be conducted in Uki, Murwillumbah and either Tweed Heads or Kingscliff as soon as practicable after the exhibition has started. The sessions need to be completed well before submissions are due so that people can get information that may contribute to the preparation of their submissions to the EIS.
- Online information sessions –- to occur during the exhibition period.
- Media releases and newspaper advertisements – these will be provided and distributed to announce the commencement of the EIS exhibition period.
- Facebook and other Council communication mediums – these will be used as appropriate.

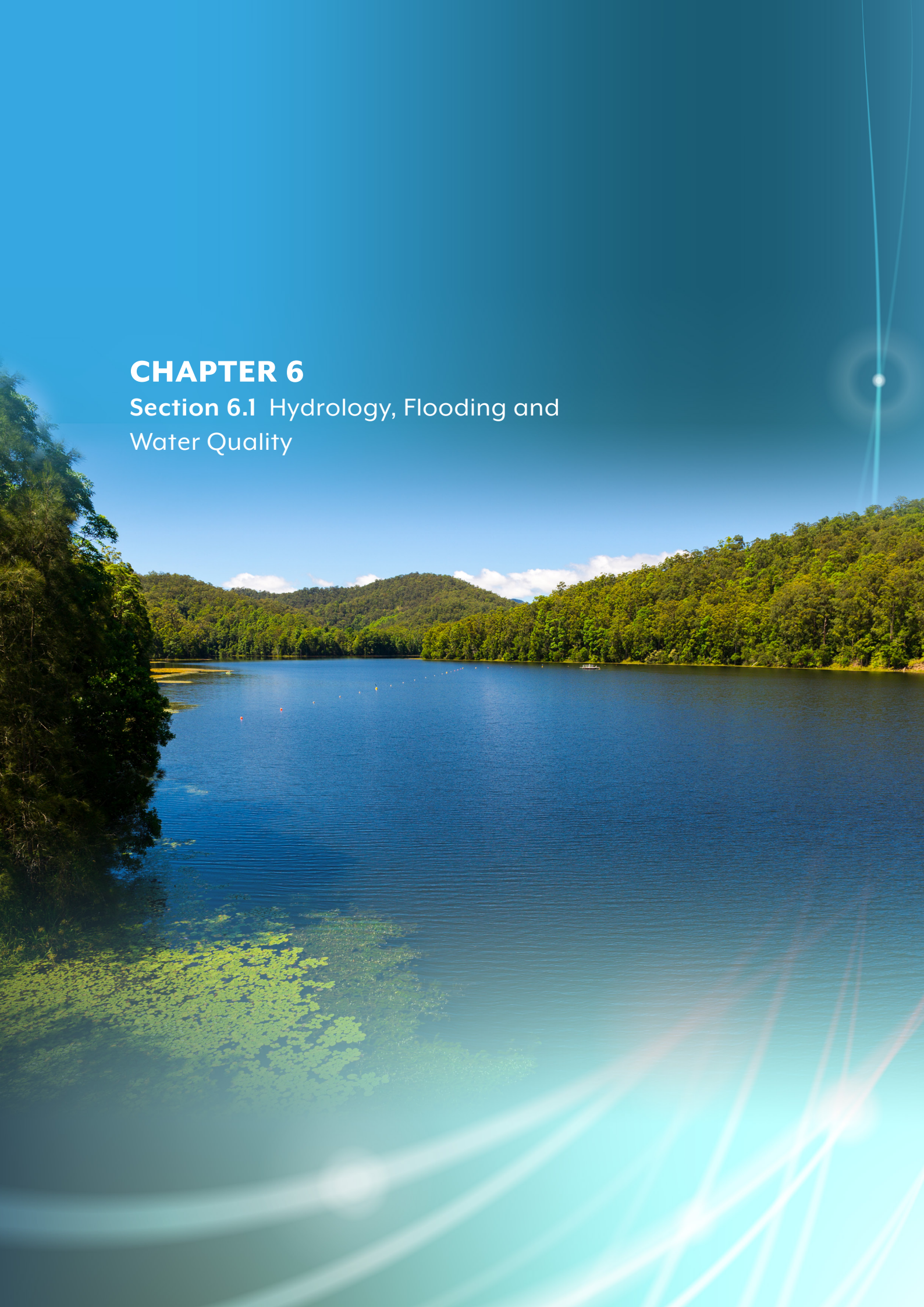
Every effort will be made to ensure that the community is informed of when the Clarrie Hall Dam Raising EIS is on public exhibition. The information and consultation at this time will focus on ensuring people understand the process for accessing and reviewing the EIS and making submissions to DPHI.

Council officers and the KBR project team will be available to answer questions about the content of the EIS, point community members to the sections of their interest/concern and help ensure that they have the information they may require to help them with their submissions to the EIS.



CHAPTER 6

Assessment of environmental, social, economic and cumulative impacts of the Proposal



CHAPTER 6

Section 6.1 Hydrology, Flooding and Water Quality

6 Assessment of impacts

6.1 HYDROLOGY, FLOODING AND WATER QUALITY

This section provides a summary of potential impacts to hydrology during construction and operation of the Proposal, as detailed in the Surface Water Assessment (SWA) provided in Appendix G1, the Flood Impact Assessment provided in Appendix F and the Groundwater Impact Assessment provided in Appendix G2.

A summary of the relevant SEARs and where they are addressed is included in Table 6-1.

Table 6-1 SEARs relevant to hydrology, flooding and water quality

Relevant key issue requirement/s	Where addressed
1. The Proponent must describe (and map) the existing hydrological regime for surface and groundwater resources (including reliance by users and for ecological purposes) likely to be impacted by the proposal and identify any requirements for baseline monitoring of hydrological attributes. Mapping must include upstream and downstream tributaries that may potentially be impacted.	Section 6.1.2 Appendix G1 Annexure A Appendix G2 Chapters 4 and 5
2. The Proponent must assess and model the impact of the operation of the proposal and any ancillary facilities (both built elements and discharges) on hydrology in accordance with the current guidelines, including:	-
(a) natural processes within rivers, wetlands and floodplains that affect ecological health, aquatic connectivity and access to habitat for spawning and refuge	Section 6.1.2 Appendix G1 Annexure A Appendix G1 section 5.6.3
(b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species and groundwater users	Section 6.1.3 Appendix G2 Chapter 7
(c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources	Section 6.1.3 Appendix G1 section 5.6
(d) direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	Section 6.1.3 Appendix G1 section 5.8
3. The Proponent must detail a framework for managing stratification within the dam and associated algal blooms and water releases from the dam that ensures impacts to upstream and downstream areas and ecosystems are minimised. The framework must include consideration of the potential rates of rise and fall in the river and timing of water releases and consider antecedent conditions within the river, flooding impacts up to the probably maximum flood and water clarity and temperature.	Section 6.1.3 Appendix G1 section 5.7.2
4. The Proponent must assess and model the impacts on flood behaviour during construction and operation for a full range of flood events including:	-
(a) any detrimental increases in the potential flood affectation of other properties, assets and infrastructure including changes to flood hazard categories	Section 6.1.3 Appendix F section 6.5

Relevant key issue requirement/s	Where addressed
(b) flood storage capacity of the proposal, including quantifying what flood events can be mitigated by the dam	Section 6.1.3 Appendix F section 6.5
(c) the effect of the proposal on flood behaviour in the broader catchment including any change to flood storage areas	Section 6.1.3 Appendix F section 6.5
(d) consistency (or inconsistency) with applicable Council floodplain risk management plans	Section 6.13 Appendix F
(e) impacts on flood emergency management - these matters must be discussed in consultation with the NSW State Emergency Services and Council	Section 6.13
(f) any increase in social and economic costs to the community from changes in flood behaviour.	Appendix F section 6.5
5. The EIS must include a sensitivity analysis for increases in rainfall intensity as a result of climate change, and the risk and vulnerability of the project to changes in flooding behaviour resulting from climate change in accordance with and using appropriate NSW Government guidelines, data and modelling (including justification about the use of those guidelines, data and modelling).	Section 6.1.3 Appendix F
6. The Proponent must describe background conditions for current operations and any water resource likely to be affected by the proposal, including:	-
(a) existing surface and groundwater quality	Section 6.1.2 Appendix G1 section 3.9 Appendix G2 Chapter 5
(b) frequency and quality of dam discharges including for environmental flows	Section 6.1.2 Appendix G1 sections 3.6.1vi and 3.9
(c) downstream intake locations	Section 6.1.2 Appendix G1 section 3.7.1
(d) Water Quality Objectives (as endorsed by the NSW Government) as appropriate that represent the community's uses and values for the receiving waters	Section 6.1.2 Appendix G1 section 3.9
(e) water quality monitoring programs and indicators and trigger values/criteria.	Sections 6.1.3 and 6.1.4 Appendix G1 section 3.9 Appendix G2 Chapter 8
7. The EIS must assess the impacts of the proposal on water quality, including the nature and degree of impact on receiving waters for both surface and groundwater.	Section 6.1.3 Appendix G1 section 5.7 Appendix G2 Chapter 7
Climate change risk	
2. The Proponent must quantify specific climate change risks with reference to the NSW Government's climate projections, including relevant data and information from NSW and ACT Regional Climate Modelling partnership (NARCLiM) (data, models, simulations, guidance), and incorporate specific actions in the design and operation where reasonable and feasible. NARCLiM 1.5 must be used, unless otherwise agrees by the Planning Secretary. Other data, projections, or information may also be used in addition to NARCLiM.	Section 6.1.3 Appendix G1 sections 5.6.2 and 5.7.3

Relevant key issue requirement/s	Where addressed
3. An assessment of potential future climate variability impacts on the operation and management of the dam and associated delivery works (such as water delivery by way of river operations, or pipe infrastructure), having regard to research on groundwater recharge and surface run-off and the NSW Climate Impact Profile.	Section 6.1.3 Appendix G1 sections 5.6.2 and 5.7.3

6.1.1 Methodology

The methodologies for conducting the assessments for surface water, flooding and groundwater are discussed in this section.

Surface water assessment

The surface water assessment area includes the construction and operational footprint of the Proposal (see Chapter 3 Figure 3-1 to Figure 3-3) and downstream watercourses that may be impacted.

Downstream watercourses that were assessed include the sections of Doon Doon Creek and the Tweed River where flow regimes or water quality changes may occur due to the Proposal. They are:

- Doon Doon Creek from the dam wall to the Tweed River
- the Tweed River from the Doon Doon Creek confluence to Bray Park Weir.

Surface water modelling

The existing surface water environment was characterised to allow the assessment of potential impacts through the following 3 models:

- a streamflow regime model of the Tweed Valley waterways, used to investigate potential changes to dam release volumes, the timing of releases, and the effects of climate change on flow regimes (Appendix G1 Annexure A)
- a limnology model, used to investigate the expected changes to water quality within the reservoir (Appendix G1 Annexure B)
- a hydraulic model of Doon Doon Creek and the Tweed River, used to investigate cold water transmission downstream from the dam, stream power, depth and velocity of water in waterways (Appendix G1 Annexure C).

The 3 models were developed by EMM by updating the Tweed River Valley Source model (Source model) to reflect the updates in the Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2023 (DCCEEW 2023a), which was released during the EIS preparation period. The updates were conducted in consultation with DCCEEW – Water.

The Source model was also updated by EMM to accommodate the climate and hydrological data required to assess the Proposal. Further information on the models is provided in Appendix G1.

Results from the 3 models provided information on the existing environment, as summarised in section 6.1.2 and detailed in the SWA (Appendix G1 Chapter 4). The results were also used to describe and assess surface water impacts associated with the Proposal, as summarised in section 6.1.3 and detailed in Appendix G1 Chapters 5 and 6.

Risk analysis

The assessment of potential impacts to the surface water quality and quantity, water users and receptors, as well as the streamflow regime has been conducted in relation to construction and operation using a risk analysis method (see Appendix G1 section 1.8).

Regulatory and policy context

The regulatory and policy context for the Proposal is discussed in Chapters 2 and 4. Further details of legislation that is relevant to the surface water assessment are provided in Appendix G1 section 2.2, and a summary of legislation and guidelines that are of particular importance follows below.

Water Sharing Plan

Water resources within the Tweed Valley, including all surface water and groundwater contained in unconsolidated sediments of the alluvial aquifers, are managed under the provisions of the Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2023 (WSP) (DCCEEW 2023a).

The WSP identifies 32 water sources that are grouped into 3 extraction management units (EMUs). Volumes of water are committed under each EMU for entitlements granted by water access licenses (WALs), and an estimate of combined annual extractions in the exercise of native title rights, harvestable rights, and domestic and stock rights (DPE 2022e). The total licensed entitlement within the WSP area is 35,346 ML/year, with a further 10,553 ML/year committed to the exercise of basic land holder rights. The combined total entitlement of 45,899 ML/year within the WSP area represents the average annual potential extraction.

The WSP defines the limits to the availability of water for each EMU. The water availability for each EMU is assessed annually. A long-term average annual extraction limit (LTAAEL) and an annual higher-flow extraction limit, as set out in Part 4 Subdivision 2 of the WSP. As of 2023, the LTAAELs are numerical values – for example, the standard LTAAEL for the Tweed River catchment EMU is 56,936 ML for the year. The Tweed River catchment EMU is relevant to the Proposal because it manages the Doon Doon Creek Water Source and the Mid Tweed Water Source, which encompass the Proposal area.

Licence holders have the option to convert to a higher-flow extraction licence, which provides 2.5 units of high-flow access for every 1 unit of a normal unregulated river licence entitlement surrendered. At the commencement of the WSP in 2023, there were no unregulated river (high-flow) access licences.

The WSP has a total volume of surface water licensed for extraction of 34,896 ML (450 ML is groundwater), compared to an annual average flow of approximately 365,000 ML for the Tweed River at Bray Park Weir. The licensed allocation of 27,613 ML (around 79% of total licence entitlement for the WSP) is for town-water supply.

The WSP imposes rules on water licence trading, granting works approvals, and granting new entitlements and native title access licences.

Any effects of new infrastructure, such as a new dam and its operating regime, on the extraction of water by licensed water users needs to consider the system operation rules in Part 6 Division 5A of the WSP. The Minister has powers to suspend or adjust these rules if deemed necessary for the purposes of maintenance, refurbishment or modification works to the dam, which may temporarily affect the flow rate or behaviour of water for at least 24 hours. The system operation rules outlined in the WSP govern the flow regime and releases from Clarrie Hall Dam.

Protection of the Environment Operations Act and regulation

The Protection of the Environment Operations Act 1997 (POEO Act) provides the statutory framework for managing water pollution in NSW. It is supported by the Protection of the Environment Operations (General) Regulation 2009 (POEO Regulation), which among other functions prescribes certain matters for the purposes of the definition of water pollution.

The definition of 'water pollution' in the POEO Act sets out the general and specific circumstances that constitute pollution. At its broadest, water pollution means introducing any matter into

waters that changes the physical, chemical or biological condition of the water. It also includes placing any matter where it might fall, descend, be washed, be blown or percolates into any waters (e.g. soil, which might be washed into a waterway from land disturbance during construction of the project).

Schedule 5 of the POEO Regulation includes a list of specific substances (prescribed matter), which, if they are introduced onto or into waters, are automatically assumed to constitute pollution of waters (i.e. animal matter, soil, thermal waste, any matter that contains faecal coliforms, pesticides, etc.).

Schedule 3 of the Protection of the Environment Operations (General) Regulation 1998 defines discharging water 2 degrees Celsius hotter or colder than the body of water into which it is discharged as water pollution. Clause 56A makes an exemption from a water pollution offence if the water is discharged from a water supply work pursuant to an approval under the WM Act that contains conditions dealing with cold water releases. Due to this exemption, potential cold water pollution (CWP) from Clarrie Hall Dam is regulated by conditions of approval under the WM Act and not regulated by the POEO Act and the 2 degrees Celsius temperature differential limit does not apply to dam discharges.

Drought and water restrictions policy 2022

Tweed Shire Council's Drought and Water Restrictions Policy 2022 outlines the various demand- and supply-side drought response actions required at various stages during an extended drought period or in the event of operational problems. The policy enables Council's Water and Wastewater Unit to make operational decisions about implementing, easing, and removing water restrictions for the Shire. The fundamental purpose of the policy is to minimise the risk of the community running out of water, and to ensure there is always sufficient water available to satisfy the basic needs of the community (TSC 2022b).

Water strategies

As outlined in Chapter 2, the Proposal is outlined as a key initiative in the Far North Coast Regional Water Strategy (FNCRWS) to help improve water security for the region, particularly in the light of climate change, climate variability and a growing population.

Cold water pollution

The NSW Cold Water Pollution Strategy (DPI 2012b) was developed to specify guidelines for the management of releases from major dams across the state. The strategy was updated in draft form in 2017.

The NSW Government has endorsed the principle of requiring dam operators to 'match the temperature of releases from individual dams as closely as possible to the natural temperature regime having regard to the associated costs and benefits'.

The strategy recommends that the natural temperature be estimated using either field data collected over an extended period before the dam is constructed, unimpacted reference sites such as the river upstream of the dam, or physics-based models.

Although somewhat arbitrary, a rolling 5-day cumulative anomaly with a minus 15 degree-days pass/fail threshold is recommended in the strategy as meeting the principles.

NSW water quality and river flow objectives

The NSW Water Quality and River Flow Objectives (DECCW 2006) are the agreed high-level goals for surface water quality and flow management for catchments throughout the state. The river flow objectives identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality, prepared by the Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ 2000), describe the water quality objectives (WQOs) for marine and freshwater environments, aquatic ecosystems, primary industries and recreational water.

Australian drinking water guidelines (ADWGs)

The ADWGs include two different types of guideline value:

- a health-related guideline value, which is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption
- an aesthetic guideline value, which is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer; for example, appearance, taste and odour.

Flood Impact Assessment

The Flood Impact Assessment (Appendix F) was conducted by:

- collecting and reviewing data related to the Proposal, including any available hydrological and hydraulic models
- developing a TUFLOW hydraulic model of Clarrie Hall Dam to define existing dam conditions, with the dam spillway modelled using the existing rating curve
- modifying the TUFLOW hydraulic model to reflect the proposed raised dam conditions, with the dam spillway modelled using the proposed rating curve. The proposed raised dam conditions included the proposed upgrades at McCabes Bridge
- conducting hydraulic simulation for various events design and climate change scenario events
- undertaking a flood impact assessment to determine the potential effects on flood behaviour caused by the proposed Clarrie Hall Dam upgrade both upstream and downstream for all simulated design events
- providing reporting and mapping based on the outcomes of the hydraulic simulations.

Modelled design events

Hydraulic simulations for the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF design events were modelled to assess the likely impacts of the Proposal, as well as climate change conditions for each of the design events.

Hydraulic modelling was undertaken using the TUFLOW version 2020-10-AD-iSP. In order to assess and determine the likely flood impacts of the proposed raised dam condition, 2 scenarios were modelled – for the 'existing case' and the 'proposed case', as summarised in Table 6-2.

Table 6-2 Summary of modelled scenarios

Scenario	Summary
Existing case	Represents the dam in its existing condition, with the spillway level at 61.5 m AHD and the wall of the dam at 70.4 m AHD.
Proposed case	Represents the wall of the dam at 77 m AHD and the spillway raised by 8.5 m to 70.0 m AHD. The scenario also includes the proposed upgrade to McCabes Bridge.

The outline of the TUFLOW hydraulic model setup for both scenarios is provided in Appendix F section 4.

To ensure that the maximum flood levels were captured for both the existing case and the proposed case, all the durations, 6-hour, 9-hour, 12-hour, 18-hour and 24-hour storm events were modelled for the 5% AEP, 1% AEP, 0.5% AEP and 0.2% AEP design events, using the selected temporal patterns outlined in Appendix F.

The 24-hour and 48-hour storm events were run for the PMF.

Flood frequency analysis

A flood frequency analysis (FFA) was undertaken on recorded stream flow data at the gauge at Uki.

Hydraulic structures

The hydraulic model included hydraulic structures (bridges and culverts). The locations of the hydraulic structures are shown in Figure 6-1.

Bridges that have been identified within the hydraulic model and were known to affect flow and water levels within Doon Doon Creek and the Tweed River were modelled as layered flow constrictions. The layered flow constrictions parameters were approximated based on aerial photography and local topography. Table 6-3 presents the bridges identified and included within the hydraulic model.

Table 6-3 Bridges identified within the hydraulic model

Bridge	Description and location
Doon Doon Rd 1	Doon Doon Road crossing Doon Doon Creek; 3.0 km upstream of McCabes Bridge
Doon Doon Rd 2	Doon Doon Road crossing Doon Doon Creek; 2.3 km upstream of McCabes Bridge
McCabes Bridge	At Commissioner Creek Road crossing Doon Doon Creek; upstream of the Clarrie Hall Dam. As part of the upgrade to the dam, this bridge is also proposed to be upgraded
Kyogle Rd 1	Kyogle Road crossing Doon Doon Creek; downstream of Clarrie Hall Dam, close to confluence with Tweed River
Kyogle Rd 2	Kyogle Road crossing Rowlands Creek; close to confluence with Tweed River
Kyogle Rd 3	Kyogle Road crossing Smiths Creek; close to confluence with Tweed River
Byangum Bridge	Kyogle Road crossing Tweed River

Four reinforced concrete box culverts were modelled on Doon Doon Road at its crossing of Pine Log Creek, situated approximately 1.2 km upstream of McCabes Bridge.

Six culverts identified downstream of the dam on Clarrie Hall Dam Road were modelled parallel to Doon Doon Creek. The culverts were all assumed to be 600-mm diameter, single-barrel, reinforced concrete culverts.

Other culverts within the hydraulic model located downstream of the confluence of Doon Doon Creek and the Tweed River were not modelled, as the regional nature of the hydraulic modelling did not warrant inclusion of these structures.

Model extent

The hydraulic model extends from approximately 10 km upstream of the spillway at Clarrie Hall Dam to 400 m downstream of Bray Park Weir, which is situated approximately 15 km downstream of the dam. The TUFLOW model extent is presented in Figure 6-1.

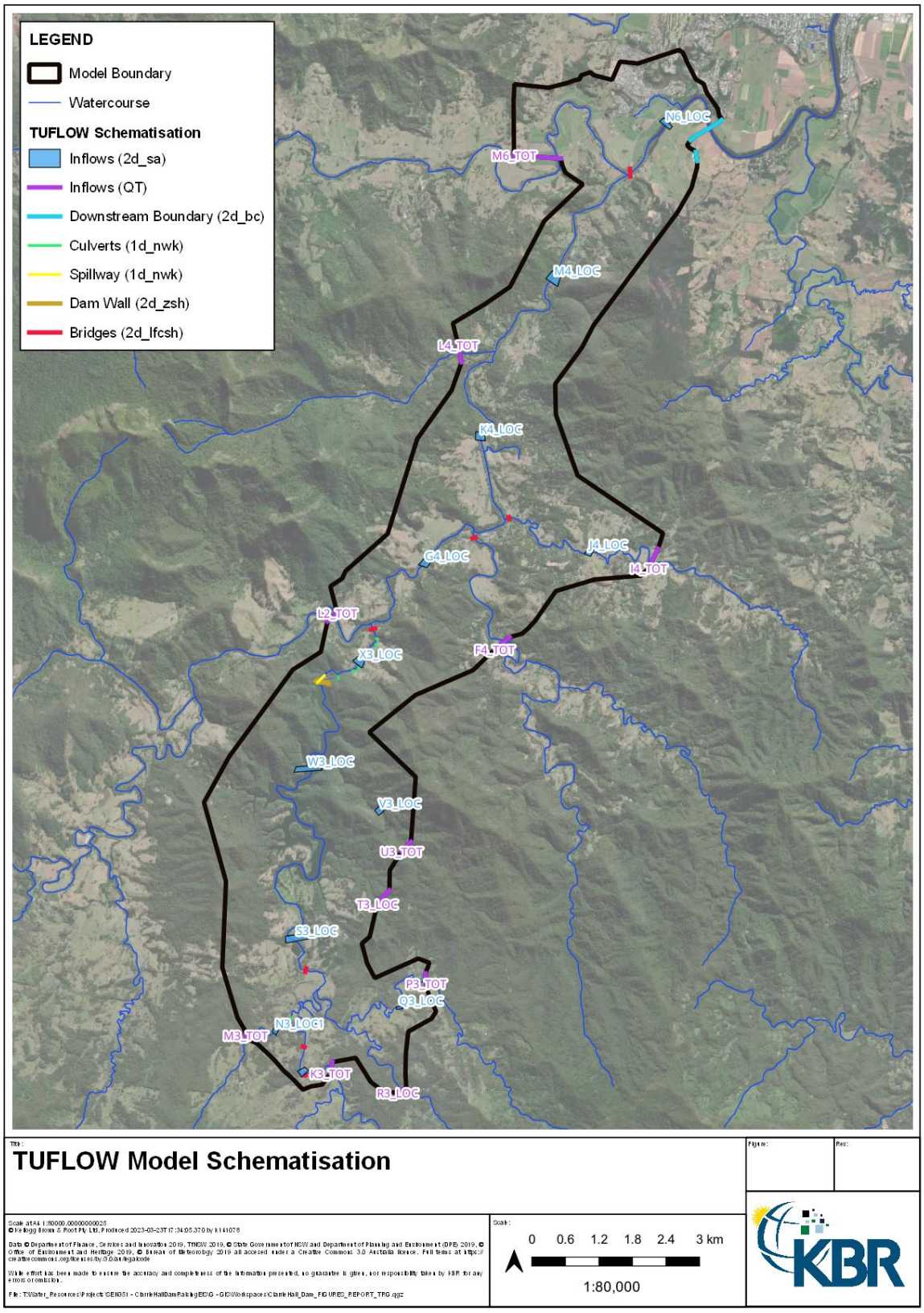


Figure 6-1 TUFLOW model schematisation

Initial water level

Clarrie Hall Dam was assumed to be at FSL in both the existing case and the proposed case at the start of the hydraulic simulation – that is, the water level at spillway crest levels. Hence, initial water levels of 61.5 m AHD and 70.0 m AHD were applied for the existing case and proposed case, respectively.

Validation of calibration events

The Uki gauge is situated within the bounds of the current TUFLOW model at the town of Uki. The Uki gauge records river flow in the Tweed River and is situated approximately 4.5 km downstream of the dam.

Validation modelling was conducted on the TUFLOW model to determine the performance of the TUFLOW modelling against the 3 historic flood events.

The 3 calibrated RORB models of each of the historic events were provided by Council.

The results of the of the validation event modelling demonstrated that the TUFLOW model can produce discharges that suitably replicate recorded flows at the Uki gauge.

Further information on calibration of the modelling is provided in Appendix F section 5.

Model boundaries and topography

A 16 m grid was used for the dam's existing FSL storage at 61.5 m AHD, and an 8 m grid size applied to the remainder of the modelled terrain for both the existing case and the proposed case.

The hydrological study of the Clarrie Hall Dam conducted by WRM (2017) forms the basis of the hydrological inputs and was originally conducted using Australian Rainfall and Runoff (AR&R) 1987 (Institution of Engineers 1987) methods. The RORB hydrological model, as provided by Council, was updated to incorporate AR&R 2019 (Ball et al. 2019) methods. The outputs of the updated RORB hydrological model are used as inflow inputs into the TUFLOW hydraulic model.

Model topography was based on LiDAR and a bathymetry survey of Doon Doon Creek and the Tweed River conducted in 2023.

Climate change

The climate change scenario applied the updates to the climate change factors proposed in the Draft update to the Climate Change Considerations chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation (Department of Climate Change, Energy, the Environment and Water, 2024a (Cth)), which is scheduled for release towards the end of 2024.

The updated climate change guidelines present temperature projections based on shared socioeconomic pathways (SSPs) that cover a broad range of potential future development options identified as pathways with emissions that are very low (SSP1-1.9), low (SSP1-2.6), medium (SSP2-4.5), high (SSP3-7.0) or very high (SSP5-8.5).

AR&R 2019 recommends the application of representative concentration pathway (RCP) 4.5, which aligns with the medium development option (SSP2-4.5) in the updated climate change guidelines. For the purpose of the study, the more conservative, high development (SSP3-7.0) pathway for the long-term projection (2081-2100) was applied. Climate change factors were calculated and applied to the Intensity-Frequency-Duration (IFDs) data.

Groundwater assessment

The groundwater impact assessment was conducted through a combination of desktop review, field work and assessment of impacts using a risk analysis method.

The groundwater assessment area comprises the Doon Doon Creek sub-catchment area, as well as the area immediately downstream of the confluence of between Doon Doon Creek and the Tweed River, to the confluence between the Tweed River and Rowlands Creek. The groundwater study area is shown in Figure 6-2.

Desktop review

The assessment of potential impacts on groundwater considers the requirements of the WMA, relevant WSPs and the NSW Aquifer Interference Policy (AIP) (for some activities). The National Water Commission developed guidelines and a risk framework for assessing local and cumulative effects of mining activities on groundwater systems (Moran et al. 2010). While this is not a mining project, the framework remains applicable and defines the following 4 possible direct groundwater effects arising from a project:

- altered groundwater quantity (groundwater levels, pressures and fluxes)
- altered groundwater quality (concentration of salts and other important water quality constituents)
- altered surface water – groundwater interaction
- physical disruption or removal of aquifers (excavation quarry pits).

Direct effects encompass the changes to physical and/or quality aspects of groundwater due to water-affecting activities, or the changes to the physical characteristics of aquifers affected by these activities. Indirect effects of water-affecting activities are those that arise in response to direct effects (Moran et al. 2010). The assessment of potential receptor exposure to adverse changes in the groundwater regime (quantity, quality, groundwater and surface water interactions, and physical disruption of aquifers) requires:

- knowledge of the location of sensitive receptors within the landscape, particularly in relation to the location and area of influence of water-affecting activities
- an understanding of the receptor's reliance on groundwater (e.g. depth to water table, groundwater flux to baseflow-fed streams, groundwater quality to meet beneficial purposes)
- an understanding of the spatial and temporal scale of direct groundwater effects at the location of sensitive receptors.

Water Management Act

The WMA includes the concept of ensuring 'no more than minimal harm' for both the granting of WALs and the granting of project approvals. Minimal-impact considerations have been developed for impacts on groundwater sources, connected water sources, and their dependent ecosystems, culturally significant sites and water users.

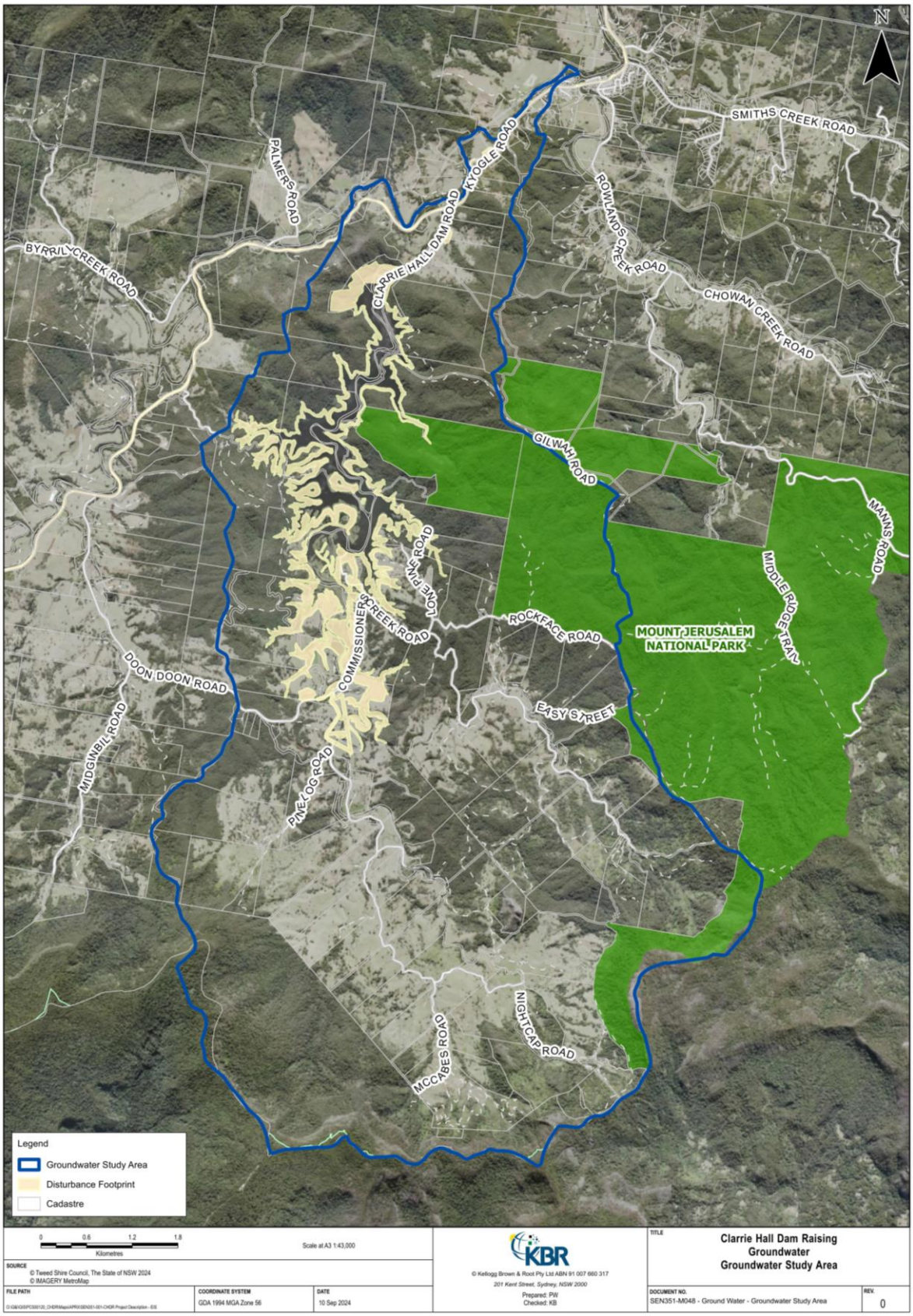


Figure 6-2 Groundwater study area

Source: EMM (Appendix G2)

Water Sharing Plans

The groundwater study area overlies 2 WSP areas that relate to the alluvial and regional fractured rock groundwater units. These areas are:

- Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016 (NSW Government 2016):
  - Clarence-Moreton Basin groundwater source
  - North Coast Volcanics groundwater source
  - New England Fold Belt Coast groundwater source
- Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2023 (DCCEEW 2023a):
  - Mid Tweed River water source
  - Doon Doon Creek water source.

The use of groundwater for construction activities is not proposed, so groundwater licences are not required.

NSW Aquifer Interference Policy

Projects that intercept groundwater or exchange water between one water source and another also need to consider the NSW AIP (DPI 2012). This policy requires projects to hold licences that account for the volume of water intercepted or exchanged and consider changes in water quality and water levels at sensitive receptors in accordance with prescribed minimal impact criteria.

Groundwater assessment toolbox for major projects in NSW – overview document

The overview document on the groundwater assessment toolbox, (DPE 2022) provides a framework to investigate, assess the impacts on, manage and monitor groundwater resources and their interaction with surface water resources within the footprint of a major project. This technical guideline references the assessment criteria in the AIP, as well as the Australian Groundwater Modelling Guidelines (Barnett et al. 2012).

The guideline on the groundwater assessment toolbox is an overview guidance document that comprises more detailed guidance documents. These documents denote the DPE Water's requirements for new groundwater assessments for SSD/SSI projects, and guidance in regard to monitoring and management plans, and compliance reporting.

Risk assessment guidelines for groundwater dependent ecosystems

The risk assessment guidelines for groundwater dependent ecosystems (GDEs) (Serov et al. 2012) (GDE Risk Assessment Guidelines) are the NSW requirements for assessment and management of GDEs under the WMA.

Groundwater bore search

The WaterNSW groundwater database was searched to identify records of private landholder bores within a 5 km radius from the centre of the study area.

Groundwater dependent ecosystems

The desktop assessment included the following reviews to identify potential GDEs located within the vicinity of the study area:

- review of the GDE Atlas (BoM 2022)

- review of the Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016 (NSW Government 2016)
- review of the Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2023 (DCCEEW 2023a)
- collation of depth to groundwater information from the NSW DPE – Water database
- review of aerial photographs, topographic and geologic maps.

Field work

Groundwater-related field work was undertaken to:

- determine the status and properties of groundwater bores within the assessment area
- explore the type and extent of the upgradient floodplain alluvium.

Field work comprised a landholder bore census, and the hand-augering of 11 shallow boreholes at 4 locations between 14 and 15 March 2023. The bore census was undertaken at bores within the assessment area, comprising the Doon Doon Creek catchment area and at 2 bores immediately downstream of the confluence between Doon Doon Creek and the Tweed River.

Assessment of impacts

Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Serov et al. 2012) has developed a risk assessment approach, documented in the Risk Assessment Guidelines for Groundwater Dependent Ecosystems. The following risk factors relevant to the Proposal were considered in the assessment:

- impacts to groundwater quantity: fluctuations in groundwater levels and/or pressure, changes in seasonal baseflow conditions
- impacts to water quality: changes in water quality that may impact any beneficial uses of the shallow groundwater and connected ecosystems
- impacts to the biodiversity of any GDEs: species diversity or composition, dieback of vegetation, increased exotic species or removal/alteration of habitat.

The risk assessment approach considered the risk of impact (low, medium or high) as well as the ecological value of the GDE (low, medium or high) to determine the overall risk.

6.1.2 Existing environment

The existing surface water, flood and groundwater environment is described in this section.

Surface water

Water Sharing Plan

The WSP requires that minimum releases of water must be made each day from Clarrie Hall Dam as shown in Table 6-4.

Table 6-4 Minimum releases from Clarrie Hall Dam

Flow at Oxley River Eungella gauge (201001)	Target flow rate for releases
≥ 13 ML/day	4 ML/day
>3 to < 13 ML/day	2 ML/day
≤ 3 ML/day	1 ML/day

The Minister may adjust or suspend the requirement to make minimum releases in emergency or for dam maintenance/modification.

Drought and water restrictions policy 2022

A summary of the current Tweed district water supply scheme water restriction triggers and reduction in water use target is provided in Table 6-5. The drought policy presents restrictions and triggers for each of the 3 water supply schemes operated by Tweed Shire Council: the Tweed district water supply network, the Uki water supply, and the Tyalgum water supply.

Table 6-5 Restriction triggers for Tweed District Water Supply Scheme

Restriction level	Residential water-use saving target litres per person per day) (L/p/d)	Residential water-use target (L/p/d)	Implemented at % of dam capacity	Eased at % of dam capacity
Level 1	10	150	85	100
Level 2	20	140	75	95
Level 3	30	130	65	85
Level 4	40	120	55	75
Emergency	60	100	45	65

Other circumstances that can trigger restrictions include:

- saltwater contamination at Bray Park Weir
- other contamination events including floods
- treatment plant failure
- major asset failure
- power supply failure.

Waterways

Doon Doon Creek

Clarrie Hall Dam is located on Doon Doon Creek, with a 60 km2 catchment at the dam wall. Within the NSW HydroLines dataset (DPIE 2023a), Doon Doon Creek at the dam location is classified as a 5th order waterway.

The NSW RiverStyles database (DPE 2023b) describes the Tweed River upstream from Bray Park Weir as ‘confined valley setting, gravel bed with floodplain pockets’, aligning with field observations that the stream bed is rocky, with the bed predominantly formed from cobble-sized rocks. Downstream from the dam wall, Doon Doon Creek is incised into the landscape with wooded banks and a rocky bed featuring sequences of pools and riffles (Figure 6-3).



Figure 6-3 Pool and riffle in Doon Doon Creek downstream of Clarrie Hall Dam

Source: EMM Appendix G1

Tweed River

The Tweed River flows in a generally easterly direction towards the coast. In the upper reaches, the river has a stony bed with sequences of pools and riffles (Figure 6-4).

Several towns lie along the Tweed River and rely on its flow for water supply. In particular, Bray Park Weir at Bray Park near Murwillumbah has been constructed to create a weir pool to allow extraction of water for town-water supply.

Downstream from Bray Park Weir the Tweed River is estuarine and is affected by tides. The river meets the ocean at Tweed Heads on the NSW–Queensland border.

At and around the junction with Doon Doon Creek, the NSW HydroLines dataset defines the Tweed River as a 6th order waterway. The Oxley River joins the Tweed River 2 km upstream from Bray Park Weir. Downstream from the junction with the Oxley River, the Tweed River is classified as a 7th order waterway.



Figure 6-4 Pool and riffle in the Tweed River between Uki and Doon Doon Creek

Source: EMM Appendix G1

Climate

Climate data were obtained from the Bureau of Meteorology (BoM), the Queensland Government Scientific Information for Land Owners (SILO), and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

SILO is a database of Australian climate data from 1889 to the present. It provides daily meteorological datasets for a range of climate variables in ready-to-use formats suitable for biophysical modelling, research and climate applications.

Current climate

The climate of the Proposal region is subtropical, with average summer maximum temperatures above 29 degrees Celsius and winter maximums of around 20 degrees Celsius. Rainfall occurs year-round and there is a pronounced summer/autumn wet season and a winter/spring dry season.

Global scale influences that affect the region in which the Proposal is located include the El Niño/La Niña Southern Oscillation (ENSO), the Southern Annular Mode (SAM), and the subtropical ridge. Regional scale influences such as easterly troughs, east-coast lows and cut-off lows may also affect climate conditions at the Proposal site. Climate influences are discussed in detail in Appendix G1 section 3.3.2.

BoM station 58129 (Kunghur) recorded an average rainfall of 1,502 mm/year over the period 1966–2022 (excluding years with more than 20 days of missing data), whereas BoM station 58019 (Doon Doon at McCabes Road) recorded an average rainfall of 2,149 mm/year between 1952 and 2022.

The Tweed River catchment has one of the highest annual rainfalls of any significant catchment in NSW, and in 2022, station 58019 recorded the state annual rainfall record of 4,607 mm (BoM, 2023a).

The subtropical climate of the Tweed Valley is characterised by a pronounced summer- and autumn-dominated annual rainfall regime and a winter/spring dry season (Figure 6-5). High rainfall has been observed during most months, with high rainfall accumulations usually associated with strong east-coast lows and decaying tropical cyclone events.

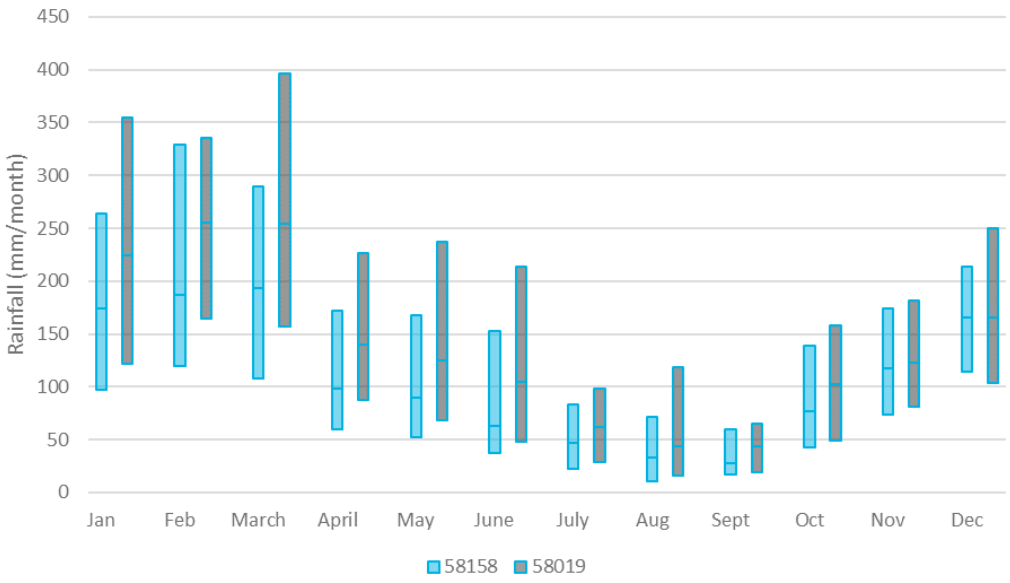


Figure 6-5 Clarrie Hall Dam monthly rainfall totals

Source: EMM Appendix G1

BoM estimates that an average of 1 cyclone in every 2 cyclone seasons is likely to affect the Tweed Valley, and most recently Cyclone Debbie delivered intense rainfall and widespread flooding in 2017.

In February 2022, a combination of weather systems and antecedent wet conditions resulted in flooding assessed to be greater than the 1% AEP event (CSIRO 2022).

The median yearly pan evaporation estimated for the Murwillumbah site by SILO since 1973 is 1,529 mm/year. Evaporation is generally expected to exceed rainfall at Clarrie Hall Dam from June to January.

Average wind speeds measured at Murwillumbah range from 7 km/h to 18 km/h, with higher average wind speeds recorded in spring and early summer, and lower average recorded wind speeds in late summer, autumn and winter. Afternoon wind speeds tend to be higher than morning wind speeds.

Average summer maximum temperatures are above 29 degrees Celsius, while winter maximums are around 21 degrees Celsius.

Historical climate

The Proposal area has experienced long-term climate cycles due to effects such as the ENSO and SAM climatic processes. This has resulted in wet periods and droughts, as illustrated in the long-term rainfall trend shown in Figure 6-6.

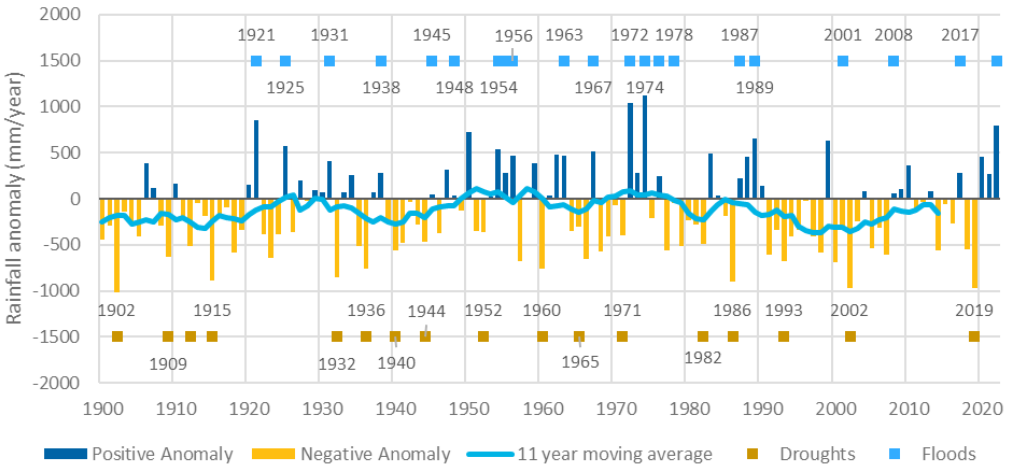


Figure 6-6 Historical rainfall trend at Murwillumbah, and regional flood and drought markers

Source: EMM Appendix G1

Historic droughts have generally not been longer than 2 to 3 years. The drought of 2019 during a strong El Niño event is one of the worst on record; during that period, Murwillumbah recorded its lowest annual rainfall total of 717 mm. Major floods have also occurred with regularity through the period of streamflow records, with the last notable major flood on the Tweed River occurring in 2022.

From 1890 to 1998 the mean average annual temperature at Murwillumbah has fluctuated between ±1°C from the 1961–1990 base period mean annual average temperature. After 1998, temperature anomalies of greater than 1°C have occurred. The data shows a warming trend at the site since around 1966. This result is consistent with data for other sites in NSW and Australia, which also show a long-term warming trend over roughly the same period since the mid-20th century.

Future climate

The NSW Climate Impact Profile (DECCW 2010a) provides projections of climate change and impacts of these changes on settlements, land and ecosystems of NSW. The Climate Impact Profile outlines some of the risks NSW faces to help decision-makers develop their planning and response strategies. Expected regional climatic changes in the north coast region are:

- rising temperatures
- increasing rainfall in summer and autumn
- increasing evaporation.

ENSO years will continue to be drier than average but also become hotter, leading to more extreme impacts. La Niña years are likely to continue to be wetter than average but will also become warmer. During El Niño events, water stress is likely to be more pronounced because of higher temperatures.

A detailed description of the application of NSW and Australian Regional Climate Modelling (NARCliM) climate modelling to Proposal hydrology is provided in Annexure A. NARCliM is a collaboration led by the NSW Government with the ACT and South Australian governments with input from the University of New South Wales's Climate Change Research Centre (UNSW CCRC). It was established to produce regional climate projections and data for studies into the impacts of climate change in south-east Australia, including the Proposal area. In summary, it is expected that by 2065 there will be:

- a decrease in rainfall of approximately 20%
  - large decreases in rainfall in winter and spring (Figure 6-7)
  - little change to rainfall in summer and autumn
- an increase in evaporation of approximately 10%.

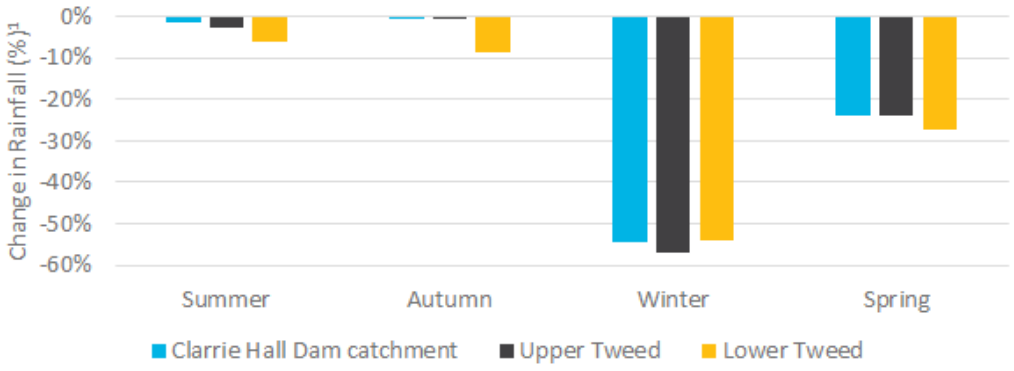


Figure 6-7 ACESS1-3 seasonal rainfall projections (2065)

Source: EMM Appendix G1

Changes in rainfall and higher evaporation rates are likely to lead to less water for streams and rivers in the Northern Rivers, which will have downstream consequences for storages and place pressure on the area's water resources. Lower flows and higher temperatures may also reduce water quality. For example, low flows, higher temperatures and elevated nutrients create a more favourable environment for potentially harmful algal blooms (CSIRO 2007).

Streamflow

Streamflow records are available for the Tweed River at Uki (201900) since 1967 and the Oxley River at Eungella (201001) since 1957. There is no streamflow gauge located within Doon Doon

Creek downstream from Clarrie Hall Dam. However, dam operators have maintained records of manual release volumes. Both gauges demonstrate perennial conditions, with summer and autumn having higher flows than winter or spring.

Doon Doon Creek is not gauged; however, estimates of streamflow have been developed using the DPIE Source model (Figure 6-8) (further details in Appendix G1 Annexure A), illustrating:

- perennial flow – supported by dam releases; with minimum flows of 4 ML/day supported by dam releases occurring 50% of the time during summer and spring
- flows typically (20th to 80th percentile) in the range of 4–100 ML/day.

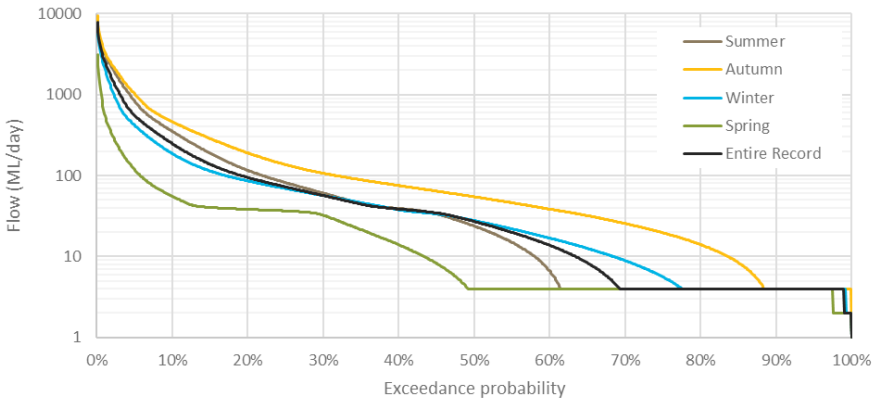


Figure 6-8 Flow duration curve at Doon Doon Creek downstream of Clarrie Hall Dam, current climate

Source: EMM Appendix G1

Recorded stream depths at gauge locations indicate that the Tweed River at Palmers Road crossing is typically 0.5–1 m deep, while at Uki the depth is typically around 1–1.5 m (Figure 6-9 and Figure 6-10).

Through the length of the river, depths will vary through riffles and pools and other localised features.

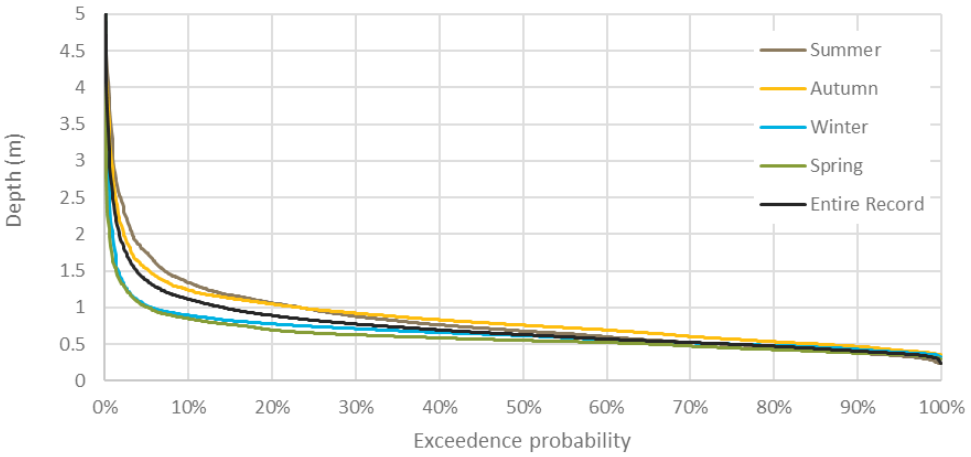


Figure 6-9 Stream depth curve for Tweed River at downstream Palmers Road crossing (201015)

Source: EMM Appendix G1

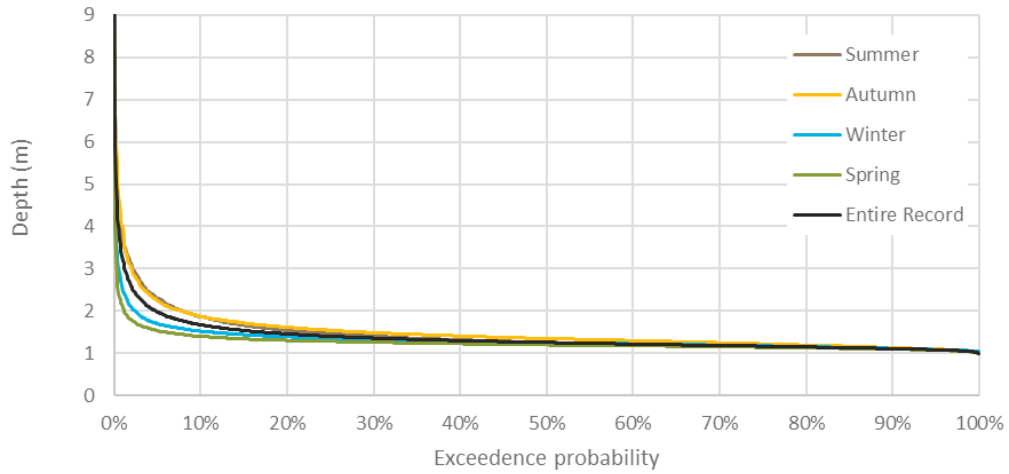


Figure 6-10 Stream depth curve for Tweed River At Uki (201900)

Source: EMM Appendix G1

The modelled Doon Doon Creek hydraulics (Appendix G1 Annexure C) and streamflow regime (Appendix G1 Annexure A) indicate that Doon Doon Creek is typically shallow during periods of minimum release. The creek increases in depth by around 1 m during higher-flow events (10th percentile).

Surface water – groundwater connectivity

Between Clarrie Hall Dam and Bray Park Weir, Doon Doon Creek and the Tweed River are conceptualised as gaining streams, meaning that groundwater discharges enter the waterways and contribute to baseflow (see Appendix G2).

Water infrastructure

Clarrie Hall Dam

The Clarrie Hall Dam catchment is approximately 60 km2. Approximately 1.4 km downstream of the Clarrie Hall Dam, Doon Doon Creek joins the Tweed River, with a combined catchment area of 230 km2. Approximately 9 km downstream from the Doon Doon Creek – Tweed River confluence, the Oxley River (240 km2 catchment) joins the Tweed River, with a total combined catchment of 570 km2. The Tweed River, which reaches the coast at Tweed Heads, has an upstream catchment area of around 1,326 km2 including the Tweed River, Rous River and Terranorra Creek catchments. The Tweed River estuary extends from the coast to Bray Park Weir.

Most of the time, the reservoir is full and water flows over the dam's spillway into Doon Doon Creek and downstream to the Tweed River. During low flow conditions, flows in the Tweed River are supplemented with releases from Clarrie Hall Dam to meet the demand for town or domestic water supply and irrigation, and to meet environmental flow requirements specified in the WSP (as per Appendix G1 Table 2.1).

The dam features a multi-level offtake (MLO) via an inlet tower that can be operated to draw water from various levels within the reservoir water column (Figure 6-11). Two fixed cone dispersion valves (FCDVs) of 400 mm and 900 mm diameter allow regulation of flow releases.

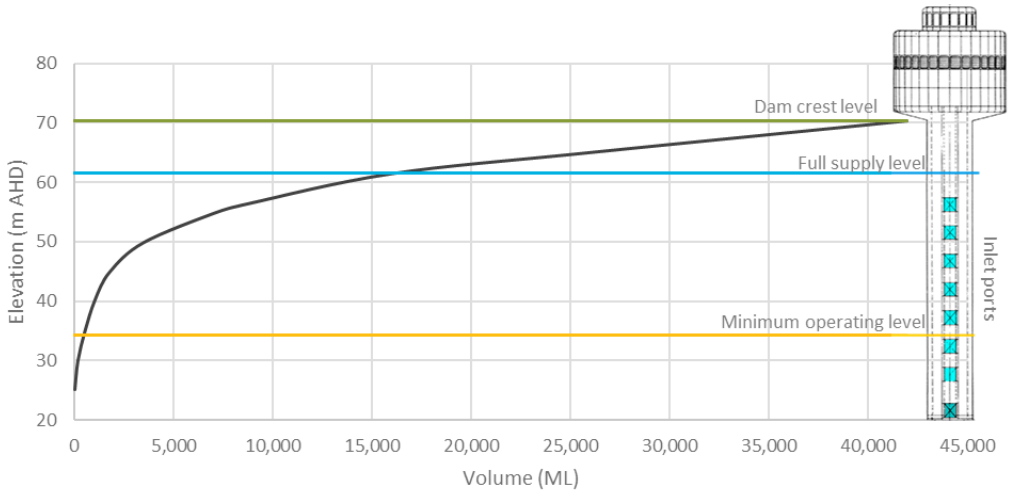


Figure 6-11 Approximate Clarrie Hall Dam depth–volume relationship and release elevations

Source: EMM Appendix G1

The reservoir is full and overflowing most of the time, and is drawn down in drought. The average measured storage volume over the period 2008–2023 is around 16,000 ML, approximately 100% of the full design capacity.

Dam operational data was provided by Tweed Shire Council for the period March 2008 to February 2023. During this time, water flowed over the spillway for around 65% of the time.

Based on dam surveillance data from 2012–2022, the primary source of water for the dam is inflow from Doon Doon Creek into storage. Rain falling directly on the surface of the storage only accounts for 6% of dam inflows.

Annual water balance results show that managed releases are consistently low, whereas spill volumes account for the vast majority of the outflows. Spill volumes vary significantly over time, generally in response to rainfall.

The spillway discharges water once the water level in the reservoir exceeds 61.5 m AHD. Spillway discharges occur on approximately 65% of days (Figure 6-12) and occur more often and with larger volumes during autumn.

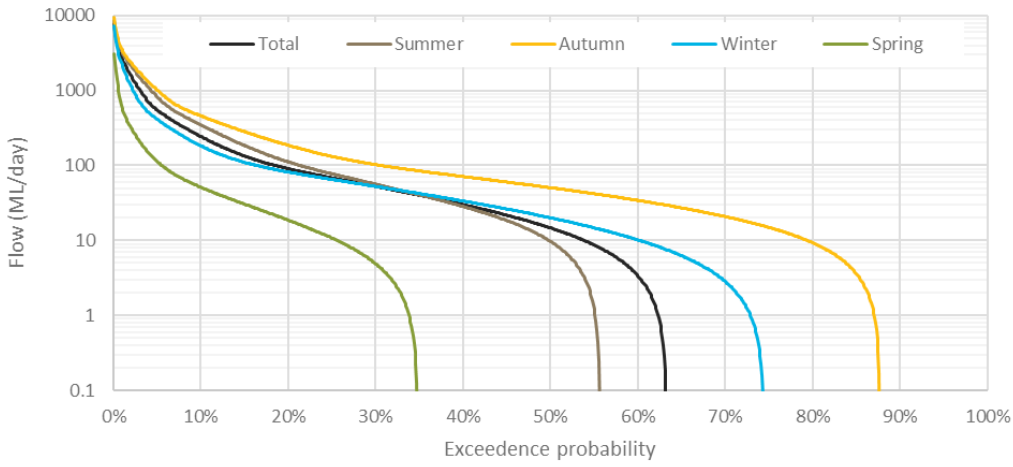


Figure 6-12 Spillway discharges (modelled)

Source: EMM Appendix G1

Peak discharges from the existing reservoir via the existing spillway during flood events are estimated to be as per Figure 6-12. The Proposal would not affect storm inflows to the reservoir, but the larger reservoir will attenuate flows, and the new spillway would have different flow characteristics to the existing spillway.

Further detail of expected peak outflows and downstream flood effects (i.e. short duration effects in response to large storms) is provided in this section and Appendix F.

Tweed District water supply scheme

The pool upstream of Bray Park Weir is supplied with flow from both the Tweed and Oxley rivers, and the weir acts as the dominant upstream control of the river levels near Murwillumbah. Releases are made from Clarrie Hall Dam to top up the Bray Park Weir pool (DCCEEW 2023a) via run-of-river water transfers.

Raw water is pumped from the Tweed River from the pool immediately upstream of the Bray Park Weir and transferred to the Bray Park water treatment plant for treatment and distribution via the Tweed district water supply network.

Tidal influence penetrates up the Tweed River to the Bray Park Weir, and in this way the weir acts as a saltwater barrage. The weir can be raised in response to high tides with demountable flood barriers (concrete blocks and sandbags), to reduce the risk of overtopping and saltwater contamination of the weir pool.

The 3 water supply systems operated by Tweed Shire Council are shown in Table 6-6. The Tweed district water supply network services the major urban centre of Tweed Heads, the town of Murwillumbah, and the coastal strip from Kingscliff to Pottsville including the villages of Mooball and Burringbar. Uki and Tyalgum are serviced by their own water supply networks.

Table 6-6 Water supply systems in the Tweed LGA

System	Tweed district	Uki	Tyalgum
Water source	Doon Doon Creek	Doon Doon Creek	Upper Oxley River
Source type	Surface water storage and weir pool	Large in-stream storage and run-of-river abstraction	Weir pool and run-of-river abstraction
Storage capacity	Clarrie Hall Dam (16,000 ML), Bray Park Weir (520 ML)	Clarrie Hall Dam	Tyalgum weir pool (7.52 ML)
Serviced areas	District except for Uki and Tyalgum	Uki	Tyalgum
License entitlement as per water sharing plan	27,500 ML/year	67 ML/year	46 ML/year
Water treatment plant	Bray Park Weir WTP 100 ML/day	Uki WTP 0.44 ML/d	Tyalgum WTP 0.25 ML/day

The Tweed district and Uki water supply networks are supplied by releases from Clarrie Hall Dam, whereas the Tyalgum water supply network is sourced from the upper Oxley River and is not affected by releases from Clarrie Hall Dam.

The total number of connections for Tweed district is expected to increase by approximately 133%, to 61,016, over the next 50 years (Hydrosphere 2020). The average demand is only expected to increase by approximately 89% over the same time period (Figure 6-13), due to ongoing demand management factors and increased development of multi-residential properties with lower demand than single residential properties. Annual water demand is currently around 10,000 ML/year but has been forecast to grow to around 17,000 ML/year by 2065. The unrestricted dry

year demand is 4.3% higher than the average demand for Tweed district water supply (Hydrosphere 2020).

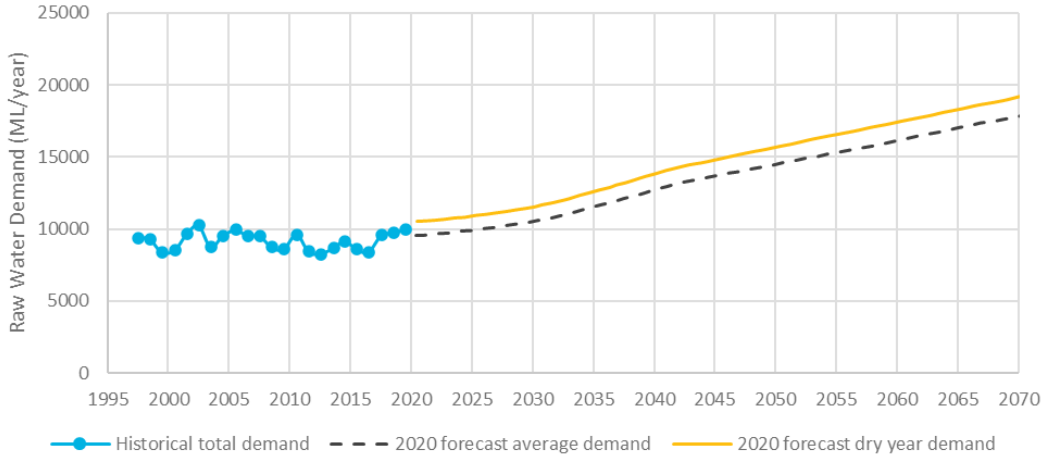


Figure 6-13 Shire-wide historical demand and 2020 demand forecasts

Source: Hydrosphere 2020a

Surface water use

Water access licences issued under the WM Act are fully separated from land title and are not recorded in the NSW Water Register (WaterNSW n.d.).

Both the NSW Water Register and the Water Access Licences Register were reviewed to identify surface water users.

The management of the Tweed River catchment water resources is described in the WSP. Total licensed entitlement for the plan area is 35,346 ML/year, and there are 32 water sources within the plan area. Of particular relevance to the Proposal are the Doon Doon Creek water source and the Mid Tweed River water source, located in the Tweed River catchment EMU.

Clarrie Hall Dam and the catchment area reporting to it are associated with the Doon Doon Creek water source. There are 5 irrigation WALs and 1 domestic and stock WAL within the Doon Doon Creek water source, with a combined share component of 56 shares, equivalent to 56 ML/year when water availability is 100% (Table 6-7). As of 2023, there were currently no active unregulated river (high flow) access licences.

Table 6-7 WAL summary for the Mid Tweed River and Doon Doon Creek water sources

Water source	Access licence category	Number of WALs	Share component (volume available at 100% allocation) (ML per year)
Doon Doon Creek	Unregulated River (irrigation)	5	52r
	Domestic and stock	1	4
Total		**6**	**56**
Mid Tweed River	Local water utility	2	27,567
	Unregulated River (irrigation)	23	1,228
	Domestic and stock	2	27
	Aquifer	1	40
Total		28	28,862

There are 2 flow classes specified in Division 3 of the WSP for the Mid Tweed River and Doon Doon Creek water sources, as set out in Schedule 1 at Appendix G1 Table 3.4.

In any particular year, WALs may be limited to extraction of only part of the associated volume, as allocations may be reduced below 100%:

- in response to water availability, such as may occur during drought, or
- to maintain total average extractions within the LTAAEL.

Tweed Shire Council has WALs to extract 27,613 ML per year (representing 79% of the total water entitlement). Under the WM Act, water utility extractions for town-water supply are given higher priority than extractions for commercial purposes, such as irrigation or water bottling.

Irrigated agriculture

Apart from urban use, other water users extract water for irrigation, and stock and domestic use. Rural Tweed, within RU1, RU2, R5, 7(d), 7(f), and 7(l) zoned land occupies 96,665 ha, or around 75% of the total area of the Tweed Shire.

Tweed Shire is recognised as a state-level significant agricultural producer; in 2013 the Shire contributed approximately 30% of state product value of sugarcane and bananas and 10% of the state's tropical orchard fruit value. The land use and landscape of the region continue to maintain a predominantly agricultural outlook, with agriculture supporting 10% of the workforce (TSC 2020a).

Environmental receptors

Water and connectivity of waterways is required within the Tweed River for ecological processes such as native fish migration, spawning and recruitment, and vegetation maintenance. Meeting the full life cycle needs of an aquatic organism (plant or animal) might require a combination of several different flow magnitudes, frequencies and durations over time.

To support environmental outcomes within Doon Doon Creek and Tweed River, the WSP specifies minimum releases from the reservoir of 1–4 ML/day, depending on flow in the Tweed River (see Appendix G1 section 3.6.1iv). Water quality objectives are discussed below and in Appendix G1 section 3.9 and are included in the assessment of impacts in section 6.1.3. Groundwater dependent ecosystems are discussed in the Groundwater Impact Assessment in this section and Appendix G2.

Terrestrial water-dependent ecosystems include:

- bank and floodplain vegetation
- Stotts Island Nature Reserve, approximately 33 km downstream of the dam – not likely to be affected by the Proposal.

Aquatic ecology surveys conducted for the Proposal (see section 6.3 and Appendix I) indicate that of the fish species present in the Tweed River, only Australian Bass (*Percalates novemaculatea*) have a life cycle stage with a flow trigger.

Australian Bass are catadromous, meaning adults migrate downstream to spawn in estuaries. This migration occurs during flood events between May and July (Lintermans, M, 2007) when water temperatures are below 15 degrees Celsius, with fish returning between August and April.

Australian Bass may migrate during a series of shorter pulse flows, or during consistent moderate flows. In the Tweed River it is estimated that flows required to prompt migration are as per Table 6-8. The frequency of flows that may cue migration are discussed further in Appendix G1 section 5.6.3.

Table 6-8 Australian Bass migration flow cues, Tweed River

Environmental process	Month	Flow threshold (ML/d)	Duration
Spawning migration	May to July	800	Multiple 3-day pulses
		150	5 days
Upstream migration	August to April	1,700	Multiple 3-day pulses
		150	5 days

Water quality

Water quality objectives

The SWA adopted the NSW Water Quality Objectives – Tweed River catchment (NSW WQOs) (DECCW, 2006) as they provide the most relevant objectives. The NSW WQO targets, however, are limited to pH, electrical conductivity [EC], dissolved oxygen, turbidity, nitrogen, and phosphorus. ANZG (2018) default guideline values are used in this assessment for toxicants (metals).

ADWG thresholds are relevant to water quality delivered by the Shire to potable water customers after water treatment but are not required to be met in raw water sources prior to treatment.

A comparison of adopted and other WQOs is provided in Appendix G1 (Table 3.6).

Water quality monitoring

Routine water quality monitoring is undertaken by Tweed Shire Council at around 60 water sampling sites distributed across 7 water quality reporting zones in the Shire.

A baseline assessment was conducted that focused on monitoring locations in the Upper Tweed catchment, which encompasses the freshwater reaches of Doon Doon Creek, the Tweed River catchment down to Bray Park Weir, Clarrie Hall Dam, and Uki and Bray Park WTP intakes. The selected sites are shown in Figure 6-14. Bray Park Weir pool is the downstream limit of the baseline assessment.

Monthly monitoring of catchment sites typically includes general water quality characteristics (pH, EC, turbidity, temperature, dissolved oxygen, biochemical oxygen demand, total suspended solids), major ions, nutrients (total nitrogen, total phosphorus), algae, aluminium, and indicators of faecal contamination. Results of the baseline assessment are provided in Appendix G1 section 3.9.2. In summary:

- EC is well below the WQO of 350 µS/cm at all monitoring sites (a higher EC indicates higher salinity).
- WQOs for pH are generally met at the MLO (Figure 6-14). Lower pH has been observed at sites X and Z, potentially influenced by decaying leaf litter or reduced turn over in shallower parts of the reservoir.
- The turbidity WQO range is generally met at all monitoring locations, with infrequent results up to an order of magnitude greater than the WQO range observed in the dam reservoir. These turbidity spikes are typically associated with rainfall-runoff events, most notably the record flood events that occurred in March 2017 and March 2022.
- Historical dissolved oxygen (DO) observations have generally been within WQOs for most sites, with some sites below WQOs and with occasional spikes.
- Median total nitrogen (TP) and total phosphorous (TN) concentrations are regularly above the WQO limits, with elevated TP concentrations in upper catchments attributed to erosion of rich volcanic soils (Hydrosphere 2017).

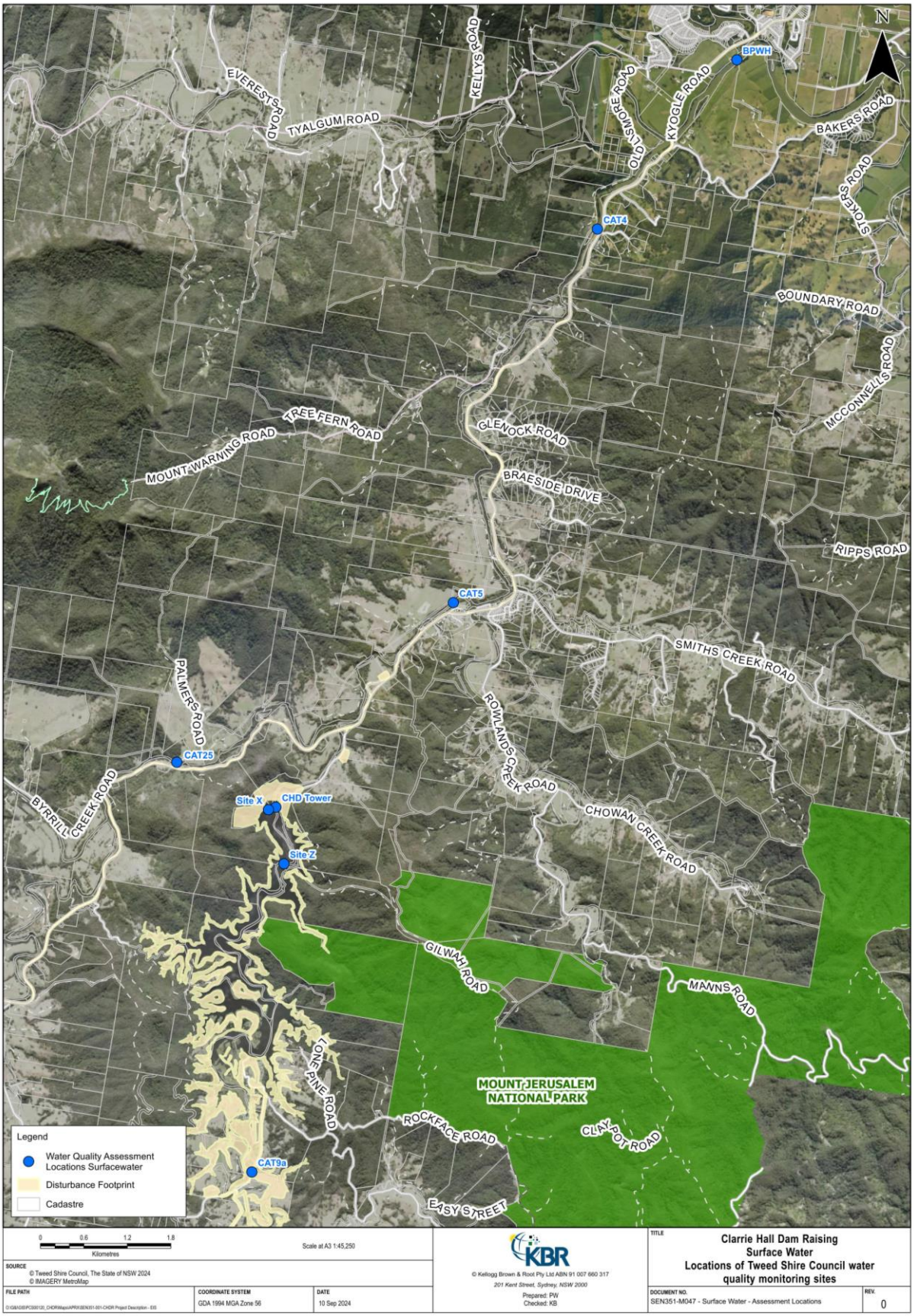


Figure 6-14 Locations of Tweed Shire Council water quality monitoring sites

- Monitoring for cyanobacteria is undertaken upstream from Clarrie Hall Dam (site CAT 9a, Figure 6-14), within the reservoir (site X and Z, Figure 6-14), and downstream from the dam (sites CAT 4 and CAT 5, Figure 6-14.)
- Cyanobacteria is not commonly detected within Doon Doon Creek and the Tweed River. When detected, cell counts tend to be in the order of 100–1,000 cells/mL during winter months, and 1,000 – 10,000 cells/mL in summer months. Within the reservoir, cyanobacteria are more common, with cell counts ranging from 1,000–100,000 cells/mL. Algal concentrations are regularly above the WQO range during the summer months when surface layer temperature and stability, and nutrient availability are favourable to growth.

Thermal stratification

The development of thermally distinct layers in a reservoir is known as thermal stratification. Clarrie Hall Dam is a warm monomictic reservoir, which means it stratifies once per year during summer when the surface of the waterbody absorbs heat (solar radiation from the sun) and is generally well mixed during winter. As the top of the water column heats up during the warmer months (late spring to early autumn) a density gradient develops, and the water column separates into distinct layers.

Thermally stratified water bodies contain warmer water near the surface, a transitional zone called a thermocline, and cooler water near the base. When stratified, water near the surface tends to be better mixed by wind and waves, and contain higher oxygen levels, while cooler water near the reservoir bed tends to have lower oxygen content and can contain higher mineral and organic content due to interaction with sediments.

Stratification can promote algae growth near the surface, as the upper water layer remains warm and well oxygenated, and has high exposure to sunlight. When possible, operators would utilise the MLO to take water from the warm upper layer. However, during algae blooms it may be necessary to utilise an offtake within the thermocline. Due to these factors, thermal stratification is a key process contributing to CWP.

CWP is defined as water released from reservoirs that is at least 2 degrees Celsius cooler than the ambient water temperature (NOW 2011) and can have effects on aquatic ecosystems. In particular, some fish species can receive thermal shock when water suddenly changes temperature, as can occur when a dam release starts.

Water temperature data is recorded by Tweed Shire Council within Clarrie Hall Dam using sensors deployed from floating buoys at depths of 2 m, 4 m, 6 m, 10 m, and 18 m below the water surface, with data recorded at weekly intervals since 7 May 2001. These data show that temperatures are typically around 15 degrees Celsius throughout the water column in winter and that there is stratification during summer (see Appendix G1 Figure 3.38).

An artificial mixer operated between 2002 and 2017 (see Appendix G1 Annexure B). During the period the mixer was operating, the temperature during summer at 10 m depth was approximately 4 degrees Celsius cooler than near the surface. After the mixer was damaged in 2017, a stronger temperature gradient developed during warm months, with temperature differences of around 10 degrees Celsius between 2 m and 10 m below the surface (see Appendix G1 Figure 3.38). Without the mixer, temperatures at depth remained around 15 degrees Celsius throughout the year, whereas with the mixer the warm water from the surface was circulated to the base of the reservoir (see Appendix G1 Figure 3.39).

River temperature

Tweed Shire Council monitored water temperature in Doon Doon Creek, the Tweed River and the Oxley River from March 2023 to provide data to inform the SWA. The monitoring found:

- river water temperatures vary approximately 1–2 degrees Celsius between day and night

- water temperature can vary through the river system by around 3–4 degrees Celsius on any particular day
- summer river water temperatures were 25–30 degrees Celsius, similar to the temperature in the upper layer of the Clarrie Hall Dam reservoir
- winter river water temperatures were around 1 –17 degrees Celsius, similar to winter reservoir temperatures

In April 2023, Council released a cold water slug from the reservoir for 12 hours to provide data for CWP model calibration (Appendix G1 Annexure C).

CWP modelling (Appendix G1 Annexure C) scenarios investigated cold water releases in summer, with:

- released water 9 degrees Celsius colder than the ambient Tweed River water temperature
- flows ranging from 10 ML/day to 70 ML/day, approximately the range required for managed water releases for town-water supply.

When required, current typical releases from Clarrie Hall Dam for water supply is around 40 ML/day The modelling was conducted on the worst case release of up to 70 ML/day and found that if cold water releases were made from Clarrie Hall Dam, CWP effects could reach up to 11 km downstream of the dam before the released water warmed due to interaction with the receiving environment (Figure 6-15). With smaller release rates, the length of river affected by CWP would reduce (Figure 6-16).

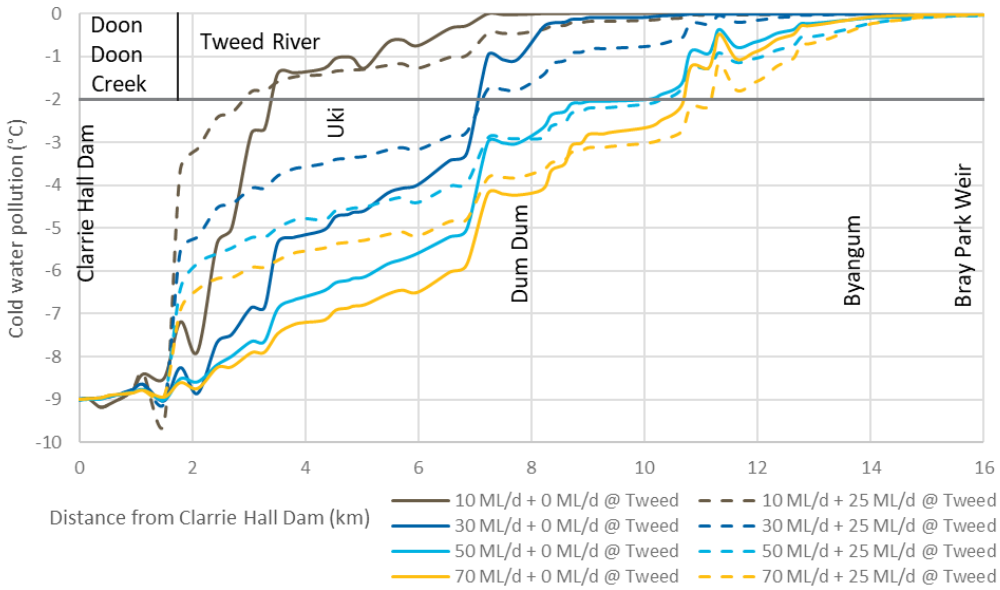


Figure 6-15 Modelled cold water pollution travel distances with 0 ML/d and 25 ML/d inflow at the Tweed River, releases of 16°C water into 25°C water for the 2018 scenario

Source: EMM Appendix G1

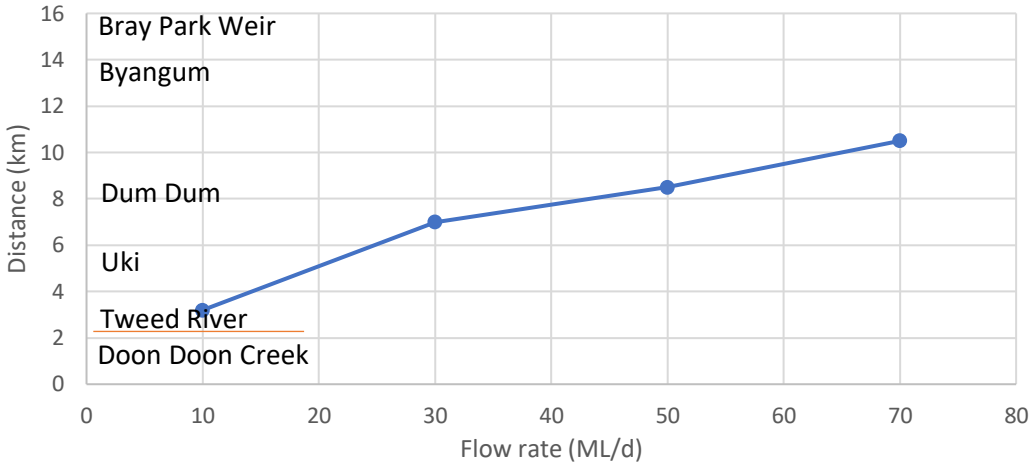


Figure 6-16 Distance before water released at 16°C warms to 23°C

Source: EMM Appendix G1

Flood assessment

Peak discharges and water level

For the existing case, the PMF design event modelled a peak water level of 71.05 m AHD at the dam, which overtopped the dam's embankment (currently at 70.4 m AHD). While the spillway discharged a peak flow of 1,367 m3/s during the PMF, a flow of 288 m3/s overtopped the wall of the dam. Some of the overtopped dam water flowed onto Clarrie Hall Dam Road and made its way down the road before rejoining Doon Doon Creek further downstream. Flood depths of not more than 1 m were simulated on this stretch of the road.

Flood mapping of the results from the hydraulic modelling of the design events for the existing case is shown in Figure 6-17 to Figure 6-21.

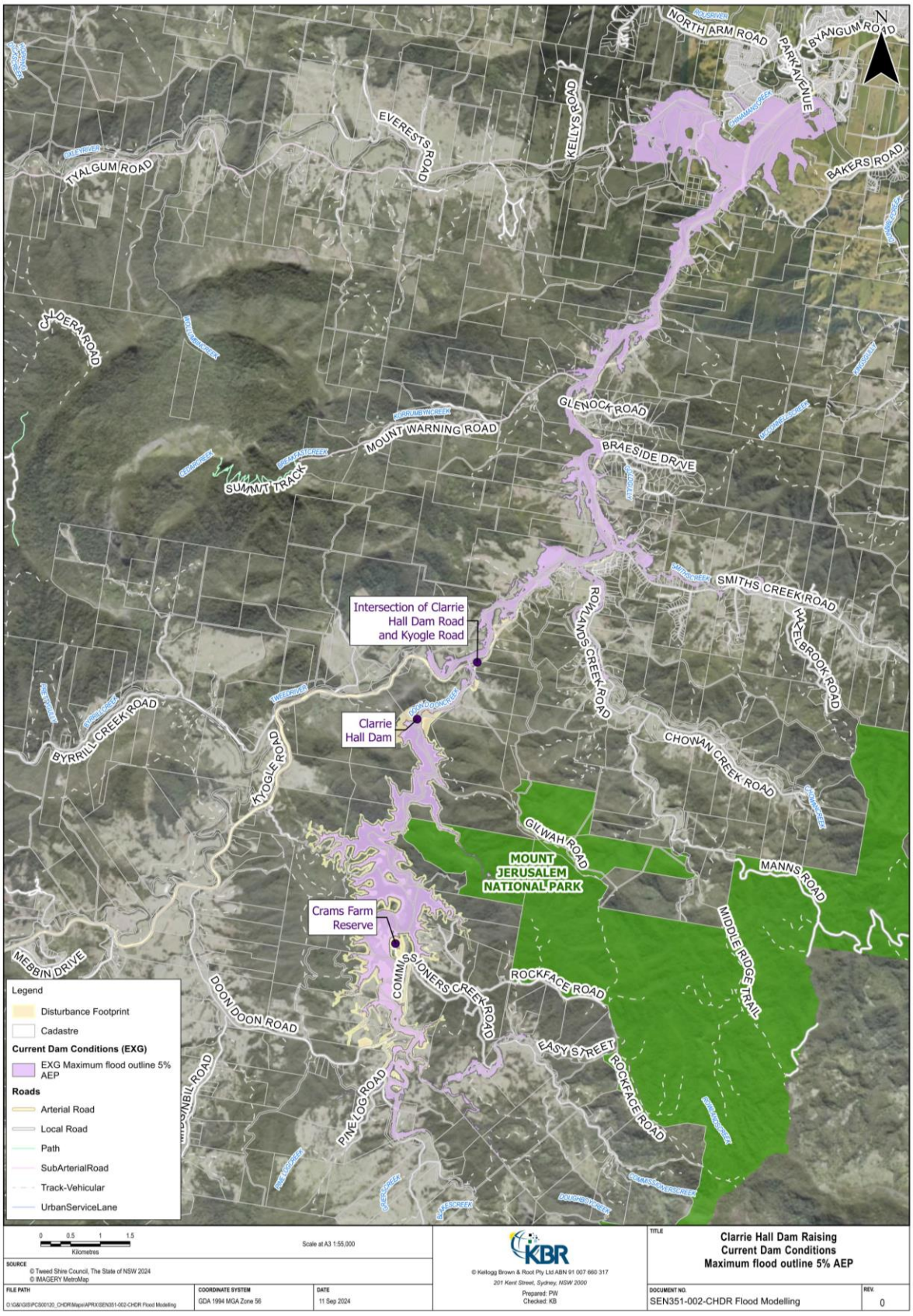


Figure 6-17 Existing flood conditions – maximum flood outline 5% AEP

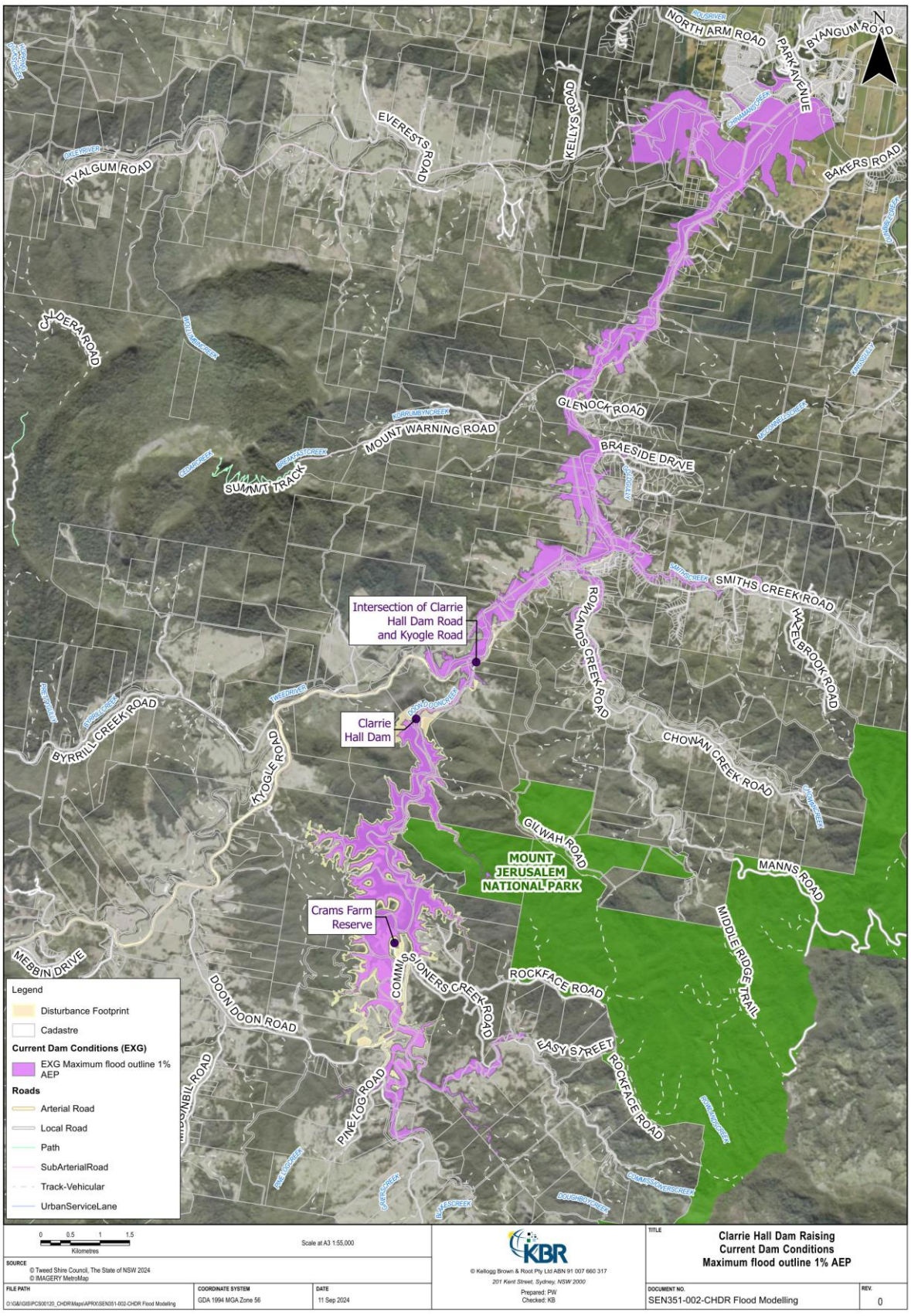


Figure 6-18 Existing flood conditions – maximum flood outline 1% AEP

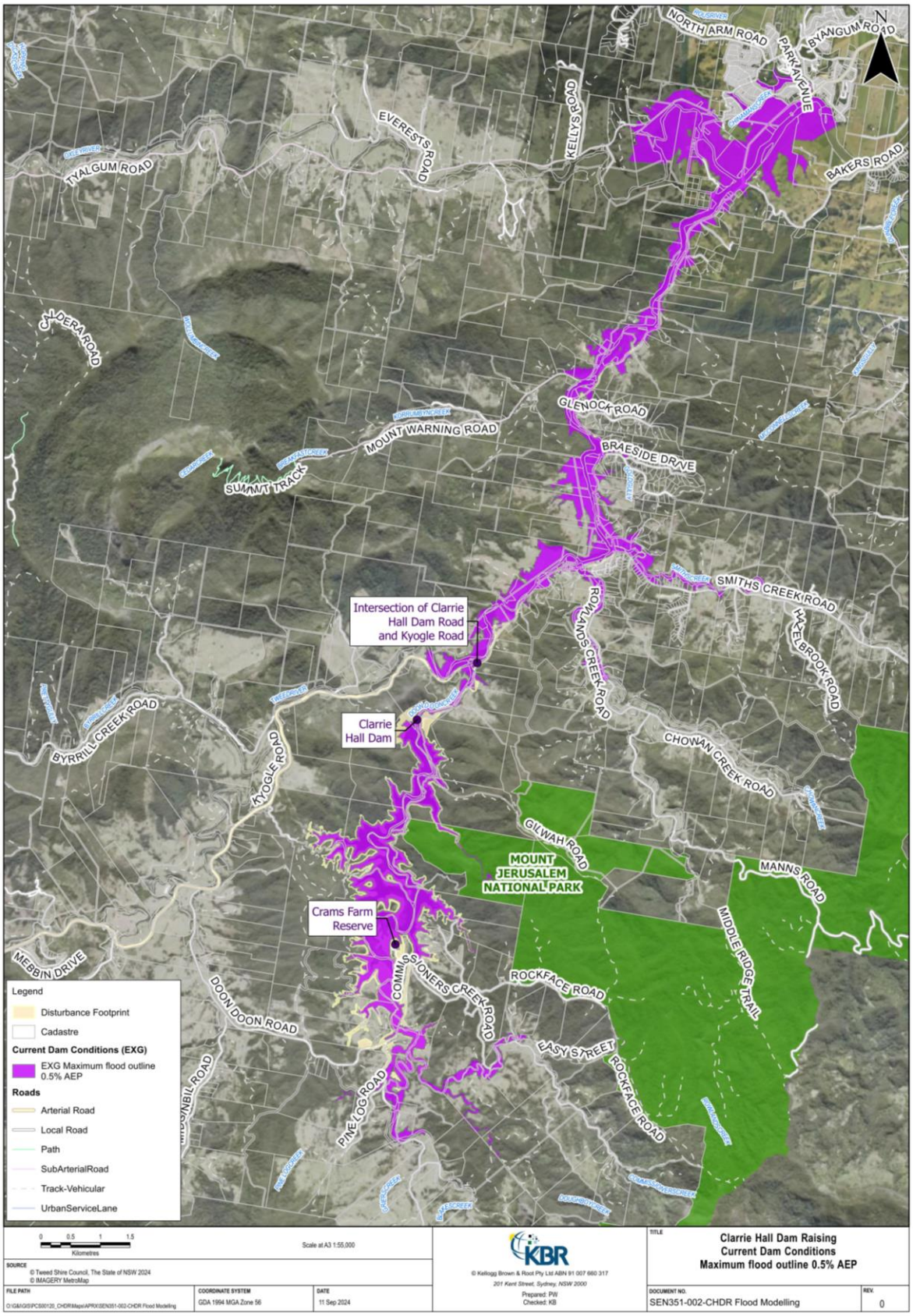


Figure 6-19 Existing flood conditions – maximum flood outline 0.5% AEP

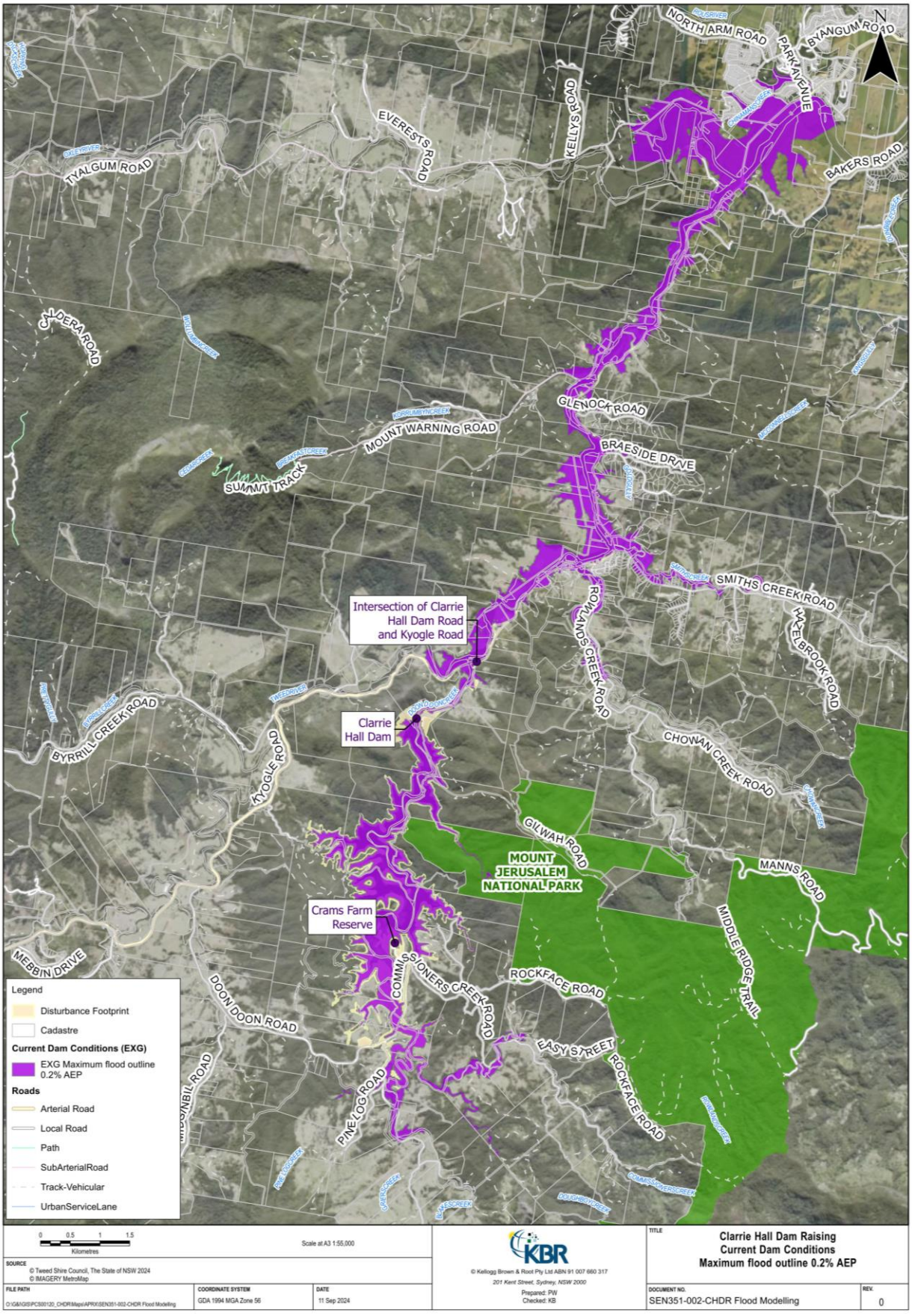


Figure 6-20 Existing flood conditions – maximum flood outline 0.2% AEP

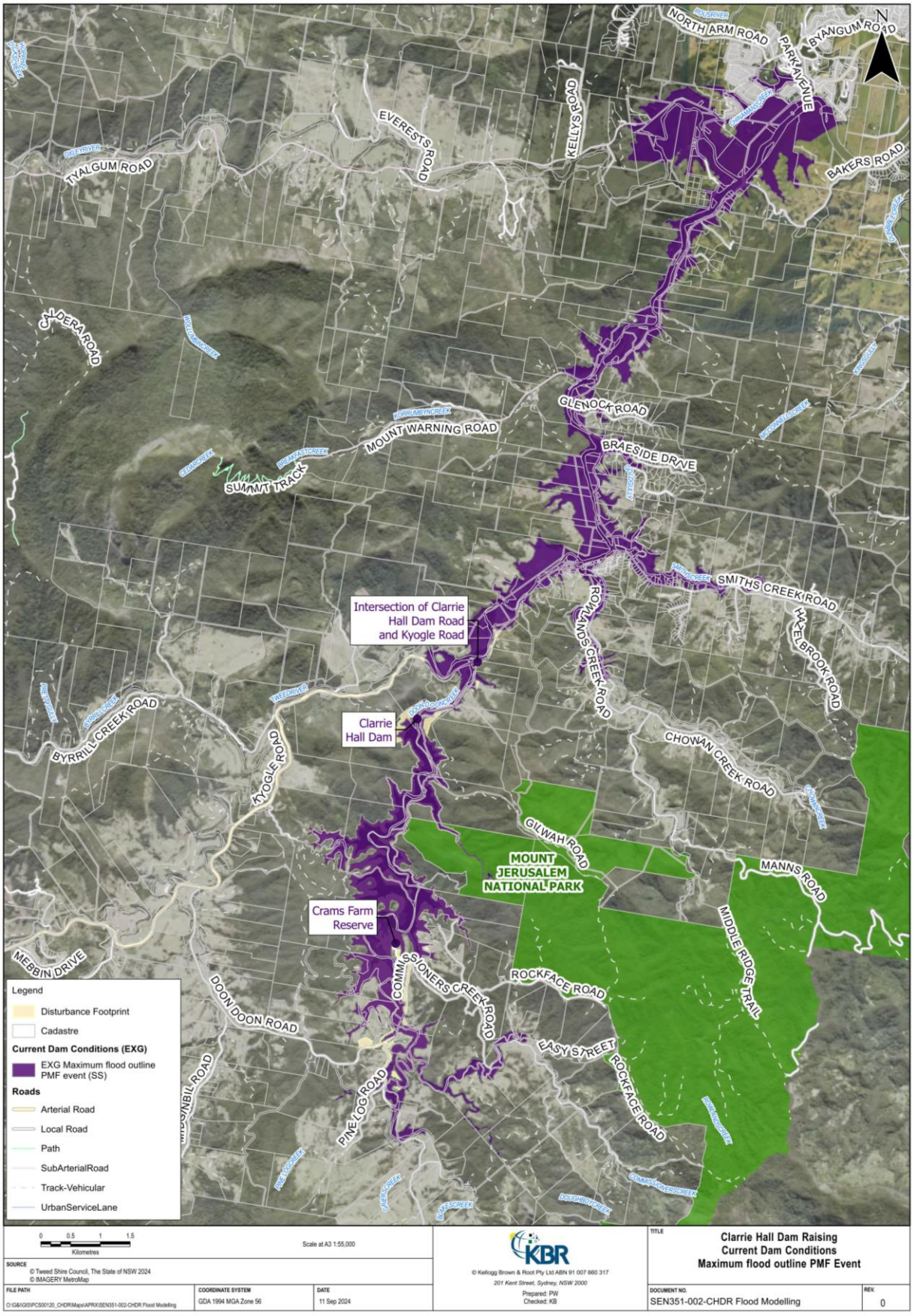


Figure 6-21 Existing flood conditions – maximum flood outline PMF event

Flood levels and velocities were also extracted at 12 reporting points located upstream and downstream of the dam. The locations are shown in Figure 6-22.

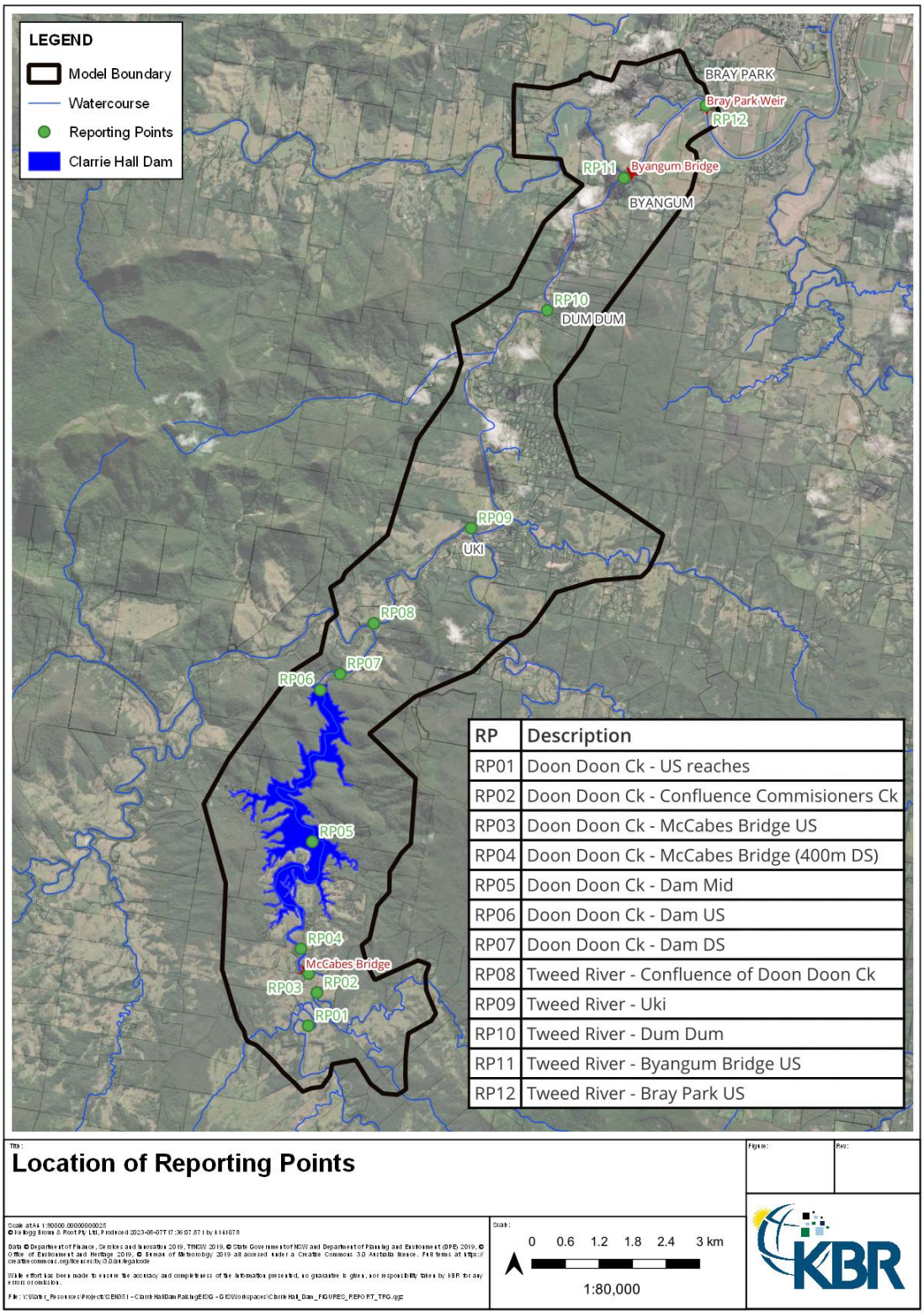


Figure 6-22 Location of reporting points (RPs)

Upstream of the dam

Peak flood levels extracted at the locations of the reporting points (RPs) for areas upstream of the dam for the existing case are presented in Table 6-9.

Table 6-9 Flood levels (m AHD) upstream of Clarrie Hall Dam – existing case

RP	Description	Flood levels (m AHD)				
		5% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
RP01	Doon Doon Ck – US reaches	75.00	75.95	76.07	76.24	76.31
RP02	Doon Doon Ck – Confluence Commissioners Creek	68.85	70.15	70.35	70.67	71.97
RP03	Doon Doon Ck – McCabes Bridge US	67.74	68.64	69.06	69.29	71.33
RP04	Doon Doon Ck – McCabes Bridge (400bm DS)	65.79	66.71	66.84	67.28	71.18
RP05	Doon Doon Ck – Dam Mid	64.98	66.22	66.40	67.05	71.15
RP06	Doon Doon Ck – Dam US	64.96	66.18	66.36	67.00	71.05

Flood velocities extracted at the reporting locations for areas upstream of the dam for the existing case are presented in Table 6-10.

Table 6-10 Flood velocities (m/s) upstream of Clarrie Hall Dam – existing case

RP	Description	Flood velocities (m/s)				
		5%	1%	0.5%	0.2%	PMF
RP01	Doon Doon Ck – US reaches	2.17	2.23	2.24	2.27	2.29
RP02	Doon Doon Ck – Confluence Commissioners Creek	3.16	3.72	3.67	3.82	3.20
RP03	Doon Doon Ck – McCabes Bridge US	1.94	2.61	2.48	2.81	2.45
RP04	Doon Doon Ck – McCabes Bridge (400 m DS)	2.28	3.03	3.08	3.20	2.72
RP05	Doon Doon Ck – Dam Mid	0.15	0.20	0.20	0.25	0.27
RP06	Doon Doon Ck – Dam US	0.09	0.12	0.13	0.14	0.29

Downstream of the dam

Peak flood levels for the various design events (AEPs) were extracted at the reporting locations for areas downstream of the dam for the existing case are presented in Table 6-11.

Table 6-11 Flood levels (m AHD) downstream of Clarrie Hall Dam – existing case

RP	Description	Flood levels (m AHD)				
		5%	1%	0.5%	0.2%	PMF
RP07	Doon Doon Ck – Dam DS	29.63	30.93	31.10	31.64	35.17
RP08	Tweed River – Confluence of Doon Doon Ck	27.18	29.08	29.28	29.75	32.99
RP09	Tweed River – Uki	21.24	23.16	23.38	23.94	28.85
RP10	Tweed River – Dum Dum	12.26	14.05	14.27	14.91	21.10

RP	Description	Flood levels (m AHD)				
		5%	1%	0.5%	0.2%	PMF
RP11	Tweed River – Byangum Bridge US	9.12	10.13	10.38	10.76	14.13
RP12	Tweed River –Bray Park US	6.56	7.24	7.37	7.70	11.35

Flood velocities extracted at the reporting locations for areas downstream of the dam for the existing case are presented in Table 6-12.

Table 6-12 Flood velocities (m/s) downstream of Clarrie Hall Dam – existing case

RP	Description	Flood velocities (m/s)				
		5%	1%	0.5%	0.2%	PMF
RP07	Doon Doon Ck – Dam DS	2.17	2.24	2.25	2.31	3.17
RP08	Tweed River – Confluence of Doon Doon Ck	2.72	2.94	2.98	3.08	3.90
RP09	Tweed River – Uki	2.74	2.71	2.71	2.69	2.70
RP10	Tweed River – Dum Dum	1.91	2.00	1.98	1.97	1.96
RP11	Tweed River – Byangum Bridge US	1.80	2.00	2.02	2.08	3.05
RP12	Tweed River – Bray Park US	3.60	4.07	4.11	4.16	4.20

Groundwater assessment

Values

The groundwater at the Proposal site supports the following values:

- aquatic ecosystems, where groundwater discharges as baseflow to permanent streams and there is the potential for facultative reliance on groundwater
- drinking water systems, where groundwater discharges into Doon Doon Creek, which is part of a drinking water catchment
- primary industries, irrigation.

Geology

The study area is in the northern portion of the New England Fold Belt (NEFB) and eastern portion of the overlying Clarence-Moreton Basin.

The study area predominantly overlies Jurassic and Triassic sedimentary and volcanic units, of the Clarence-Moreton Basin, comprising Walloon Coal Measures to the Chillingham Volcanics. The dominant lithology is sandstone with minor shale as recorded in publicly available bore logs in and around the study area.

The Chillingham Volcanics outcrops where Doon Doon Creek incises the valley upgradient from the dam wall and is described as slightly polyporphritic rhyolite (Hawke 1979a). The original and proposed quarry sites target highly weathered rhyolite, to a depth of approximately 10 to 32 m (Public Works Advisory 2018).

Geological outcrops relevant to the study area are shown in Figure 6-23. The geology of the Proposal area is discussed in section 6.8 and Appendix M.

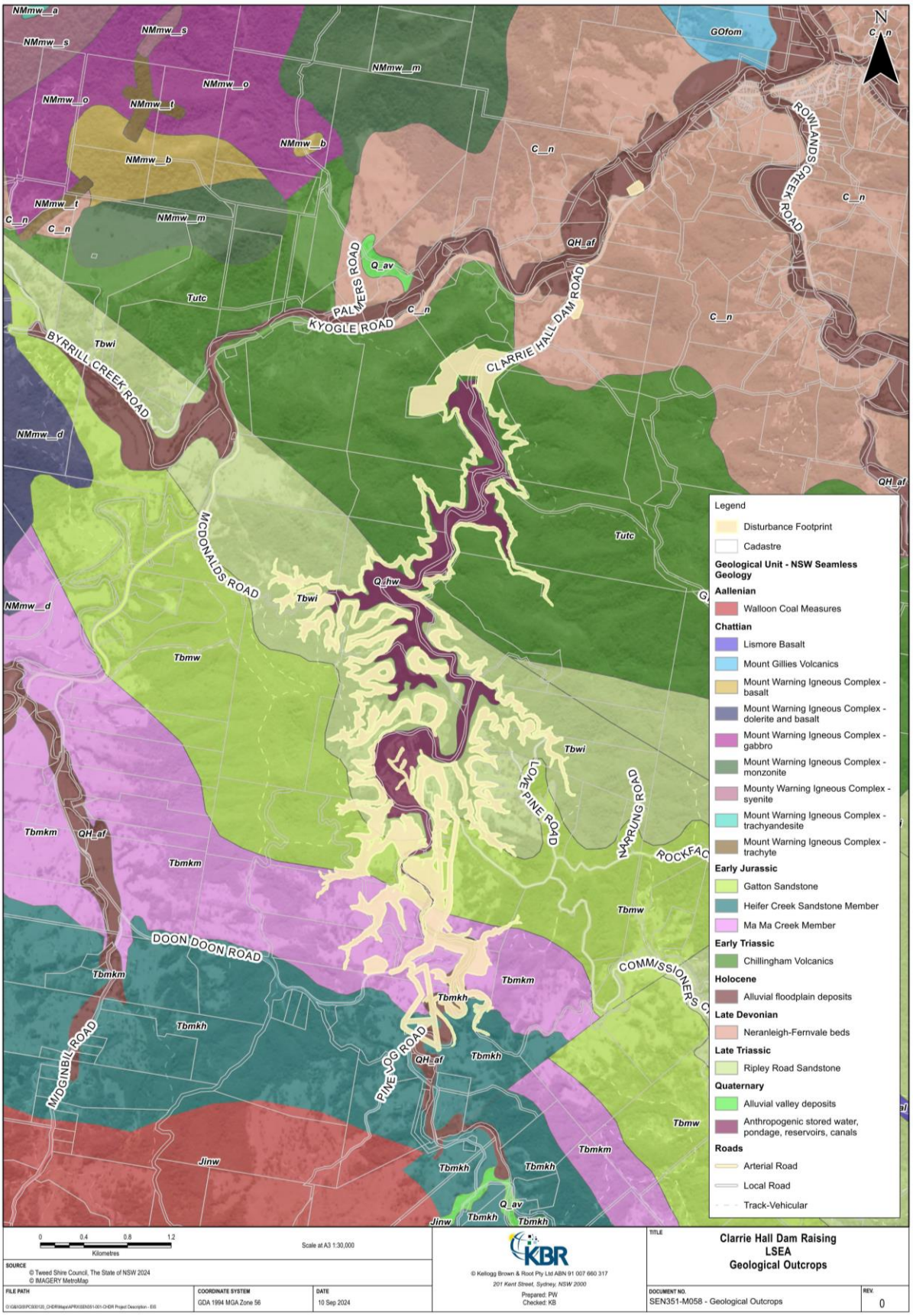


Figure 6-23 Geological outcrops of the study area

Hydrogeology

The groundwater systems comprise:

- minor local shallow groundwater associated with alluvial deposits
- local groundwater systems associated with the Tertiary volcanic caps
- local to regional groundwater systems associated with the porous and fractured rock units within the Clarence-Moreton Basin
- local to regional groundwater systems associated with the fractured rock units of the NEFB.

Generally, this is a low-yielding region with no highly productive aquifer systems.

Groundwater

The WaterNSW groundwater database search results provided the locations of the registered bores shown in Figure 6-24, with available details included in Appendix G2 Table 5.1.

Most bores (i.e. 20 bores) target the NEFB groundwater system. The main lithologies targeted were shale, greywacke and sandstone of the porous and fractured rock units, and basalt from the Tertiary volcanics. No bores target the Quaternary alluvium. The average bore depth was 34 m, with bore depths ranging from 8 to 79 m.

Seven bores reported yields greater than 1 L/s, with the maximum yield being 5 L/s. The average standing water level was 17 m below top of casing (mbtoc), with the standing water level ranging between3 and 45 mbtoc.

Groundwater bore census

For the bore census, an EMM Hydrogeologist visited several bores, interviewed landholders about their groundwater use and recorded details as provided in Appendix G2 Table 5.2. Physicochemical field parameters collected by EMM indicate groundwater from the Clarence-Moreton Basin sandstone units is fresh (average EC of 187 microsiemens per centimetre (µS/cm)) and slightly acidic. The one groundwater sample from the fractured rock NEFB groundwater system was slightly brackish (EC of 943 µS/cm) and neutral. Review of salinity measurements from boreholes within a 5 km radius from the centre of the study area indicates total dissolved solids range between 74 and 410 ppm (or an EC of 115–640 µS/cm), which is also considered fresh to slightly brackish.

Alluvial mapping

Eleven shallow boreholes (i.e. less than 2.2 m) were hand-augered at 4 locations within 100 m of Doon Doon Creek in the southern end of the study area to assess local alluvial/colluvial conditions. Overall, the alluvial/colluvial strata in the southern flood plains was not consistently water-bearing and only approximately 2 m in thickness.

Groundwater levels

The original groundwater levels across the site would have been modified by dam storage levels.

There is a steeper hydraulic gradient on the left abutment in the west compared to the right, although this is expected to change with topography. On the mountain peaks, the depth to groundwater is approximately 20 mbgl; closer to Doon Doon Creek, the depth to groundwater is much shallower, at closer to 1 mbgl or less (Hawke 1979a).

Upstream of Doon Doon Creek where the valley widens, the measured depth to groundwater in the deeper fractured rock is approximately 3.6 mbgl, below the minor local alluvium, recorded from 2 borehole locations (GW065390 and GW065508). Groundwater depths for the remainder of the boreholes vary considerably, owing to topography.

Groundwater flow follows a muted reflection of topography; however, there is insufficient recent information to draw groundwater flow contours around the dam, Doon Doon Creek and downstream areas. Local groundwater flow near the dam wall is expected to be towards the dam on the western flank and flat or away from the dam on the eastern flank.

Sensitive receptors

Key environmental and third-party receptors that are of relevance to this assessment – as they may have a level of dependence on groundwater – include:

- third-party groundwater users (i.e. water supply bores operated for stock and domestic, irrigation or other commercial purposes)
- listed high priority GDEs and culturally significant sites listed in the relevant water sharing plans
- potential GDEs, as characterised by publicly available mapping (BoM GDE Atlas) and field mapping and investigations, including:
  - terrestrial GDEs
  - aquatic GDEs
  - subterranean GDEs
- surface water/groundwater connectivity, including discussion around gaining and losing streams.

Third-party landholder bores

The NSW DPE – Water database was searched to identify records of third-party landholder bores located within the Proposal area. Seven landholder bores were identified via the desktop-based investigation. However, only a possible 4 bores are considered active following the bore census field work undertaken by EMM. Bore details are included in Table 6-13 and shown in Figure 6-24. All 4 licensed bores are conservatively considered to be active bores (and are shown in bold) and are designated as basic rights bores. These bores have a presumed 1 ML annual allocation.

Table 6-13 Landholder bores

Bore ID	Groundwater system	Lithology	Approval or status	Approval number	Water source
GW302075	NEFB	–	Abandoned	–	–
GW306456	NEFB	Slate	**Basic rights**	30WA313662	New England Fold Belt Coast groundwater source
GW070198	C-M Basin	Shale and basalt	**Basic rights**	30WA309636	Clarence-Moreton Basin groundwater source
GW065390	C-M Basin	–	Abandoned	–	–
GW065508	C-M Basin	–	Abandoned	–	–
GW303096	C-M Basin	Sandstone and basalt	**Basic rights**	30WA309904	Clarence-Moreton Basin groundwater source
GW073044*	C-M Basin	Shale and sandstone	**Basic rights**	30WA309705	Clarence-Moreton Basin groundwater source

*Notes: * = bore presence and condition not verified in the field by EMM.*

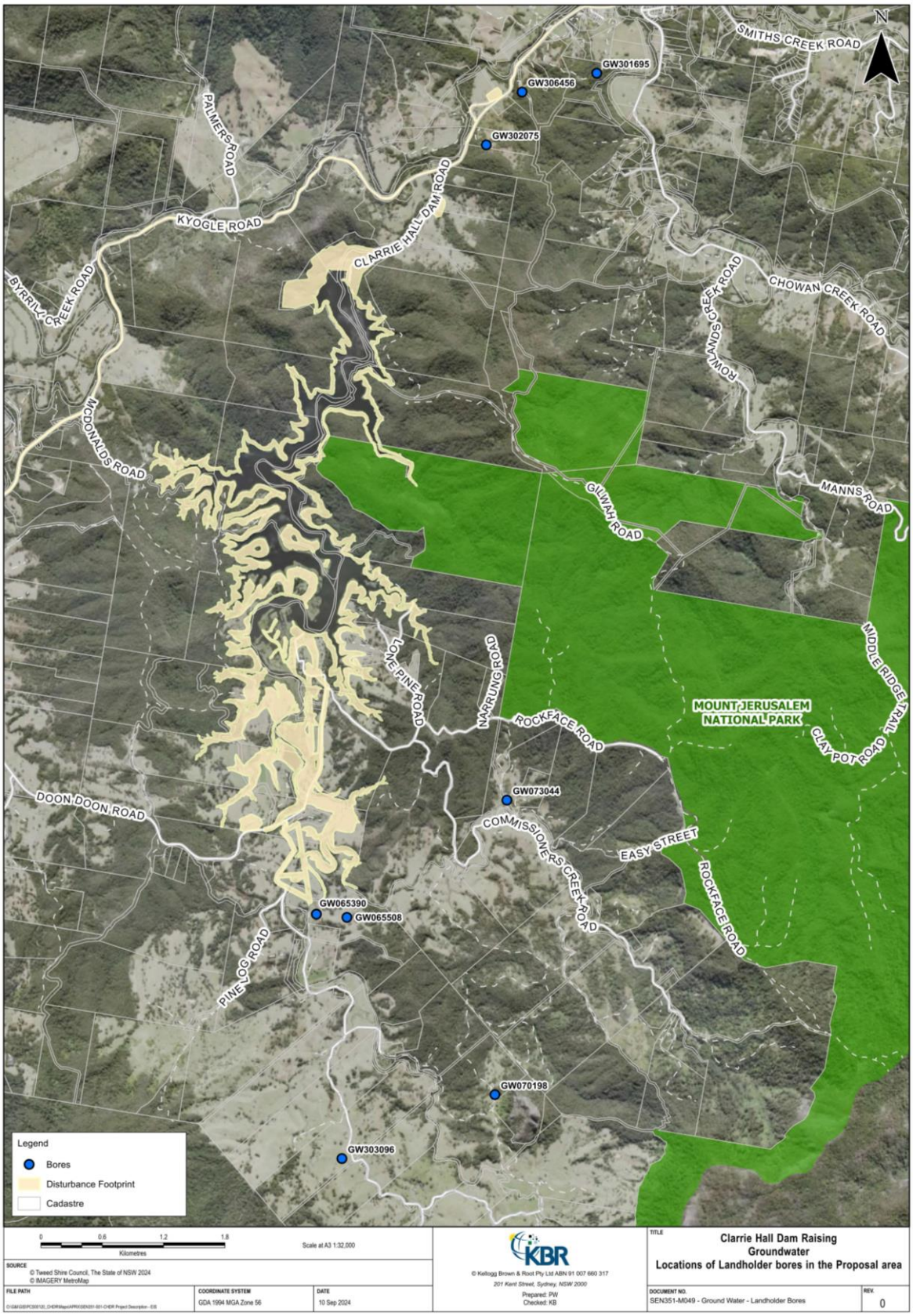


Figure 6-24 Locations of landholder bores in the Proposal area

High priority groundwater-dependent ecosystems

There are no 'high priority' GDEs listed in the WSPs. However, the Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources notes high priority GDEs are currently under investigation, and some may be identified during the term of this plan.

Potential groundwater-dependent ecosystems

A review of the BoM GDE Atlas (BoM 2022a) shows the following potential terrestrial GDEs mapped within the study area (Figure 6-25), where the potential reliance on groundwater has been inferred from aerial imagery:

- River Oak – high potential GDE
- Wet Bangalow-Brushbox – moderate potential GDE
- Northern Moist Blackbutt – low potential GDE
- Wet Bloodwood-Tallowwood – low potential GDE
- subtropical and warm temperate rainforest – low and medium potential GDE.

BoM mapping indicates low potential GDE across most of the operational and construction areas, with 3 small patches of moderate potential GDE, mapped as Wet Bangalow Brushbox forest, and subtropical and warm temperate rainforest. Field verification (Appendix G1) found that these vegetation types are not unique in the context of the construction development site, with no indication of groundwater utilisation in these areas.

One 'known' GDE, Wet Heath, is mapped in the south of the development area. However, field surveys found the area is dominated by wet sclerophyll forest, albeit disturbed and partially cleared.

The Tweed River is considered to support potential aquatic GDEs owing to possible groundwater baseflow contributions, according to the BoM GDE Atlas. The BDAR (Appendix H) says it unlikely that groundwater is essential to vegetation communities within the construction area. This is due to the regional high rainfall volumes, the typical depths to groundwater (which averages 17 mbgl in the fractured rock system), and the predominance of groundwater occurrence in fracture networks. There may be some utilisation of groundwater by riparian vegetation upstream of the existing dam, where groundwater can be shallower in the alluvium (at approximately 4 mbgl) and is recharged by river flow and rainfall. These areas are largely cleared, with native vegetation limited to scattered trees and small patches of forest.

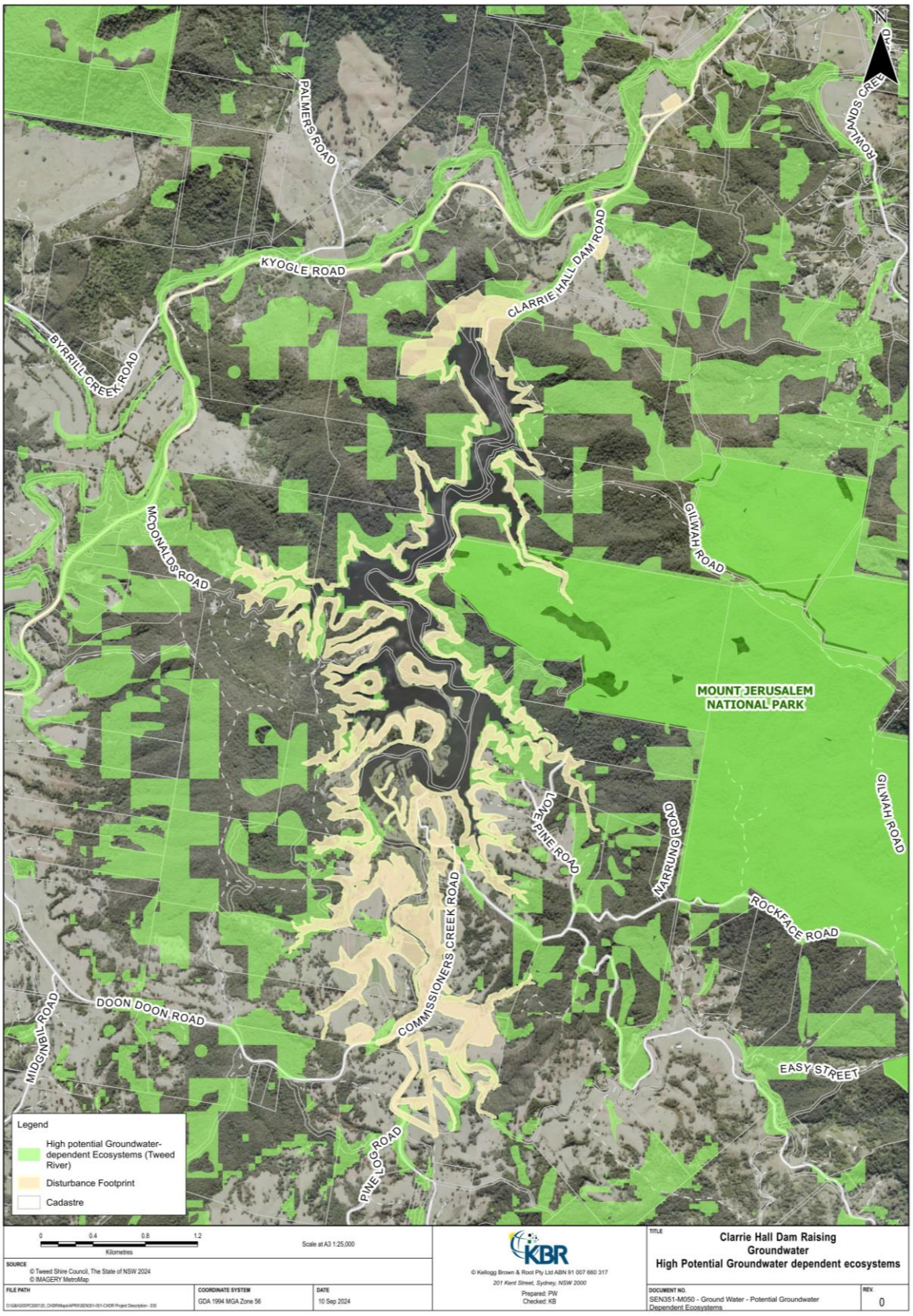


Figure 6-25 High potential groundwater-dependent ecosystems

Hydrogeological conceptual model

The study area comprises an incised valley system, with 2 regional groundwater systems – the Clarence-Moreton Basin groundwater system in the west and New England Fold Belt groundwater system in the east and to the north. Groundwater is predominantly hosted by these competent, porous and fractured rock units. The bulk of groundwater movement and permeability in the fractured and porous rock groundwater systems is determined by secondary porosity. Groundwater is predominately intercepted at fractures, with permeability decreasing with depth, coinciding with further consolidation of the rock matrix.

Minor alluvium/colluvium occurs in the upstream reaches of Doon Doon Creek, with the potential to host unconfined groundwater, although this was found to be scarce. The alluvial deposit is thin, shallow and rich in clay, which limits storage and permeability. The upstream alluvium overlies the Clarence-Moreton Basin, and the permeability is via primary porosity.

Potential alluvial groundwater is recharged by rainfall infiltration and flooding events from Doon Doon Creek. Groundwater recharge processes for the fractured and porous rock units are via rainfall infiltration on the upper slopes, ridgeline and hilltops where there is sub-crops or outcrops, seepage of rainfall run-off from valley slopes and potential leakage from the alluvium where water-bearing. Groundwater discharge from the geological boundaries between the Tertiary volcanics/Alstonville Plateau in the south can also recharge the underlying Clarence-Moreton Basin and surface water systems.

Groundwater discharge processes for the alluvium include:

- drainage to Doon Doon Creek during/following flooding as a result of bank storage
- leakage from the alluvium to the underlying porous rock units
- transpiration from vegetation intercepting shallow groundwater.

Groundwater discharge processes for the porous and fractured rock groundwater systems include:

- seepage/springs and evaporation along hill slopes. Historically, permanent springs were located on both the left and right dam abutments (Hawke 1979) that seeped from below 60 m AHD; however, the location and current status of these springs are not known. Public Works Advisory (Appendix B) reported no seepage locations in the gully downstream of the dam
- discharge to Doon Doon Creek and Tweed River comprising groundwater baseflow contribution
- pumping from landholder bores.

There is a north-west – south-east trending fault through the southern end of the study area (Figure 6-26). The influence of this structural feature is unknown – it may be a discharge feature for regional groundwater.

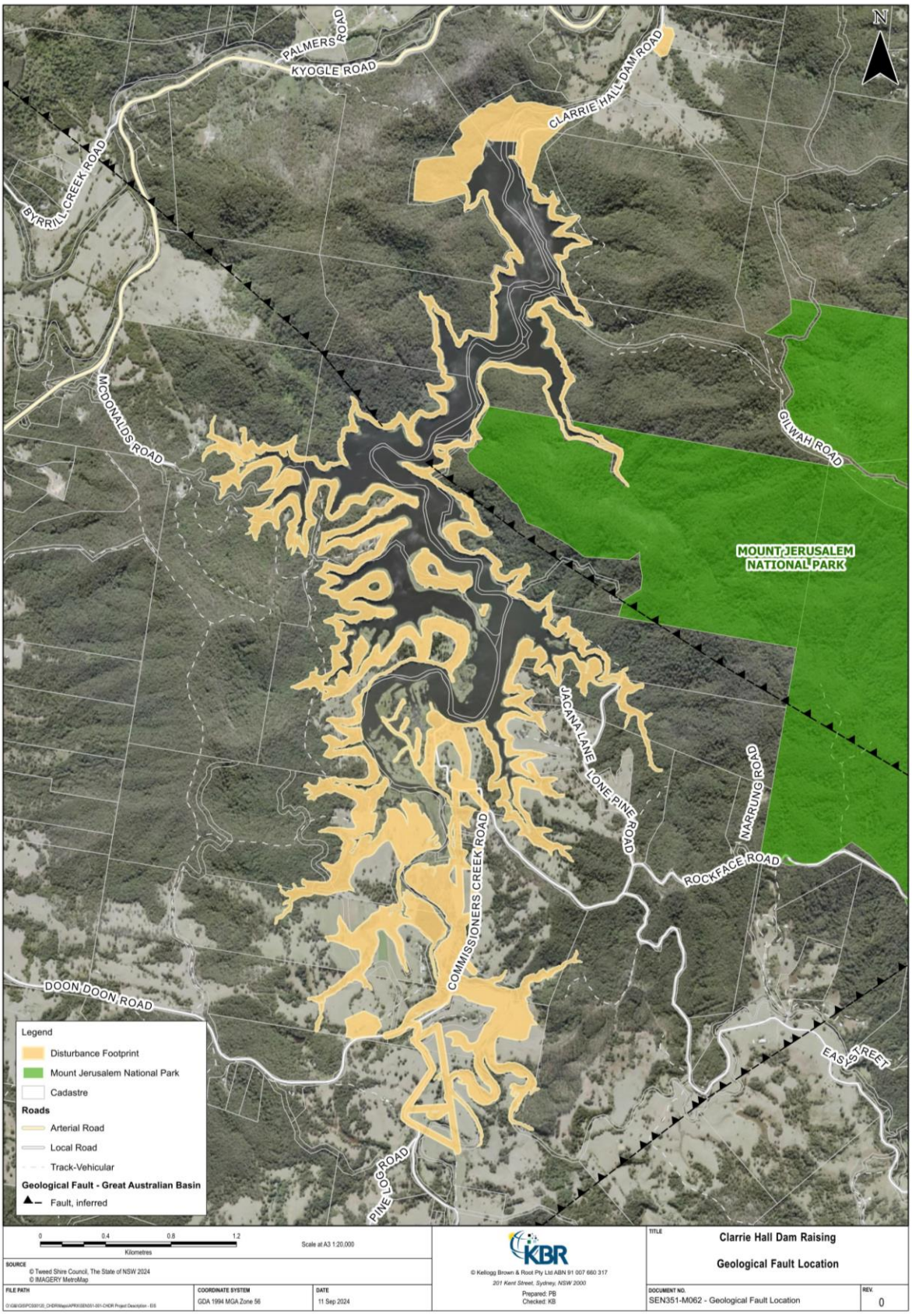


Figure 6-26 Geological fault location

Depths to groundwater are variable and are influenced by topography. The regional groundwater flow direction is presumed to be towards the north-east, consistent with topographic gradients, where groundwater flows from catchment highs to valley floors. The localised groundwater flow direction is largely controlled by stratigraphy, dip of the strata, faulting, fractures and topography.

Overall, there is not a high reliance or utilisation of groundwater in the study area, and bore yields are approximately 1 L/s. There are 5 bores licensed for basic rights within the study area – 2 upstream and 2 downstream, beyond the inundation area. The BoM-mapped moderate to high potential GDEs are probably opportunistic groundwater-dependent, owing to the regional high rainfall volumes and occurrence of groundwater in fracture networks at depths typically not accessible by plant roots.

Surface water groundwater interaction

In the lower reaches of Doon Doon Creek, immediately behind and downstream of the dam wall, Doon Doon Creek is conceptually a gaining system receiving groundwater discharge as baseflow, controlled by the steep hydraulic gradient created by local topography and the dam reservoir. A conceptual hydrogeological model for the lower reaches of Doon Doon Creek above the dam is presented in Appendix G2 Figure 5.6.

Further upstream, as the valley widens, the groundwater hydraulic gradient flattens, and Doon Doon Creek is probably disconnected from the regional Clarence-Moreton Basin groundwater system. A conceptual hydrogeological model for the upper reaches of Doon Doon Creek is presented in Appendix G2 Figure 5.7. This shows measurements of the water table in the porous rock being around 3.6 mbgl, which is below the creek depths of 1–2 mbgl.

The Doon Doon Creek upstream alluvium is presumably hydraulically connected to surface water, with conditions alternating between gaining and losing, based on river height. However, due to the thin extent and thickness of the alluvium, the alluvium is only partially saturated and in places could be dry for extended periods. The alluvium may act as a temporary storage for overbank flows. Water is released back to surface watercourses once river levels recede.

6.1.3 Impact assessment

Construction

Hydrology

Potential impacts during construction include decreased surface water quality due to erosion and sediment loss, chemical spills and wastewater.

Data and modelling results were used to inform the SWA to determine the expected magnitude and frequency of potential impacts (refer to Appendix G1 Table 6.1).

The Land, Soils and Erosion Assessment (Appendix M and section 6.8) found that soils at the Proposal site have been assessed as having high erosion risk due to slope and low cohesivity, but also low dispersivity. Standard methods for removing sediment from runoff are therefore expected to be effective.

Downstream dam wall construction area

The construction compound downstream of the dam wall is proposed to be constructed using imported fill material as per the concept presented in Appendix G1 Annexure E. To convey water across this construction pad, temporary waterway crossings would be designed and implemented in accordance with the NSW Government guidelines summarised in the fact sheet *Controlled activities – Guidelines for instream works on waterfront land* (DPE 2022f).

During larger rainfall events, the capacity of 'spillway culverts' would be exceeded, and a portion of rainfall runoff would traverse the construction pad. If a rain event such as the 10% AEP (1 in 10 years) storm occurred, a more significant volume of water would traverse the construction pad.

During the detailed design phase, the shear stress generated by the flow of water over the construction pad would be determined via hydraulic modelling. Lower shear stresses would have reduced capacity to move the pad material. Shear stresses could be reduced if the geometry of the pad is selected for the purpose of spreading flows out and energy dissipation. Alternatively, the pad geometry could be selected such that shear stresses are concentrated in a defined area where armouring against erosion could be employed. In either case, rock diameters would be specified such that the probability of mobilisation of the material is low. The pad design and rock selection would consider design storms up to a certain threshold (e.g. the 5% AEP, or 1 in 20 years storm). Regardless of the design storm considered, there would always be a residual risk that a larger storm could occur and could cause washout, although the likelihood is low.

It is likely that some smaller particulate material would be present within the construction pad rock matrix, due to either the grading of material during construction or transportation via vehicle movements. During rainfall runoff events, dust, dirt and smaller particulate matter could be transported downstream into Doon Doon Creek and the Tweed River, increasing turbidity and potentially depositing rock fragments downstream. A Soil and Water Management Plan (SWMP) and Erosion and Sediment Control Plan (ESCP) would manage this risk so that impacts are expected to be minimal.

Following completion of construction works, the construction pad would be partially removed, to remove the ongoing risk of erosion and mobilisation of materials.

Quarry

Rock processing onsite would be a source of dust and slimes from crushing, grading and washing.

Recycling of wash water would occur using a series of tanks and clarifiers. These systems are typically 'sealed' and are therefore less susceptible to storm flows and overflow events than open lagoons.

Rainfall runoff from the quarry and stockpile areas has the potential to contain elevated levels of suspended solids (i.e. turbidity). The ESCP would minimise this impact, and any residual sediment mobilised would run off to the Clarrie Hall Dam reservoir, allowing additional settling of particles prior to release to the surface water environment of Doon Doon Creek downstream from the dam.

Inundation area

Before the reservoir is filled, the inundation area would be prepared to provide optimal conditions for water storage.

Decomposing vegetation can release nutrients that increase the risk of eutrophication and algal blooms. Where possible, vegetation within the new full supply inundation area would be cut to stump height and left in situ. The requirements and locations for any erosion protection works and vegetation clearing within the FSL would be determined during detailed design and be based on risks identified in this EIS.

The removal of vegetation to stump level would reduce the potential nutrient load within the reservoir and reduce the likelihood and magnitude of eutrophication and algal blooms. Stumps would be left in situ, as grubbing activities would likely create significant soil disturbance, which could lead to erosion and increased reservoir turbidity.

Vegetation, which decomposes in oxygen-poor conditions within deep reservoirs, can generate methane, whilst the same vegetation decomposing in oxygen-rich conditions at the surface may generate carbon dioxide. Methane is a more potent greenhouse gas than carbon dioxide.

Therefore, removing vegetation prior to inundation of the reservoir would minimise methane production and greenhouse gas effects.

Roads

Where roads are realigned or widened, clearing and track construction works may represent a risk of soil mobilisation. The SWMP and ECSP would be prepared to manage runoff and potential sediment mobilisation from road construction sites.

Dam wall and spillway construction area

Construction access to the downstream face of the dam and the spillway would be created via importation of fill to the site through installation of temporary culverts and filling of the existing creek bed to create construction access in this constrained area, as per Appendix G1 Figure E.3.

The temporary culverts from the valve house would be designed to pass the volumes required. Releases from the valve house are controlled by operators; therefore, the likelihood of the capacity of the temporary culverts being exceeded is negligible.

The temporary culverts from the spillway would be designed during detailed design. For the purposes of the assessment, the following design parameters have been considered:

- spillway width: 15 m
- maximum design velocity: 1.5 m/s
- maximum standard culvert height: 3 m.

A 15 m wide bank of culverts matching the spillway width could pass in the order of 60 kL/s. From Appendix G1 Figure 3.27, the 40% AEP spillway flow (occurring approximately once every 2 years) is 100 kL/s. This indicates that the culverts may be able to pass minor flows from unremarkable rainfall events, but their capacity would be readily exceeded during significant rainfall events in the order of the 1 in 1-year storm or larger. When the culvert capacity is exceeded, water would flow over the temporary fill.

Concrete batching plant

The concrete batching plant would produce up to 17,500 m^3 of concrete through the construction period. Cement, aggregate and clean water would be delivered by truck to the plant, where mixing and concrete production would take place. Water could also be pumped from the dam. Concrete would then be delivered by truck to construction site areas including the spillway and intake tower.

A range of environmental risks are associated with concrete batching but with proper management and good site design they can be eliminated or reduced to as low as reasonably practicable by a range of controls that are well understood and regularly applied within the construction industry. The key environmental risks posed by the concrete batching plants are:

- polluted wastewater
- inappropriate disposal of waste.

If cement or concrete batching plant wastewater reached Doon Doon Creek or the Tweed River, it is likely that the resulting pH of the water would be detrimental to aquatic life. Other chemical or liquid storage at the site would also need to be managed.

Mitigation measures detailed in Table 6-29 would be incorporated into the design of the concrete batching plant to reduce the risk as low as reasonably practicable.

Construction compound laydown areas

Temporary stockpiles of materials would be stored at construction compound laydown areas Materials could include sand, crushed rock, steel reinforcing and cement. The laydown area would experience frequent heavy vehicle movements, which could result in loose soil.

The ESCP would be prepared to prevent the mobilisation of sediment and construction materials from the laydown yard into Doon Doon Creek or the Tweed River.

To reduce the likelihood of construction material mobilisation, the laydown areas would be located above the 1% AEP (1 in 100 years) flood level to reduce the risk of inundation mobilising construction materials.

Construction water

Construction facilities located within the construction compound downstream from the embankment would include offices, toilets, canteens and storerooms.

Water volumes estimated to be required during construction are shown in Table 6-14.

Table 6-14 Estimate of water required during construction

Water user	Volume (ML/year)
Workers' accommodation and other site facilities	7 ML/year
Concrete batching	3 ML/year
Dust suppression (see Appendix G1 section 4.5 for methodology)	250 ML/year
Total	260 ML/year

Water transfer, treatment and storage infrastructure would be required during construction (see Appendix G1 section 4.5).

Flow regime during construction and initial dam filling

The flow regime of the existing dam would remain unchanged during construction.

Following completion of the dam wall raise, the existing spillway would be plugged, and the new reservoir volume would begin to fill. Spillway discharges would cease until the reservoir reached the new FSL. During this period, minimum flow releases would be maintained via the valve house.

The raised dam would have a volume of 42,300 ML, an increase of 26,300 ML from the current volume of 16,000 ML. On average, the current dam discharges in excess of 50,000 ML via the spillway each year, so it is expected that it would take less than 1 year for the reservoir to fill to the new FSL and for the existing flow regime to be reinstated. In an intense storm event or series of storm events, the raised dam would fill more quickly.

Flooding

During the construction phase, the proposed upgrades to the dam configuration would be driven by constructability considerations to be completed during detailed design. It is therefore unclear as to what the temporary spillway width and the dam wall configurations would be during the construction phase. As such, it is not possible to appropriately simulate flood levels during the construction phase with any level of certainty.

It is likely that the existing spillway width would be maintained during the construction phase for a suitable period of time until the new spillway is operational, thus maintaining the flood risk downstream of the dam to existing conditions.

In the event that a temporary spillway would be required in the construction phase, the spillway should at the minimum maintain the existing spillway's configurations to ensure that flow through

the temporary spillway is maintained at existing conditions. This would ensure that the flood risk downstream is maintained at existing conditions.

Section 6.13 provides a summary on the flooding risk and emergency management in relation to the construction phase.

Groundwater

The following activities have the potential to impact groundwater during construction:

- land-based construction and laydown areas where there could be potential for groundwater contamination
- quarry operation and backfill, and associated material stockpiles: groundwater could be intercepted when quarrying for construction materials.

The construction and use of ancillary facilities and roads are not anticipated to intercept, penetrate or take water from the local groundwater systems and have not been further assessed.

A risk assessment of potential groundwater impacts due to construction of the Proposal are summarised in Appendix G2 Table 7.1 and below. All the activities potentially impacting groundwater are assessed as being negligible and are therefore acceptable level 1 minimal impacts under the AIP.

The Proposal does not intend to excavate material below the water table. Consequently, there is likely to be negligible groundwater take, incidental or otherwise. Groundwater quantity impacts relate to potential changes in groundwater levels from altered surface water – groundwater relationships.

Clarrie Hall Dam construction

The re-establishment of a quarry and other construction works would comprise ground excavation works. While the current depth to groundwater at the quarry site is unknown, site inspections in 2018 did not report any surface seepage, or intersection of the water table by the existing quarry (Public Works Advisory 2018). To avoid the interception of the water table in the fractured rock, it is recommended that quarry expansion occurs laterally and that the current depth of the quarry base be maintained if possible.

Construction works around the dam would likely intercept groundwater or surface water given the proximity to surface water and the high water table near the dam wall. However, construction works would have a short duration, and any potential interaction with groundwater during the dam construction would result in very localised, short-term changes to groundwater levels and/or pressure.

Groundwater quality

Spills of hazardous materials/chemicals and/or the generation of liquid waste can potentially contaminate groundwater. This has the potential to impact human and environmental health, depending on the type of contaminant, if not managed accordingly. The implementation of mitigation measures provided in Table 6-29 would manage this risk.

The use of blasting substances may result in residual substances occurring at the face of blasted material, blasting substances leaching from stockpiled material during rain events and/or the introduction of blast material into the fractured rock groundwater system where blasting occurs. The likelihood of this occurring is low, however, if blasting remains above the water table.

The extent and degree of potential groundwater contamination depends on factors such as geology, depth to groundwater, the infiltration capacity/permeability of the geology, and the presence, properties and characteristics of a potential pollutant. Potential groundwater

contamination incidences, if they even occur, are expected to be minor and localised to within the construction areas if the mitigation measures are implemented.

Operation

Hydrology

The hydrologic modelling (Appendix G1 Annexure A) results informed the assessment of operational impacts to streamflow hydrology and the reservoir water balance.

The NSW Government's Tweed River Valley Source model was used to simulate streamflow with the existing dam in place. The model was then modified to simulate streamflow with the Proposal, allowing a comparative assessment of the effects of the Proposal.

Palaeo-stochastic climate data, published by the NSW Government, was used for the hydrologic modelling (see Appendix G1 section 5.2).

The NSW Office of the Chief Scientist and Engineer recommended that palaeo-stochastic data be used to inform NSW's regional water strategies (NSW Government 2020), which represented a major advance over the use of the instrumented climate record when assessing the risk of climate variability to the management of water resources.

Dam water balance

The dam raising would have minor effects on the reservoir water balance, primarily related to the larger surface area of the reservoir. The larger reservoir surface area resulting from the dam wall raising would result in approximately 3,300 ML/year additional water captured, which otherwise would have evaporated from the landscape around the reservoir fringes.

Over the long term, the existing and raised Clarrie Hall Dam would both be expected to be full approximately 70% of the time (Figure 6-27).

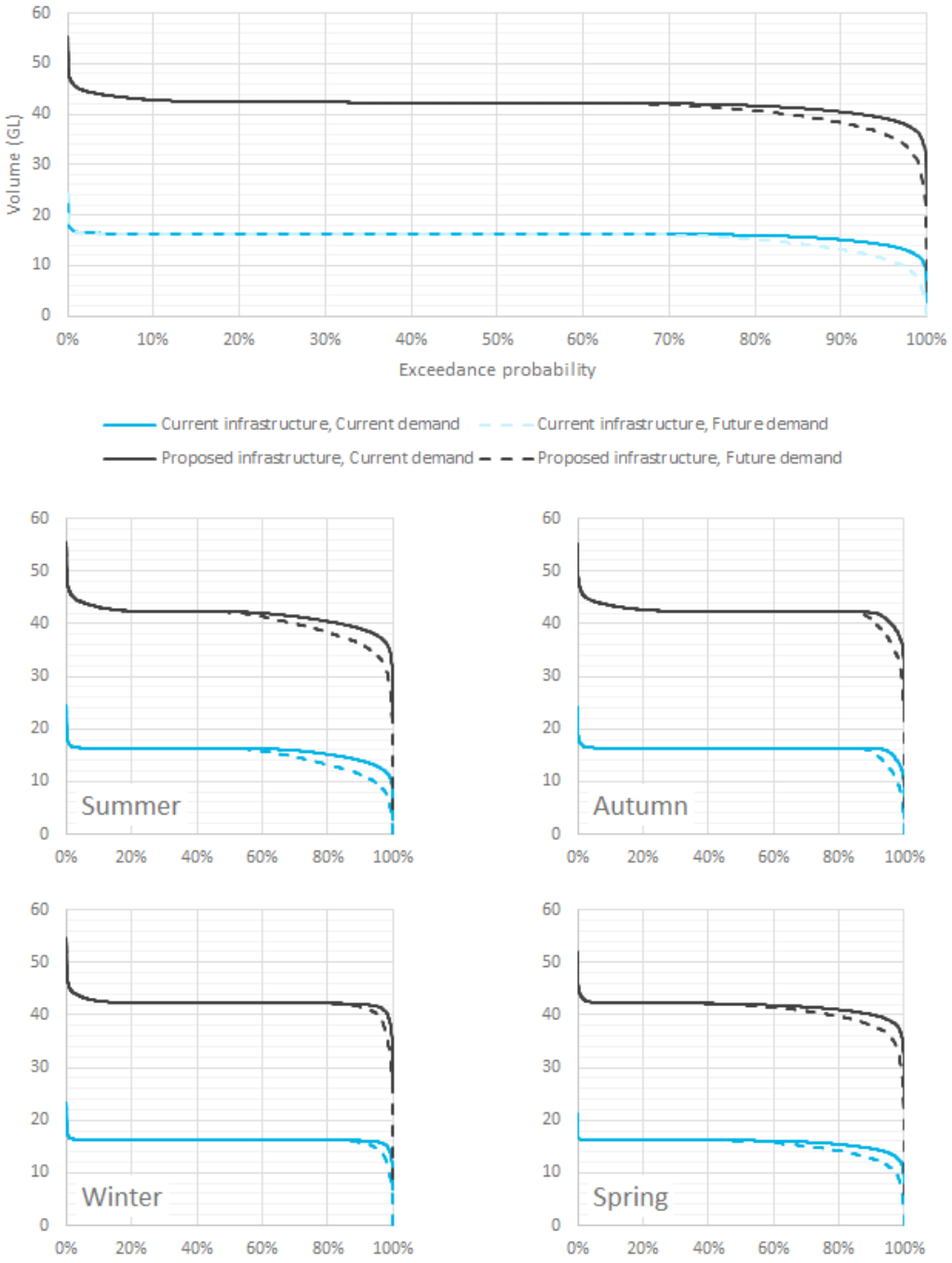


Figure 6-27 Clarrie Hall Dam stored water volume, current climate (palaeo-stochastic climate data)

Source: EMM Appendix G1

The effects of increased evaporation discussed above would reduce the volume of water that is discharged over the spillway but would not cause significant drawdown of the reservoir below FSL.

During droughts, the volume of the reservoir is expected to be drawn down. During periods when the reservoir is drawn down, no water would be discharged via the spillway, and releases would occur via the valve house.

Due to the small size of the reservoir relative to the upstream catchment, the reservoir tends to fill quickly during drought breaking rains (Appendix G1 Figure 5.2).

Further details of the future reservoir water balance are provided in Appendix G1 Annexure A.

Table 6-15 provides an overview of the model results with the current climate.

Table 6-15 Overview of model results with the current climate

Demand:	Units:	2025 demands		2065 demands	
Infrastructure		**Existing**	**Raised**	**Existing**	**Raised**
Characteristic					
Capacity	ML	16,000	42,300	16,000	42,300
FSL	m AHD	61.5	70	61.5	70
Mean managed releases (valve house)	ML/year	2,170	2,143	3,664	3,726
Mean spills (spillway flows)	ML/year	52,081	52,073	50,612	50,507
Mean evaporation volume	ML/year	3,222	6,619	3,115	6,420
Mean rainfall capture volume	ML/year	3,379	6,619	3,297	6,558

Spillway operations

In each season, the number of days that the spillway operates is expected to decrease with the larger reservoir (Figure 6-28), from around 63% of days on average to 55% of days. This effect is anticipated because the increased surface area would be subject to evaporation. Further information on the frequency of spillway operation is provided in Appendix G1 section 5.4.1.

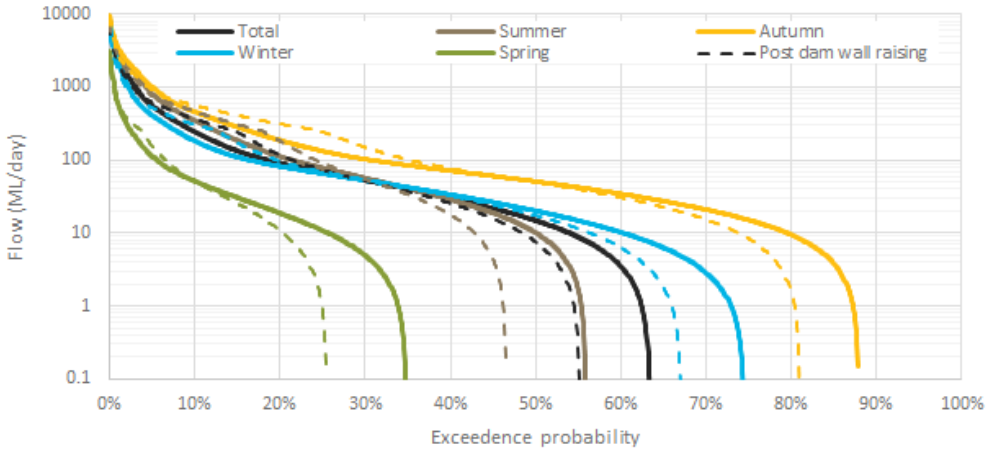


Figure 6-28 Potential changes to spillway discharges (palaeo-stochastic climate data)

Source: EMM Appendix G1

The frequency of spillway discharges of flows exceeding 100 ML/day is expected to increase with the raised dam for 2 reasons:

- The larger reservoir surface area would capture additional rainfall, leading to a greater total volume to be discharged during a rain event.
- The spillway design and reservoir routing effects combined would result in reduced peak discharges and greater attenuation of flood flows in the reservoir over the days following large rainfall. This would result in a decrease to discharged flood peaks and an increase in the number of days of moderate to high discharge in the flow recession period as the flood waters drain more slowly from the larger reservoir.

Dam operations

Dam operations are not expected to change due to the Proposal, as release volumes and timing of releases would be governed by the WSP and urban demand.

Urban demands are not anticipated to be affected by the Proposal (other than by safeguarding urban supply and reducing the likelihood of supply failure).

Flow regime changes

The Tweed River catchment is expected to receive reduced winter and spring rainfall in the future, and rising temperatures are expected to increase evaporation rates.

By 2065, there is also expected to be a 70% growth in town-water demand, due in part to increased population.

The current flow regime with the current climate and town-water demand compared to the modelled future flow regime is shown in Table 6-16.

Table 6-16 Current flow regime and climate compared to modelled future flow and climate

Location	Flow regime with current (2025) climate and town-water demand	Flow regime with future (2065) climate and town-water demand
Doon Doon Creek	Doon Doon Creek and the flows released from Clarrie Hall Dam play a minor role in Tweed River hydrology.	-
Uki	At Uki (Rowlands Creek – Tweed River junction) the total upstream catchment area is 270 km^2. The Clarrie Hall Dam catchment accounts for 22% of the Uki catchment. The changes to spillway discharges have a negligible effect on the flow frequency curves at this location (Appendix G1 Figure 5.6).	The effect of the Proposal on Tweed River flow is expected to remain negligible at Uki.
Bray Park Weir	At Bray Park Weir, the total catchment area is 570 km^2, with the Clarrie Hall Dam catchment accounting for 11% of this area. The potential changes to spillway discharges have an imperceptible effect on the flow frequency curves at this location (Appendix G1 Figure 5.7).	The effect of the Proposal on Tweed River flow is expected to be imperceptible at Bray Park Weir.

Australian Bass migration

The results of the modelled long term flow regime (Appendix G1 Annexure A) show that the Proposal is not expected to have any significant effect on Australian Bass migration within the Tweed River (Figure 6-29). Refer to Appendix G1 section 5.6.3 for further information.

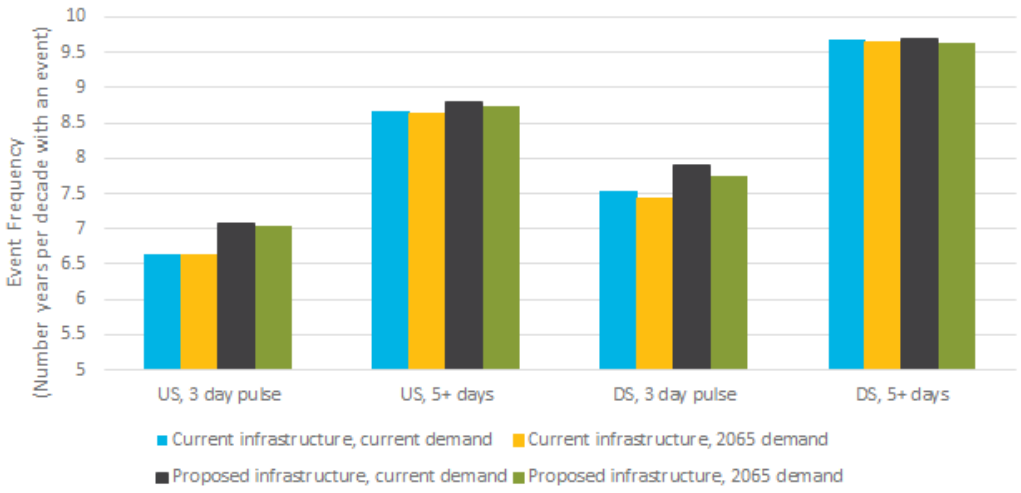


Figure 6-29 Number of years per decade with flows supportive of Australian Bass migration (palaeo-stochastic climate data)

Source: EMM Appendix G1

Reservoir water quality

Following the initial filling, organic matter would be submerged within the newly inundated area. The nutrients contained in the soils and vegetation would take some time to move into the waterbody following inundation, leading to reduced and/or more variable water quality water during the first few years after the commissioning of the raised dam. In general, the initial filling of the reservoir may be characterised by water having higher turbidity, lower DO, higher biochemical oxygen demand, higher chlorophyll-a and higher nutrients.

The initial filling effects can be minimised through the implementation of raised FSL area mitigation measures provided in Table 6-29.

Reservoir water quality is expected to vary on a seasonal and interannual basis in response to runoff from local catchments, and biogeochemical processes occurring within the reservoir. The warming or cooling of the waterbody would affect the amount of dissolved oxygen and suspended solids contain in the water column and influence the chemical reactions that take place. Mixing and circulation processes would be important in determining the physical (temperature), chemical (nutrients) and biological properties (algae). Physical and chemical water quality impacts in the reservoir, comparing the current (2025) and future (2065) climate, are shown in Table 6-17.

Table 6-17 Physical and chemical reservoir water quality impacts for current and future (2065) climate

Parameter	Impacts	
	Current (2025) climate	Future (2065) climate
Water quality	There is the potential for water quality impacts during operation of the new Clarrie Hall Dam may occur due to: • eutrophication, leading to algal blooms • low oxygen content in sediments and deeper parts of the water column, leading to: – release of metals from sediments, particularly iron and manganese – in extreme cases, fish kills. These effects are interrelated, with algal blooms contributing to anoxic conditions at depth, and stratification leading to enhanced risk of algal growth in summer.	Limnology modelling (Appendix G1 Annexure B) indicated that following the dam wall raising, climate change (to 2065) no meaningful change to suspended solids, dissolved oxygen, nitrogen compounds, or phosphorus compounds would occur.

Parameter	Impacts	
	Current (2025) climate	Future (2065) climate
Cold water pollution	Numerical limnology modelling was undertaken using the AEM3D software to investigate the potential changes to stratification, nutrient distribution, and algae growth which could occur due to the dam wall raising (Appendix G1 Annexure B). The model indicated that following the dam wall raising during summer when the reservoir is stratified, the warm surface layer may become 2–3 m thicker due to the additional surface area that is exposed to wind energy (Appendix G1 Figure 5.13).	Limnology modelling (Appendix G1 Annexure B) indicated that following the dam wall raising, climate change (to 2065) may lead to an increase in water temperature by 1–2°C.
Algae	The numerical limnology model indicated that with a larger vegetated perimeter and an increase in shallow fringes, the total nutrient (TN and TP) content of the reservoir is expected to increase. This effect is balanced by the increase in reservoir storage volume such that the average nutrient concentrations are expected to decrease. In the existing reservoir, algal growth is constrained by phosphorus concentration near the surface. After the dam raising, additional phosphorus would be available in the surface layer at the commencement of summer (Appendix G1 Figure 5.14), leading to increased frequency and severity of algal blooms. Algal blooms affecting the upper 7 m of the water column (Appendix G1 Figure 5.15) pose a risk to water quality released from the dam. When the reservoir is full and spilling, operators have little control over the release of algae from the reservoir. When releases are made via the valve house, algae water quality risks can be avoided through use of the MLO, by drawing water from depths of 7–9 m. Operators would preferentially draw water from the highest point in the water column that is not affected by algae, as deeper water has lower dissolved oxygen and higher risk of CWP.	Limnology modelling (Appendix G1 Annexure B) indicated that following the dam wall raising, climate change (to 2065) may cause: • ±10% cyanophyte algal cell counts (i.e. unchanged, with an uncertainty range) • –50% chlorophyte algal cell counts (i.e. counteracting the increase expected from dam wall raising). The large reduction in chlorophyte cell counts is associated with the change in water temperature, with a reduced period in the year with optimal water temperatures. Changes in water temperatures would favour cyanophyte (blue-green) algae, and it is possible that these species could become more common through the cooler parts of the year when they would typically die off.
Dissolved oxygen	Dissolved oxygen concentrations (Appendix G1 Figure 5.19) are expected to increase near the surface. The deeper thermocline following the dam wall raising is also expected to result in a deeper oxycline, meaning a larger body of water would be oxygenated. Near the reservoir bed, oxygen concentrations remain unchanged.	–

Limnology modelling indicated that an increase in primary production (rate of algae growth), is likely following the dam wall raising.

The modelling illustrated that releases of PO_4 (phosphate) from sediment in the enlarged hypolimnion of the raised dam would result in an increase to concentrations of total phosphorus, PO_4 and consequently Chl-a. Compounding this risk is the prediction that cyanophytes (blue-green

algae), which are currently dominant during the summer months, may become more dominant throughout the year as a result of climate change impacts (in particular the direct and indirect impacts of increased air temperature).

Reservoir destratification may be undertaken for a number of discrete reasons, including:

- management of water quality (e.g. dissolved oxygen or turbidity) at water supply offtake locations, and subsequent water treatment costs (although this would not occur in the case of Clarrie Hall Dam)
- management of temperature with the waterbody, to reduce the risk of CWP causing harm to aquatic fauna
- management of algae, as algae can generate a number of toxins and reduce dissolved oxygen, both of which are harmful to aquatic fauna.

Previously installed mixing devices in Clarrie Hall Dam have been somewhat effective in redistributing temperature gradients and have weakened, but not eliminated, thermal stratification. The overall performance of the mixers, however, has proven unsatisfactory, and Hunter H2O (2018) conclude from the monitoring data that mechanical mixers cannot maintain:

- complete thermally destratified conditions
- stable and sufficient dissolved oxygen concentrations throughout the water column
- low and stable iron and manganese concentrations
- low and stable cyanobacterial populations.

Water released from Clarrie Hall Dam would be delivered via run-of-river to water supply offtake locations. During these transfers, the water becomes oxygenated through general exposure to the atmosphere, and in particular through turbulence induced by riffle zones. As such, reservoir destratification is not required for management of the quality of water delivered to water supply offtakes.

Downstream water quality

Historical monitoring of algae within Doon Doon Creek, the reservoir, and the Tweed River has indicated frequent non-detection of blue-green algae within the Tweed River downstream from the reservoir even when the dam is full and spilling (see Appendix G1 section 3.9.2vi). There is no strong correlation between algal counts in the reservoir and algal counts in the Tweed River, and as such it is likely that increased algal counts in the reservoir due to raising would not result directly in a commensurate increase in algal counts in the river.

Downstream, the frequency of flows over the spillway during summer is expected to decrease from 55% of the time to 45% of the time following dam wall raising (Appendix G1 Figure 5.3). The modelling results show the overall risk of CWP to the downstream environment is expected to decrease following the dam wall raising (Appendix G1 Figure 5.16), while the risks associated with release of algae are expected to increase.

The risk of CWP is expected to decrease following the dam wall raising, resulting in a reduction in the magnitude of CWP released from the dam to the degree that effects at the Doon Doon Creek – Tweed River junction are expected to meet NOW recommendations for cold water management (NOW 2011).

Algae released from the dam has the potential to seed algae growth within Bray Park Weir, affecting water treatment and general amenity of the waterway adjacent to Murwillumbah. Algae blooms currently occur from time to time within the weir pool and are expected to continue following the dam wall raising.

For several years after the initial reservoir filling, organic matter and nutrients may be elevated in water released from the reservoir (Appendix G1 section 5.7.1), and there may be an ongoing a risk of increased algae counts (Appendix G1 section 5.7.2). Council operated WTPs are already equipped to respond to these conditions, such that town-water supplies would continue to meet ADWG parameter thresholds.

Geomorphology

Potential changes to bed shear through Doon Doon Creek and the Tweed River due to the Proposal were assessed (Appendix G1 Annexure D) utilising information describing the anticipated flow regime changes (Appendix G1 Annexure A), hydraulic properties of the waterways (Appendix G1 Annexure C), and critical shear stress data (Appendix G1 Table 5.2).

The assessment for Doon Doon Creek found:

- Modelled bed shear remains below 100 N/m2 in all but the largest floods. The modelling process averages shear across the model cross-section, and it likely that there would be eddies, turbulence, and non-uniform flow conditions which would result in shears up to an order of magnitude greater. This means that:
  - rocks larger than 100 mm are not expected to be mobilised in typical flow events
  - rocks 10–100 mm could be mobilised short distances before settling in locations of lower shear
  - sand and silt would be readily mobilised by typical flow events.
- Changes to the spillway and reservoir routing would result in a reduction in the frequency of flows with high shear stress in Doon Doon Creek (Figure 5.20). This means that the bed materials would be mobilised in floods less frequently.
- There could be a small increase in the frequency of flows with shear in the order of 30 N/m2, and a small reduction in the frequency of flows with shear in the order of 15 N/m2. These changes are not expected to have an effect on the bed materials present.

It is expected that in the Tweed River between Doon Doon Creek and Uki, there would be minimal change to the bed shear environment (Appendix G1 Figure 5.21).

Further information relating to shear, velocity and depth are included in Appendix G1 Annexure D.

The efficiency of reservoirs to trap sediment is dependent on water residence time, with higher residence time allowing for additional settling. From the relationship developed by Brune (1953), which was based on a study of 44 reservoirs, it is estimated that the existing Clarrie Hall Dam likely captures approximately 94.5% of inflowing sediment.

Peak concentrations of suspended solids near the surface of the reservoir are likely to be greatly attenuated in the raised dam (Appendix G1 Figure 5.23) due to increased retention time allowing for settling of fine particles, with the result that sediment trap efficiency is likely to increase to 97%.

A modified sediment trap estimation method, which scales trap efficiency based on daily inflow (Lewis, et al. 2013), provided very similar estimates of 94.2% and 96.8% sediment trapping for the existing and raised dam.

This change in sediment trap efficiency represents a large proportional change (45% less sediment exiting the reservoir following the dam wall raising) but a small absolute change (little sediment currently exits the dam, and this is not expected to change).

The decrease in sediment supply in Doon Doon Creek downstream from the dam following the wall raising would promote erosion of fine particles downstream, where these exist, while the decrease in high flows would promote sedimentation and a reduction in erosion. Taken together, these

effects mean that the nature of any geomorphological change is difficult to predict. However, the magnitude of each geomorphological effect is relatively small. As such, any geomorphological change that does occur is expected to occur as slow adjustments over an extended period of time.

In locations with a gravel/rocky bed it is likely that no geomorphological change would occur due to the project. Rocks of the sizes observed in the riverbed are not expected to be affected by erosion due to changes in reservoir sedimentation.

No geomorphological changes are expected downstream from Uki, as the Doon Doon Creek catchment represents only a small portion of the catchment upstream from Uki, with the remainder unregulated and unaffected by the project.

Water Sharing Plan

No changes to the WSP are required due to the Proposal. However, flow triggers may be updated in the WSP, which references reservoir capacity. Currently, the WSP provides rules that govern target flow releases from Bray Park Weir based on the storage volume in Clarrie Hall reservoir (Appendix G1 Table 5.3). Such amendments are not essential for Proposal operation and can be considered via a separate process after Proposal approval.

Flooding

Peak discharges and water level

For the proposed case, a peak dam water level of 76.94 m AHD was modelled for the PMF design event. While the modelled water level was higher than the existing case, the raised dam wall elevation of 77.0 m AHD ensured no overtopping of flow from the dam, thus ensuring a safer dam.

In both the existing case and the proposed case, there is no overtopping of flow at the dam's wall in the 0.5% AEP, 0.2% AEP, 1% AEP and 5% AEP design events.

Table 6-18 shows the modelled discharges and corresponding water level in the dam for all design events.

Table 6-18 Peak flows at the spillway and corresponding water level in the dam for all design events

Design event (AEP)	Spillway peak flows (m^3/s)			Dam water level (mAHD)		
	Existing case	Proposed case	Difference	Existing case	Proposed case	Difference (m)
5%	356	330	–26	64.96 (3.46 m)	72.56 (2.56 m)	7.60
1%	532	493	–39	66.18 (4.68 m)	73.31 (3.31 m)	7.13
0.5%	560	527	–33	66.36 (4.86 m)	73.45 (3.45 m)	7.09
0.2%	661	631	–30	67.00 (5.50 m)	73.87 (3.87 m)	6.87
PMF	1655*	1516	−139	71.05 (9.55 m)	76.94 (6.94 m)	5.89

**Includes spillway flow of 1,367 m3/s and overtopping of the dam's embankment (~288 m3/s) occurring in the PMF design event.*

Note: Figures in parentheses are depth above spillway levels: 61.5 m AHD (existing case) and 70.0 m AHD (proposed case).

Results for flood levels and velocities extracted at the 12 reporting points from locations of interest both upstream and downstream of the dam are discussed below.

Upstream of the dam

Peak flood levels extracted at the locations of the reporting points (RP) for areas upstream of the dam for the proposed case are presented in Table 6-19. The differences in flood levels between the existing case and the proposed case are presented in Table 6-20. The changes in peak flood level are presented in Appendix F (Appendix C1 to Appendix C5).

Table 6-19 Flood levels (mAHD) upstream of Clarrie Hall Dam – proposed case

RP	Description	Flood levels (mAHD)				
		5% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
RP01	Doon Doon Ck – US reaches	75.00	75.97	76.10	76.28	77.29
RP02	Doon Doon Ck – Confluence Commissioners Creek	72.61	73.41	73.55	74.06	77.07
RP03	Doon Doon Ck – McCabes Bridge US	72.59	73.34	73.49	73.92	77.00
RP04	Doon Doon Ck – McCabes Bridge (400m DS)	72.56	73.31	73.46	73.88	76.97
RP05	Doon Doon Ck – Dam Mid	72.56	73.31	73.46	73.88	76.96
RP06	Doon Doon Ck – Dam US	72.56	73.31	73.45	73.87	76.94

Table 6-20 Differences in flood levels (m) upstream of Clarrie Hall Dam – proposed case minus existing case

RP	Description	Differences in flood levels (m)				
		5% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
RP01	Doon Doon Ck – US reaches	0.00	0.02	0.03	0.04	0.98
RP02	Doon Doon Ck – Confluence Commissioners Creek	3.76	3.26	3.20	3.39	5.10
RP03	Doon Doon Ck – McCabes Bridge US	4.85	4.70	4.43	4.63	5.67
RP04	Doon Doon Ck – McCabes Bridge (400m DS)	6.77	6.60	6.62	6.60	5.79
RP05	Doon Doon Ck – Dam Mid	7.58	7.09	7.06	6.83	5.81
RP06	Doon Doon Ck – Dam US	7.60	7.13	7.09	6.87	5.89

Upstream of the dam's spillway, flood levels are increased by up to 7.6 m in the dam's storage area. Table 6-19 shows that the water levels in the dam increase by between 5.9 m and 7.7 m for the design events. This flood level increase is due to the raising of the dam and the spillway, which results in a higher FSL, as well as all flows out of the dam contained to the spillway.

The maximum rise in peak water level of 7.6 m is less than the dam raising level of 8.5 m. This is due to an increase in dam storage and spillway conveyance.

The severity of the rise in flood levels reduces further upstream of the dam. At the confluence of the Doon Doon Creek and Commissioner's Creek, increases in peak flood level for design events up to the 0.2% AEP event are noted to dissipate. For the PMF event, the increase in peak flood level is simulated to extend further upstream of the confluence.

Flood velocities extracted at the reporting locations for areas upstream of the dam for the proposed case is presented in Table 6-21. The differences in flood velocities between the existing case and proposed case are presented in Table 6-22.

The differences in flood velocities are presented in Appendix F (Appendix C6 to Appendix C10).

Table 6-21 Flood velocities (m/s) upstream (US) of Clarrie Hall Dam – proposed case

RP	Description	Flood velocities (m/s)				
		5%	1%	0.5%	0.2%	PMF
RP01	Doon Doon Ck – US reaches	2.17	2.23	2.24	2.28	2.29
RP02	Doon Doon Ck – Confluence Commissioners Creek	1.16	1.76	1.80	1.91	1.54
RP03	Doon Doon Ck – McCabes Bridge US	0.70	1.24	1.28	1.39	1.05
RP04	Doon Doon Ck – McCabes Bridge (400m DS)	0.42	0.78	0.80	0.86	0.63
RP05	Doon Doon Ck – Dam Mid	0.05	0.08	0.08	0.10	0.09
RP06	Doon Doon Ck – Dam US	0.41	0.41	0.41	0.41	0.41

Table 6-22 Differences in flood velocities (m/s) US of Clarrie Hall Dam – proposed case minus existing case

RP	Description	Differences in flood velocities (m/s)				
		5%	1%	0.5%	0.2%	PMF
RP01	Doon Doon Ck – US reaches	0.00	0.00	0.00	0.01	0.00
RP02	Doon Doon Ck – Confluence Commissioners Creek	–2.00	–1.96	–1.87	–1.91	–1.66
RP03	Doon Doon Ck – McCabes Bridge US	–1.24	–1.37	–1.20	–1.42	–1.40
RP04	Doon Doon Ck – McCabes Bridge (400 m DS)	–1.86	–2.25	–2.28	–2.34	–2.09
RP05	Doon Doon Ck – Dam Mid	–0.10	–0.12	–0.12	–0.15	–0.18
RP06	Doon Doon Ck – Dam US	0.32	0.29	0.28	0.27	0.12

Flood velocities are generally lower in the upstream reaches of the dam. However, in the vicinity of the spillway, the velocities are noted to have increased by up to 1.0 m/s and, closer to the wall, by more than 1.0 m/s.

McCabes Bridge

In the proposed case, the replacement of McCabes Bridge and changed road alignment resulted in increased peak flood levels and a larger flood extent upstream of the bridge. The replaced bridge, which has a deck level of 72.0 m AHD, is inundated in all the simulated storm events.

Flood extents

The flood extents are noted to be wider in the main dam's storage area, with minor increases in flood extent also noted past the confluence of Doon Doon Creek and Commissioners Creek.

Downstream of the dam

Peak flood levels for the various design events (AEPs) were extracted at the reporting locations for areas downstream of the dam for the proposed case, as presented in Table 6-23. The differences in flood levels are presented in Table 6-24. The differences in flood levels are also presented in Appendix F (Appendix C1 to Appendix C5).

Table 6-23 Flood levels (m AHD) downstream of Clarrie Hall Dam – proposed case

RP	Description	Flood levels (m AHD)				
		5%	1%	0.5%	0.2%	PMF
RP07	Doon Doon Ck – Dam DS	29.45	30.67	30.86	31.52	34.86
RP08	Tweed River – Confluence of Doon Doon Ck	26.97	28.93	29.14	29.70	32.87
RP09	Tweed River – Uki	21.06	23.02	23.25	23.82	28.73
RP10	Tweed River – Dum Dum	12.11	13.94	14.16	14.78	21.00
RP11	Tweed River – Byangum Bridge US	9.07	10.09	10.25	10.64	14.10
RP12	Tweed River – Bray Park US	6.52	7.20	7.33	7.66	11.32

Table 6-24 Differences in flood levels (m) downstream of Clarie Hall Dam – proposed case minus existing case

RP	Description	Differences in flood levels (m)				
		5%	1%	0.5%	0.2%	PMF
RP07	Doon Doon Ck – Dam DS	–0.18	–0.26	–0.24	–0.12	–0.31
RP08	Tweed River – Confluence of Doon Doon Ck	–0.21	–0.15	–0.14	–0.05	–0.12
RP09	Tweed River – Uki	–0.18	–0.14	–0.13	–0.12	–0.12
RP10	Tweed River – Dum Dum	–0.15	–0.11	–0.11	–0.13	–0.10
RP11	Tweed River – Byangum Bridge US	–0.05	–0.04	–0.13	–0.12	–0.03
RP12	Tweed River – Bray Park US	–0.04	–0.04	–0.04	–0.04	–0.03

The results from the flood modelling show that the proposed raised dam decreases flood levels downstream of the dam. Flood levels downstream of the dam, throughout the Tweed River, are generally decreased by between 10 mm and 250 mm for all design events. At Bray Park, the flood levels are generally lowered by up to 100 mm for all design events.

Flood velocities extracted at the reporting locations for areas downstream of the dam for the proposed case is presented in Table 6-25. The differences in flood velocities between the existing case and the proposed case are presented in Table 6-26. The differences in flood velocities are also presented in Appendix F (Appendix C6 to Appendix C10).

The results from the modelling show that there are minor reductions in flood velocities throughout the downstream reaches of the dam. Flood velocities are generally lower by 0.1 m/s downstream of the dam in the Tweed River for all design events. However, increased velocities of not more than 0.1 m/s are also simulated at the confluence of the Doon Doon Creek with the Tweed River. These increased velocities are mainly confined to the main channel.

Table 6-25 Flood velocities (m/s) downstream of Clarrie Hall Dam – proposed case

RP	Description	Flood velocities (m/s)				
		5%	1%	0.5%	0.2%	PMF
RP07	Doon Doon Ck – Dam DS	2.17	2.21	2.23	2.29	3.02
RP08	Tweed River – Confluence of Doon Doon Ck	2.70	2.92	2.97	3.07	3.88
RP09	Tweed River – Uki	2.72	2.70	2.70	2.70	2.70
RP10	Tweed River – Dum Dum	1.90	1.99	1.99	1.98	1.95
RP11	Tweed River – Byangum Bridge US	1.76	1.97	2.00	2.07	3.03
RP12	Tweed River – Bray Park US	3.56	4.06	4.10	4.16	4.20

Table 6-26 Differences in flood velocities (m/s) downstream of Clarrie Hall Dam – proposed case minus existing case

RP	Description	Differences in flood velocities (m/s)				
		5%	1%	0.5%	0.2%	PMF
RP07	Doon Doon Ck – Dam DS	0.00	–0.03	–0.02	–0.02	–0.15
RP08	Tweed River – Confluence of Doon Doon Ck	–0.02	–0.02	–0.01	–0.01	–0.02
RP09	Tweed River – Uki	–0.02	–0.01	–0.01	0.01	0.00
RP10	Tweed River – Dum Dum	–0.01	–-0.01	0.01	0.01	–0.01
RP11	Tweed River – Byangum Bridge US	–0.04	–0.03	–0.02	–0.01	–0.02
RP12	Tweed River – Bray Park US	–0.04	–0.01	–0.01	0.00	0.00

The simulated decreases in water levels downstream of the dam are a result of the lower peak flows discharged from the dam's spillway, as the proposed spillway provides more storage and flood attenuation. The peak flows immediately downstream of the dam and at Bray Park Weir are presented in Table 6-27.

Table 6-27 Peak flows Immediately downstream of the Clarrie Hall Dam and at Bray Park Weir

Design event (AEP)	Peak flows downstream of the dam (m^3/s)			Peak flows at Bray Park Weir (m^3/s)		
	Existing case	Proposed case	Difference	Existing case	Proposed case	Difference
5%	356	330	–26 (–7.4%)	3,208	3,139	–69 (–2.1%)
1%	532	476	–56 (–10.5%)	4,751	4,677	–74 (–1.6%)
0.5%	560	505	–55 (–9.8%)	5,028	4,950	–77 (–1.5%)
0.2%	661	630	–31 (–4.7%)	5,727	5,648	–79 (–1.4%)
PMF	1,664	1,518	–146 (–8.8%)	15,276	15,167	–109 (–0.7%)

Note: Peak flows presented are the maximum of the peak flows obtained for the critical duration at the location for each design event. Figures in parentheses are percentage differences as compared against existing peak flows.

Table 6-27 highlights the reduction in peak flows downstream of the dam for all design events. Peak flows immediately downstream of the dam are reduced by between 4.7% and 10.5% for all

design events. At Bray Park Weir, flows are reduced by between 1.4% and 2.1% for up to the 0.2% AEP design event, while the PMF flows are simulated to be approximately 0.7% lower.

Flood extents

There are minimal changes in flood extents simulated for all design events in the reaches downstream of the dam. Minor reductions in flood extents were noted at sporadic locations throughout the modelled area downstream of the dam.

The dam takes approximately 120 hours to drain to the FSL level for all design events in the proposed case.

Flood hazard

Flood hazard is typically derived from a combination of peak flood depth and velocity. The visualisation of flood hazard provides for a better understanding of the potential flood risk within the study area. The Australian Institute for Disaster Resilience (2017), in a handbook on best practice in flood management in Australia, provides hazard classifications that add clarity to the hazard categories and what they mean in practice. The classifications are divided into 6 categories, shown in Table 6-28 and Figure 6-30, which indicate the restrictions on people, buildings and vehicles.

Table 6-28 Hazard classifications

Hazard classification	Description
H1	Relatively benign flow conditions. No vulnerability constraints
H2	Unsafe for small vehicles
H3	Unsafe for all vehicles, children and the elderly
H4	Unsafe for all people and vehicles
H5	Unsafe for all people and vehicles. Buildings require special engineering design and construction
H6	Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure

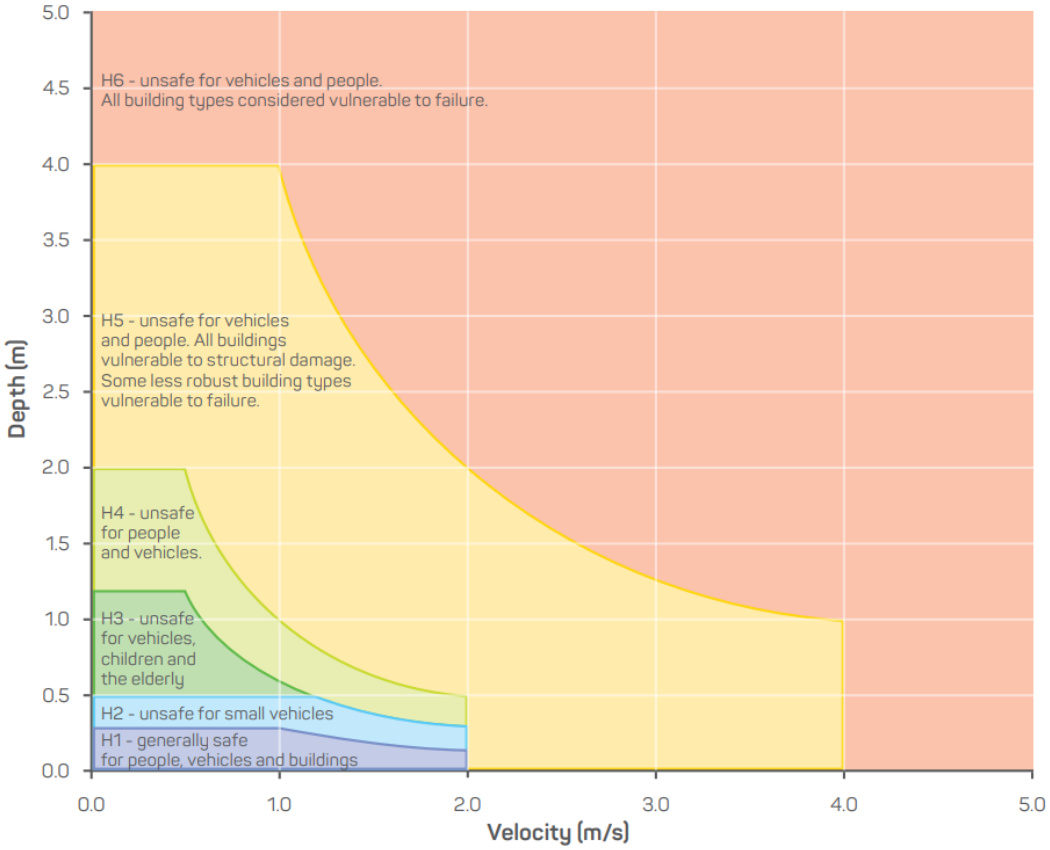


Figure 6-30 AIDR flood hazard vulnerability curves

Peak flood hazard mapping for all the design events for the existing case is presented in Figure 6-31 to Figure 6-35 and Appendix F (Appendix A11 to A16, and Appendix B11 to B16 for the proposed case).

The flood hazard differences, mapped in Appendix F (Appendix C11 to C16), show that the dam upgrade results in increases in flood hazard upstream of the dam and a decrease in flood hazard at sporadic locations downstream of the dam.

Flood hazard classifications increased mainly by one classification upstream of the dam and were mainly restricted to the creek's floodplains.

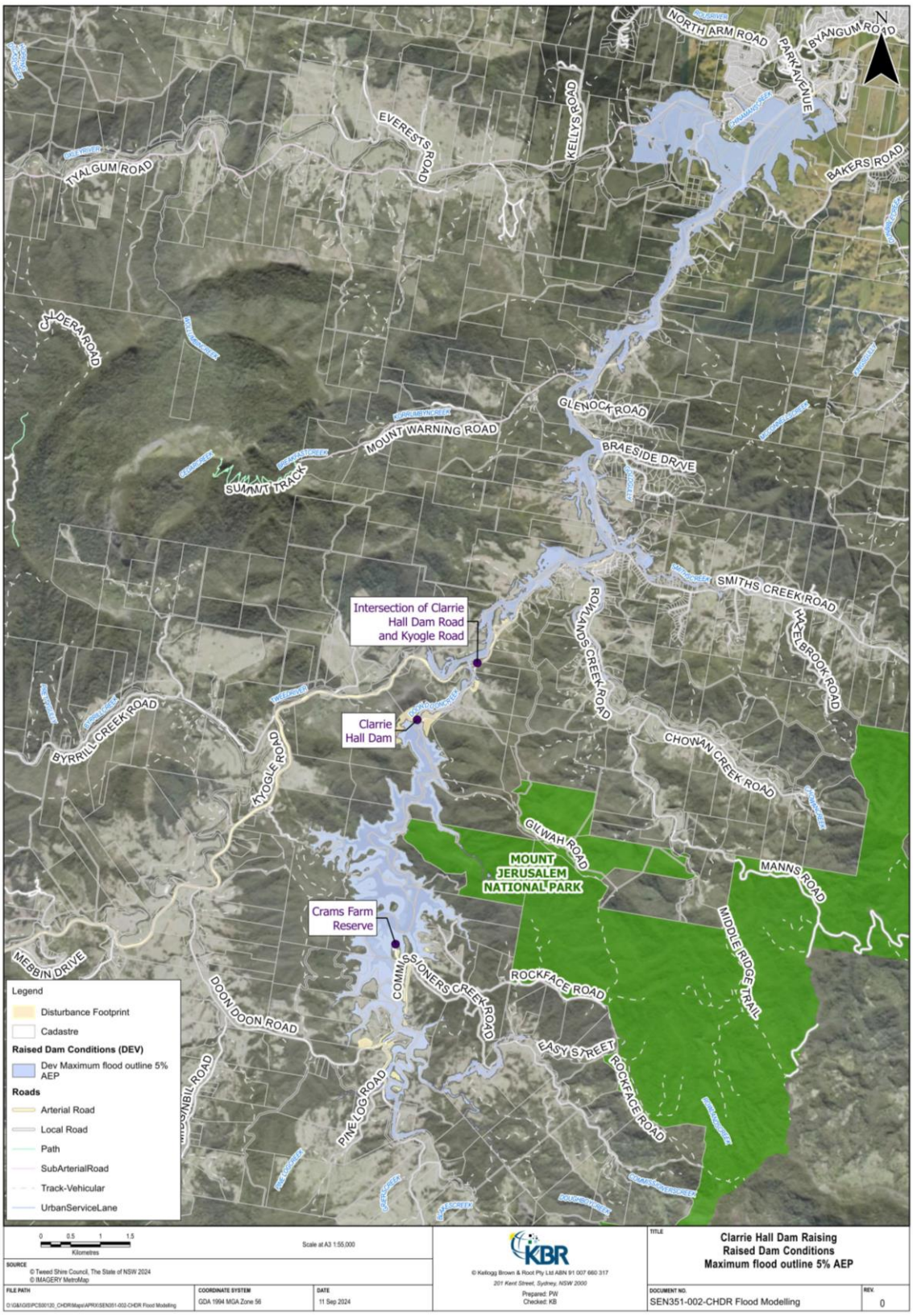


Figure 6-31 Proposal – maximum flood outline 5% AEP

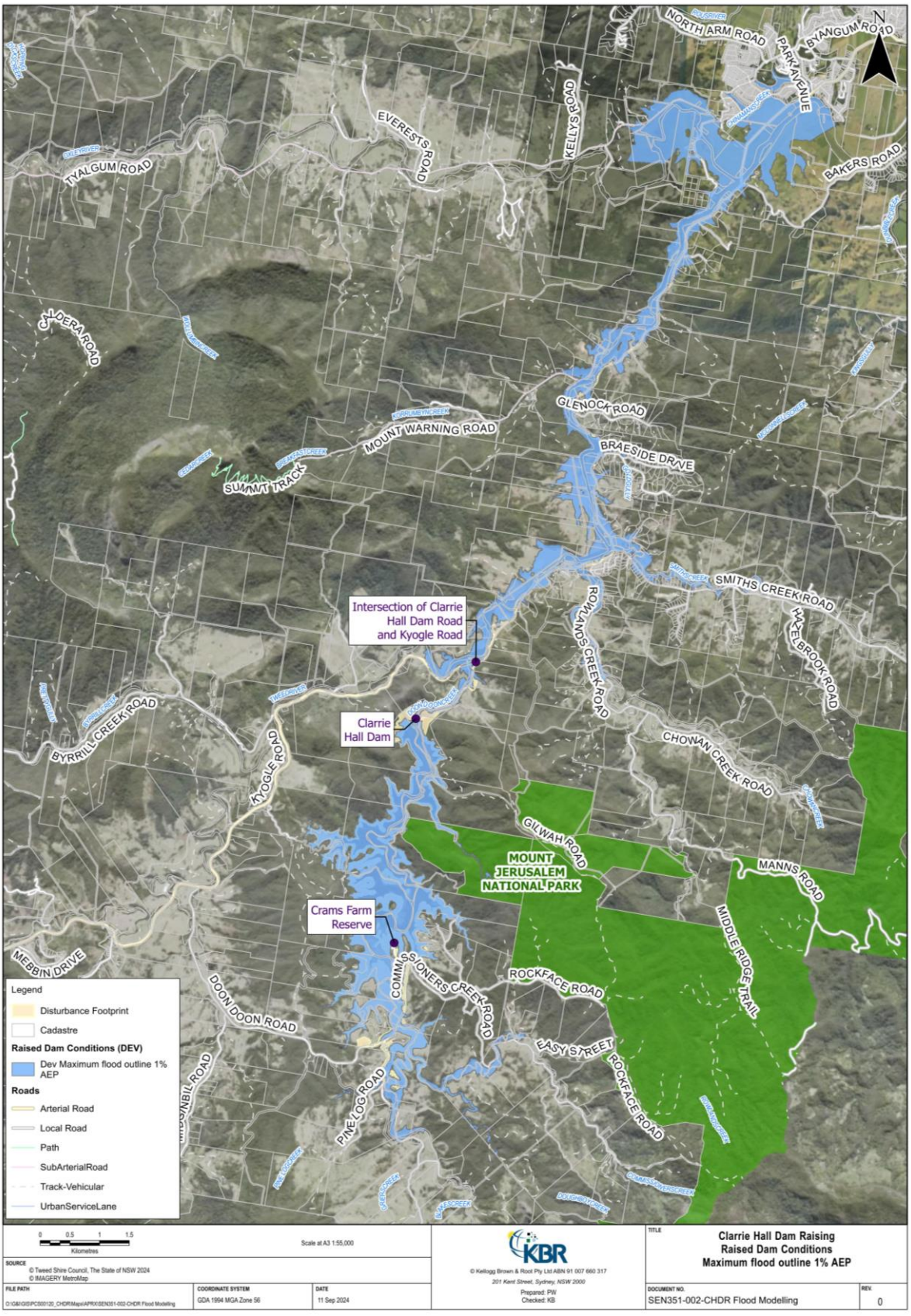


Figure 6-32 Proposal – maximum flood outline 1% AEP

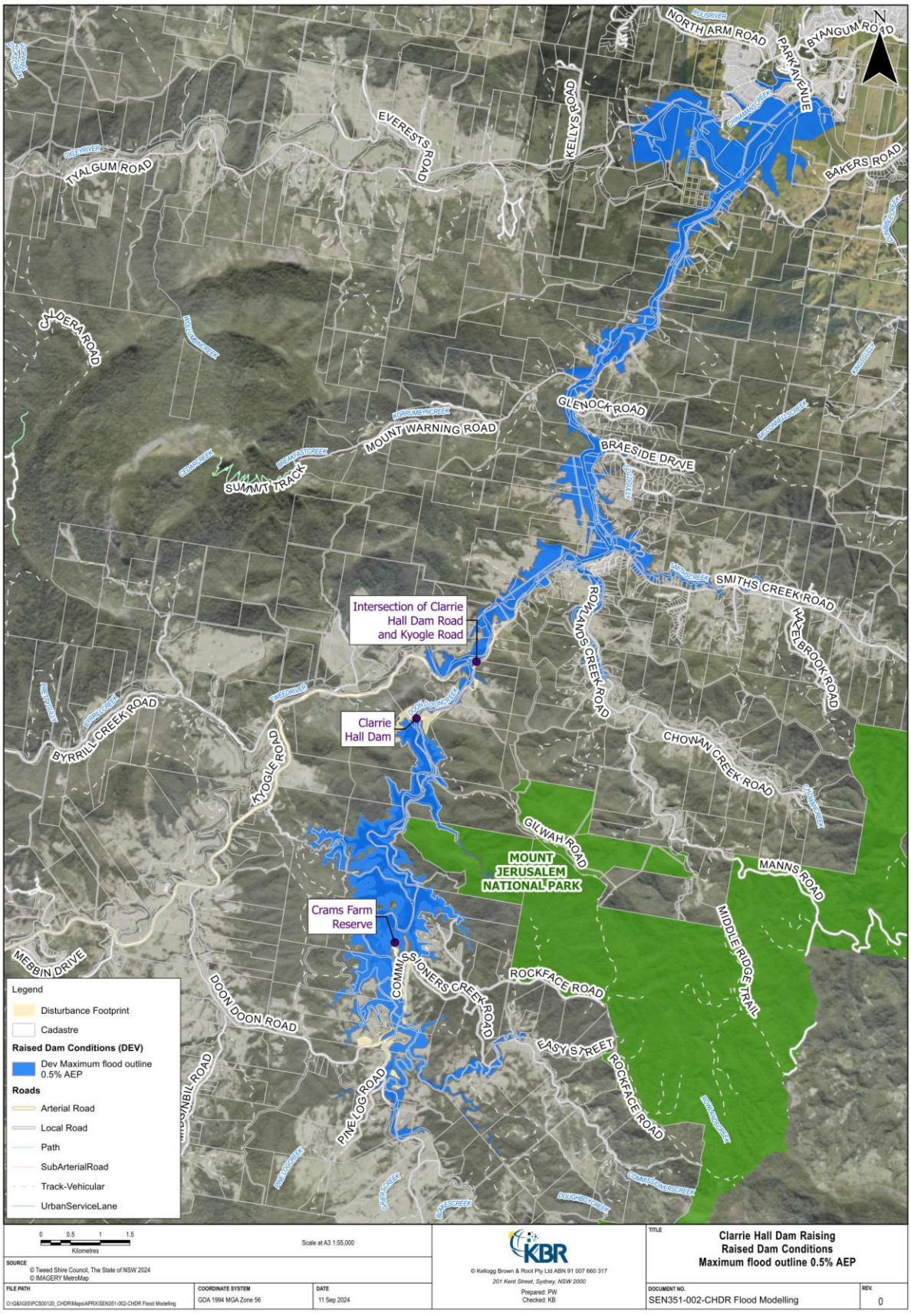


Figure 6-33 Proposal – maximum flood outline 0.5% AEP

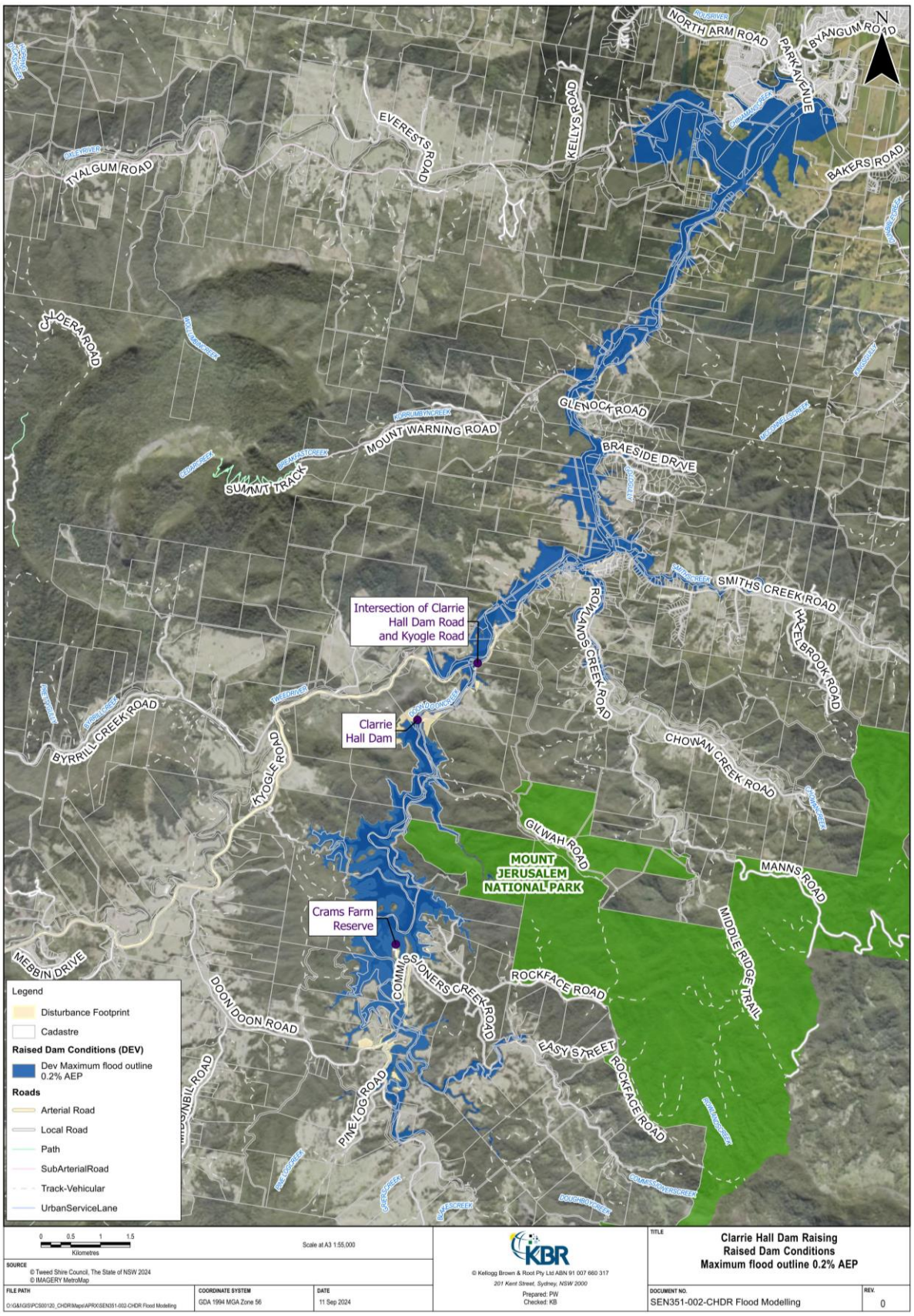


Figure 6-34 Proposal – maximum flood outline 0.2% AEP

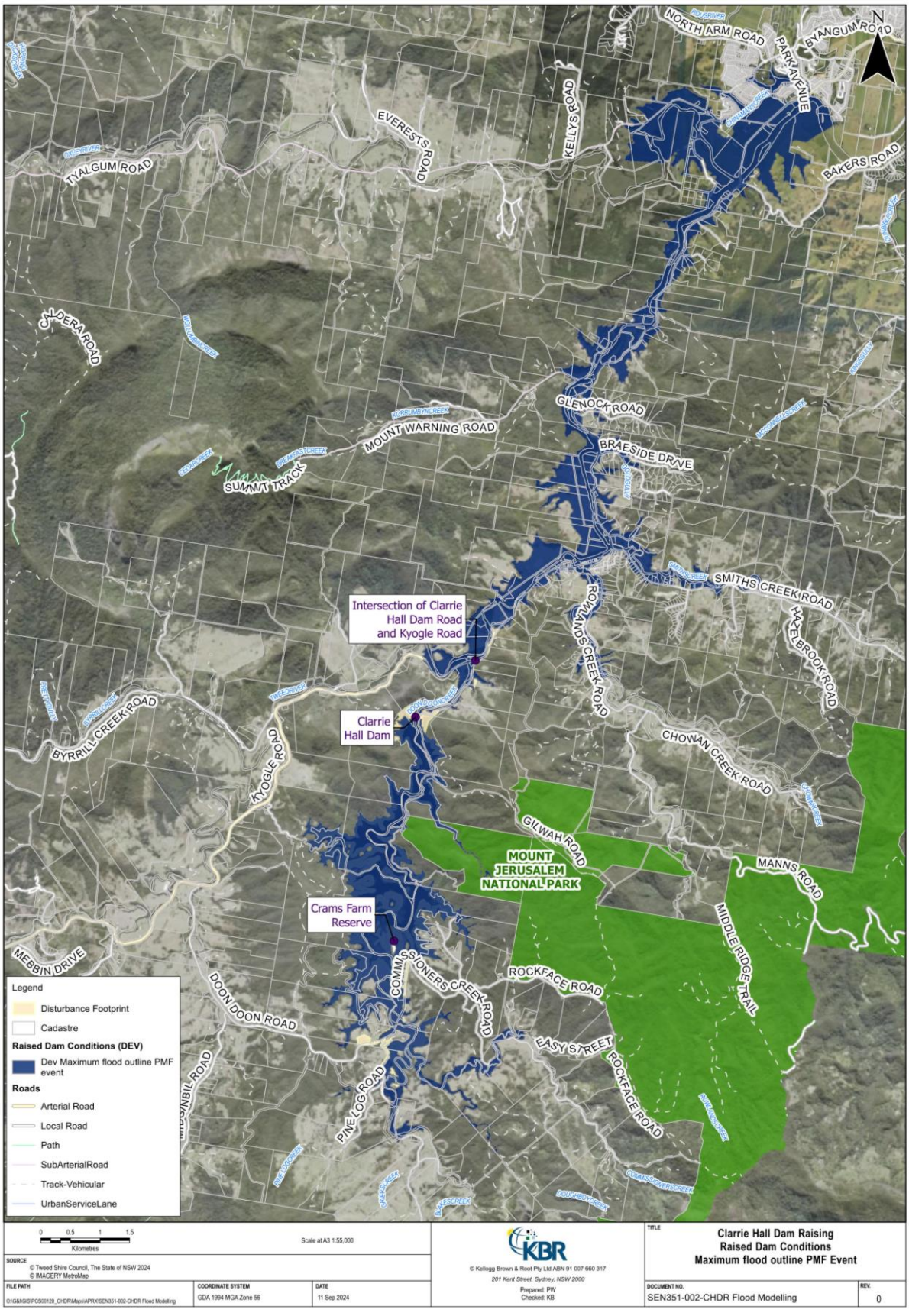


Figure 6-35 Proposal – maximum flood outline PMF

Climate change

The 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF design events with climate change (SSP3-7.0) were simulated within the TUFLOW model to determine the impacts of climate change. The flood level differences maps (proposed case minus existing case) are presented in Appendix F (Appendix D). The differences in flood levels were similar to the current climate change scenario – that is, flood levels were reduced downstream of the dam as a result of the dam upgrades.

Water levels for the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP design events with climate change were mainly contained within the dam. The PMF with climate change scenario simulated a water level of 78.23 m AHD, which resulted in the dam overtopping the proposed wall of 77.0 m AHD by 1.23 m. Further modelling would be completed during detailed design when the 'Climate Change Considerations chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation' (Department of Climate Change, Energy, the Environment and Water 2024a) is released.

Duration of inundation

An extended simulation period of 150 hours was undertaken for the proposed case for the 24-hour duration storm event to assess the duration of inundation for the area upstream of the dam above the FSL of 70.0 m AHD.

The results of the extended simulation for the proposed case indicate that the dam takes approximately 120 hours to drain to the FSL for all design events. It has to be noted that only the 24-hour duration storm was assessed, which was the longest duration run for the 5% AEP, 1% AEP, 0.5% AEP and 0.2% AEP events and which was also the critical duration for the PMF. Longer duration storms would take longer to drain. Figure 6-36 presents the water levels in the dam over the longer simulated period for all design events.

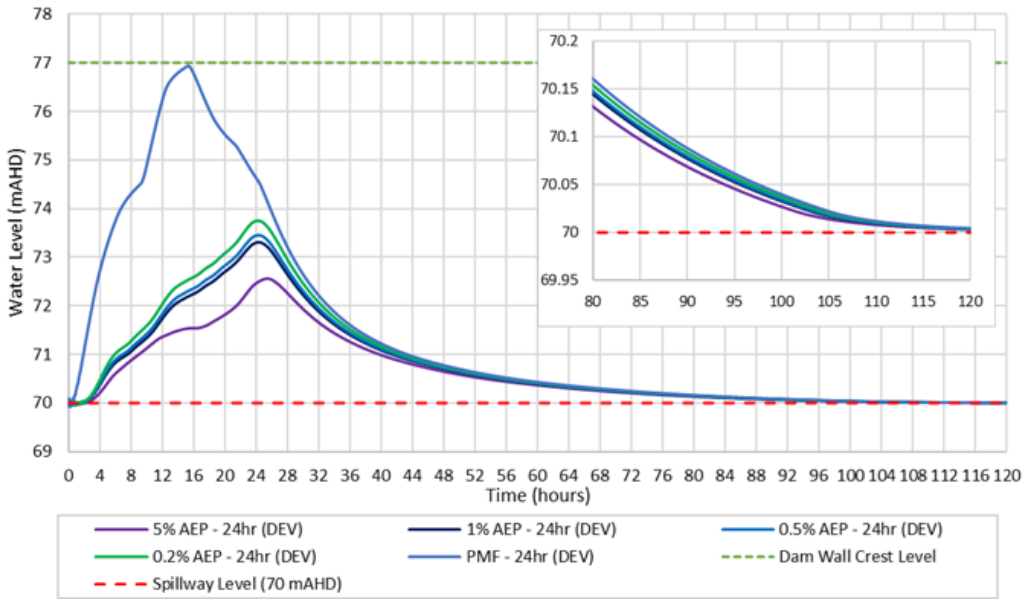


Figure 6-36 Proposed case stage hydrographs for all design events (48-hour duration) over a longe simulation period (150 hours)

Groundwater

A risk assessment of potential groundwater impacts due to operation of the Proposal is provided in Appendix G2 Table 7.1 and summarised below. All the activities potentially impacting groundwater are assessed as being negligible and therefore acceptable level 1 minimal impacts under the AIP.

During operation, the applied load from the higher water storage on the alluvial, porous and fractured rock groundwater sources has the potential to enhance recharge and cause the water

pressure (or groundwater level) to rise, altering the local groundwater flow regime (hydraulic gradient and flow path) near the inundation area and dam embankment.

Clarrie Hall Dam operation

The higher reservoir levels could locally raise groundwater levels in those groundwater systems adjacent to the dam wall and the reservoir. Public Works Advisory (2018) hypothesised that the original dam construction raised the water table around the dam wall in a very localised area. Furthermore, Public Works Advisory (2018) reported that groundwater levels are interpreted to normalise quickly with distance downstream.

Potential rises in groundwater levels are not expected to migrate beyond the FSL inundation area, as the potentially highly transmissive alluvium is very localised and minor in extent, and the fractured and porous rock units have relatively low permeability. In a fractured rock mass, the upper weathered portion typically has a lower permeability due to infilling of rock mass defects with clay (Public Works Advisory 2018).

The Clarence-Moreton Basin and New England Fold Belt groundwater systems are not highly connected to Doon Doon Creek and the Tweed River in the area immediate downstream of the dam wall. The Surface Water Assessment notes the changes in surface water flows downstream of the dam would be negligible. This means potential changes to downstream groundwater levels are not expected.

Surface water – groundwater interaction

The raising of surface water levels immediately upstream of the dam wall may result in less groundwater baseflow contributions to surface water, and more surface water loss to the groundwater system as the hydraulic gradient is altered between surface water and groundwater.

Further upstream, where the valley is broader and there is localised alluvium, the surface water and groundwater interaction is likely to remain unchanged, where surface water is losing to shallow groundwater during periods of high flow and gaining when surface water flows recede and groundwater discharges from the adjacent alluvium.

Third party landholder bores

There are no third-party landholder bores within the new FSL inundation area and construction areas. The 2 closest bores to the new FSL inundation area (GW065390 and GW065508) are both deemed to be abandoned.

Potential rises in groundwater levels are not expected to migrate beyond the FSL inundation area. Therefore, there are no expected groundwater impacts to third-party landholder bores.

Potential groundwater-dependent ecosystems

There are no high priority WSP listed GDEs in the study area, although there are some mapped areas of BoM high potential terrestrial GDEs. Field verification (Appendix G1) of potential GDEs found that these vegetation types are not unique in the context of the development site, with no indication of groundwater utilisation in these areas.

6.1.4 Mitigation measures

The mitigation actions provided in Table 6-29 address the management of direct and indirect impacts to hydrology due to construction and operation of the Proposal.

Table 6-29 Hydrology mitigation measures

Reference	Impact	Mitigation measures	Responsibility	Timeframe
HYD1	Water quality	A detailed Soil and Water Management Plan (SWMP) would be prepared and implemented as part of the CEMP. The SWMP would: • assess and detail the requirements to comply with relevant policies guidelines, legislation and other approvals • be developed in accordance with the principles and requirements in *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom 2004) and other relevant volumes • contain Erosion and Sediment Control Plans (ESCPs) for all work sites. ESCPs would be implemented in advance of site disturbance and would be updated as required as the work progresses and the sites change • contain management procedures for activities, which may result in water pollution, or minimise the risk of erosion and sedimentation • outline management requirements of excess materials including stockpiling and disposal options and requirements for unsuitable construction materials • detail the review and inspection processes for onsite measures to mitigate erosion and sedimentation and water quality risks • detail the responsibilities for the management and implementation of the SWMP. An overarching ESCP and Progressive Erosion and Sediment Control Plan would be developed for all disturbed areas. The design of treatment measures would take into account local design rainfall rates and local soil erosion hazard (see Land, Soils and Erosion Assessment). The SWMP would be site-specific and include the measures below, and any other measures required to prevent erosion, sediment loss and water quality impacts.	Contractor	Pre-construction, construction
HYD2	Water quality	A SWMP incorporating ESCPs would contain, at a minimum: • drawings of the site layout • a narrative of how erosion control and soil and water management would be achieved onsite • description of treatment measures • description of treatment maintenance measures • a schedule, and a description of how the plan would work through the various stages of construction • design calculations for the treatment measures, including hydrologic estimations of runoff volumes and rates, and swale and sedimentation basin capacities.	Contractor	Pre-construction, construction

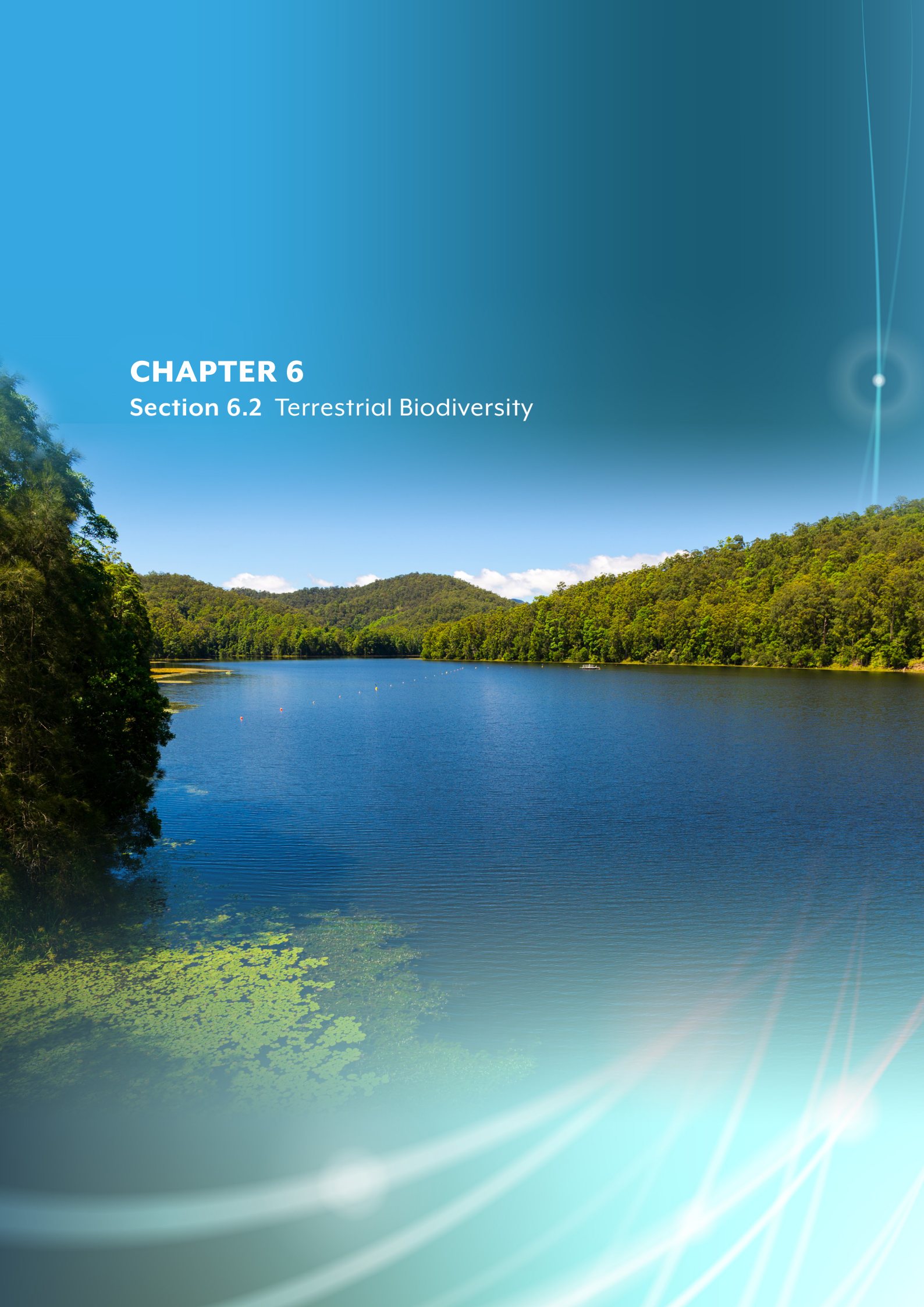
Reference	Impact	Mitigation measures	Responsibility	Timeframe
HYD3	Water quality	Install erosion and sediment controls prior to the commencement of works in accordance with the technical document by Landcom (2004), *Managing Urban Stormwater, Soils and Construction* (the Blue Book; and where applicable, the DPE Water Controlled Activity Guidelines, to: • divert surface runoff away from disturbed soil and stockpiles • retard flow velocities • retain sediment generated from construction activities, within the construction sites. • prevent pollution of waters, catchment areas upstream and downstream of the works areas, and other waterways and drainage systems • establish works sites away from waterways and riparian zones and in line with DPE Water's Controlled activities – Guidelines for riparian corridors on waterfront land.	Contractor	Pre-construction, construction
HYD4	Water quality Chemical storage and spills	A site-specific spill management plan would be prepared and include the following requirements: • Emergency spill sites should be kept at the site (vehicle kits). • Refuelling of machinery should be undertaken in a dedicated area, with the construction compound appropriately protected as outlined in the spill management plan. • Any chemicals and fuels should be stored in a bunded area at least 50 m from any waterway of drainage line. • Any hazardous materials on site to be stored in the compounds and within impervious and bunded enclosures capable of storing 120% of the volume of material stored there • Workers would be trained in the spill management plan and the use of spill kits.	Contractor	Pre-construction, construction
HYD5	Water quality	A site plan identifying where sediment and erosion controls are installed and the type of controls to be used would be prepared and implemented and be available onsite.	Contractor	Pre-construction, construction
HYD6	Water quality	The construction compound downstream of the dam wall is proposed to be constructed using material sourced onsite as per the concept presented in Appendix G1 Annexure E. Some fill may need to be imported for engineering reasons. This crossing would need to be designed to facilitate the underflow of the operational releases from Clarrie Hall Dam to supplement Tweed River Flows for extraction at Bray Park Weir. To convey water across this construction pad, temporary waterway crossings would be designed and implemented in accordance with *Controlled activities – Guidelines for instream works on waterfront land* (DPE 2022f): • 'Outlet flow culverts' would convey intentional releases from the MLO via the valve house to Doon Doon Creek downstream from the construction pad.	Contractor	Detailed design, pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
		• 'Spillway culverts' would convey minor spillway discharges in the order of the 1 EY (exceedances per year) flow event from the toe of the spillway to a point in Doon Doon Creek downstream from the proposed construction pad.		
HYD7	Water quality	During the detailed design phase, the shear stress generated by the flow of water over the construction compound downstream of the dam wall would be determined via hydraulic modelling. Rock diameters would be specified such that the probability of mobilisation of the material is low. The pad design and rock selection would consider design storms up to a certain threshold (e.g. the 5% AEP or 1 in 20 years storm).	Contractor	Detailed design
HYD8	Water quality	Construction access to the downstream face of the dam and the spillway would be created via importation of fill to the site as per Appendix G1 Figure E.3, as follows: • Install temporary culverts from the valve house to a location in Doon Doon Creek, approximately 100 m north of the valve house. • Install temporary culverts downstream from the existing spillway to a location approximately 100 m north of the valve house. • Fill the existing creek bed to create construction access across both sets of culverts.	Contractor	Detailed design, pre-construction, construction
HYD9	Water quality	Temporary culverts from the spillway should be designed during detailed design to prevent mobilisation of fill material (erosion) and transportation downstream during flow events, as follows: • Hydraulic modelling of the proposed design surface and flows should determine likely shear stress. • Rock of a suitable diameter should be selected such that mobilisation is a low likelihood.	Contractor	Detailed design
HYD10	Water quality	Following completion of construction works, the construction pad would be partially removed, to remove the ongoing risk of erosion and mobilisation of materials.	Contractor	Construction
HYD11	Concrete batching plant runoff and wastewater	The following water management measures for the batching plant would be developed before construction starts, and they would be documented as part of the SWMP: • Maintaining separation of 'clean' rainfall from surfaces, which have contact with cement and concrete, and directing 'clean' rainfall runoff to the construction compound stormwater treatment train. This may be achieved through measures such as providing roofing over mixing, unloading and dusty areas and directing the runoff from the roof areas away from the batching plant. • Sealing the batching plant surface with hardstand or paving so that local rainfall runoff within the plant site may be directed effectively to drains and sumps, and to prevent mud and pooling. • Installation of a first flush system for hardstand areas, which may receive dust drift or minor quantities spilt material. The first flush system would typically capture the first 20 mm of rainfall	Contractor	Pre-construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
		runoff and direct it to a holding area. Subsequent rainfall runoff would then be deemed clean and could be incorporated into the construction. compound stormwater management system • Bunding chemical and liquid storage areas. • Installing a vehicle washdown facility for vehicles moving in and out of the batching area. • Installing a wastewater collection and recycling system to collect contaminated water from: – agitator washout – truck washing – yard washdown – contaminated stormwater – concrete batching area – slump stand – any other wastewater from the batching plant operation. • Directing process wastewater and contaminated stormwater to a settling pond, or series of ponds, such that the water can be reused in the concrete batching process. These ponds would be contained within the batching plant area and would not discharge to the laydown yard stormwater management system. The settling pond or series of ponds should be lined with an impervious liner capable of containing all contaminants found within the water they are designed to collect. • Monitoring pond and sump water quantity and quality.		
HYD12	Water quality	Erosion and sediment control measures would be maintained and kept in place until works are complete and/or the area is stabilised.	Contractor	Pre-construction, construction
HYD13	Water quality	Adequate procedures should be detailed in the SWMP, including notification requirements to Council and the EPA, for incidents that cause material harm to the environment.	Contractor	Pre-construction, construction
HYD14	Water quality	For works undertaken within waterways, erosion and sediment control measures would be established, such as a continuous in-storage curtain.	Contractor	Pre-construction, construction
HYD15	Water quality	Daily and post-rainfall visual inspections of sediment and erosion controls would be conducted.	Contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
HYD16	Water quality	Sediment and erosion controls would be inspected before rain is expected and after rainfall, to assess the condition including whether sediment controls are well formed, clear of obstructions and drain freely.	Contractor	Pre-construction, construction
HYD17	Water quality monitoring	The SWMP would include water quality monitoring requirements and outline a trigger action response plan to minimise downstream water quality and aquatic ecology impacts (e.g. turbidity, dissolved oxygen, salinity, metals). The water quality monitoring plan should be prepared and implemented as per the surface water monitoring plan detailed in Appendix G1 section 7.	Contractor	Pre-construction, construction
HYD18	Water quality	Local weather forecasts (for high rainfall, lightning events, high wind periods and fire risk) would be monitored and work scheduled according to predicted weather conditions.	Contractor	Pre-construction, construction
HYD19	Flooding	In the event of flooding, construction works in affected areas would cease during flood events and would not commence until floodwaters have receded. Weather forecasts would be checked regularly so that equipment and materials in flood areas could be secured prior to heavy rainfall events.	Contractor	Pre-construction, construction
HYD20	Water quality	The ESCP for the dam wall construction compound should cater for events up to the 1% AEP.	Contractor	Pre-construction, construction
HYD21	Surface water and groundwater quality	The following would be located outside 1% AEP flood zone: • concrete batching plant • storage of dangerous goods including explosives • construction laydown areas • workers' accommodation.	Contractor	Pre-construction, construction
HYD22	Surface water quality	To prevent fill mobilisation from spillway and dam wall access pad to Doon Doon Creek: • Install culverts with capacity to pass minor flows. • Utilise larger diameter rock which would be resistant to mobilisation.	Contractor	Pre-construction, construction
HYD23	Surface water and groundwater quality	For construction of McCabes Bridge, the SWMP would include measures for pile bore effluent management. Pile construction work would be undertaken when no rain is forecast.	Contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
HYD24	Water use	Water volumes required during construction should be identified during detailed design. Arrangements should be made with Council for supply from Clarrie Hall Dam.	Contractor	Pre-construction, construction
HYD25	Flow regime during construction	Construction of the new spillway should be completed before closing the existing spillway.	Contractor	Pre-construction, construction
HYD26	Construction wash water	Construction wash water would be recycled using a series of tanks and clarifiers, or similar.	Contractor	Pre-construction, construction
HYD27	Road works	Where road widening or realignment would result in new or extended culverts or other drainage features, rock energy dissipation or riprap armouring would be applied downstream in accordance with AustRoads (2013) drainage design guidelines to prevent runoff causing erosion.	Contractor	Pre-construction, construction
HYD28	Water quality in the raised FSL	Where possible, vegetation within the new full supply inundation area would be cut to stump height and left in situ. The requirements and locations for any erosion protection works and vegetation clearing within the FSL would be determined during detailed design and be based on risks identified in this EIS. Some trees would not be removed due to landslip hazards, erosion hazard, BDAR advice, or other risks.	Contractor	Construction
HYD29	Surface water and groundwater quality	Handling and storage of fuel and oil within the site would be in accordance with Australian Standards, AS1940-2004 – *Storage and Handling of Flammable and Combustible Liquids* and NSW Work Cover 2005 Code of Practice for Storage and Handling of Dangerous Goods to reduce the risk of any spills or environmental release. Above-ground fuel storage in a bunded facility would be implemented as required, and refuelling would occur over a hard stand area.	Contractor	Construction
HYD30	Surface water and groundwater quality	Safety Data Sheets (SDS) would be kept in the site safety system for all chemicals used on site. The SDSs would contain information on the environmental impacts of the use of certain chemicals and include detail on emergency response, cleanup and disposal. Handling and storage of all chemicals within the Proposal site would be in accordance with the *Dangerous Goods Act 1975* (NSW), and Australian standards, including AS 1940-2004 – *Storage and Handling of Flammable and Combustible Liquids.*	Contractor	Construction
HYD31	Surface water and groundwater quality	The detailed design phase of works would ascertain the depth to the water table in areas proposed to be quarried, or would commit to lateral expansion and the maintenance of the new quarry base at or above the current quarry base, to prevent intersection of the water table.	Contractor	Detailed design
HYD32	Groundwater interception at the quarry	To avoid the interception of the water table in the fractured rock, it is recommended that quarry expansion occurs laterally, with the current depth of the quarry base maintained if possible.	Contractor	Construction



CHAPTER 6

Section 6.2 Terrestrial Biodiversity

6.2 TERRESTRIAL BIODIVERSITY

This section provides a summary of potential impacts to terrestrial biodiversity during construction and operation of the Proposal, as detailed in the Biodiversity Development Assessment Report (BDAR) provided in Appendix H.

A summary of the relevant SEARs and where they are addressed is included in Table 6-30. The BDAR also addressed the advice issued by the Biodiversity Conservation Directorate (BCD) when it was consulted regarding the issuing of the SEARs.

Table 6-30 Relevant SEARs – terrestrial biodiversity

Relevant key issue requirement/s	Where addressed
1. Biodiversity impacts related to the proposal are to be assessed in accordance with section 7.9 of the Biodiversity Conservation Act 2016, the Biodiversity Assessment Method 2020 (BAM) and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method, unless OEH and the Department determine that the proposed development is not likely to have any significant impacts on biodiversity values.	Section 6.2; Appendix H
2. The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method.	Section 6.2.3; Appendix H, section 7
3. The BDAR must include details of the measures proposed to address the offset obligation as follows: (a) the total number and classes of biodiversity credits required to be retired for the proposal (b) the number and classes of like-for-like biodiversity credits proposed to be retired (c) the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules (d) any proposal to fund a biodiversity conservation action (e) any proposal to make a payment to the Biodiversity Conservation Fund. If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.	Section 6.2.3; Appendix H, section 8
4. The BDAR must be submitted with all spatial data associated with the survey and assessment as per Appendix 10 of the BAM.	All spatial data would be submitted to the Department of Planning, Housing and Infrastructure via the Biodiversity Offsets and Agreement Management System upon submission of the BDAR
5. The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the *Biodiversity Assessment Method Order 2017* under s6.10 of the Biodiversity Conservation Act 2016.	Details of the accredited assessor are provided at the beginning of the BDAR (Appendix H)

Relevant key issue requirement/s	Where addressed
6. The EIS should map habitat (actual and predicted) for the Giant Barred Frog (*Mixophyes iteratus*) and calculate the area of this habitat to be directly or indirectly impacted. Other threatened frogs known, or with potential to occur, or with potential to be indirectly impacted, should also be discussed and assessed in terms of the spatial extent of actual or potential habitat in the locality and whether these areas will be indirectly impacted. Species that should also be considered for inclusion in this list are Hip-pocket Frog (*Assa darlingtonia*), Loveridge's Frog (*Philoria loveridgei*) and Fleay's Barred Frog (*Mixophyes fleayi*).	Section 6.2.3; Appendix H: section 5.4.6, section 7.2.2 section 9.1.2
7. An assessment of the numbers of Red Lilly Pilly (*Syzygium hodgkinsoniae*) likely to be directly or indirectly impacted by the proposal should also be included in the EIS. The spatial extent of this habitat should be provided as a map and a calculated area.	Section 6.2.3; Appendix H: Figure 4.1, section 9.1.2
8. The Lowland Rainforest Threatened Ecological Community should be clearly mapped and the extent of likely direct and indirect impacts from the proposal should be assessed.	Section 6.2.3; Appendix H: Figure 4.1, section 9.1.2 –

6.2.1 Methodology

The terrestrial biodiversity assessment was undertaken in accordance with the requirements of the following guidelines and legislation:

- *Biodiversity Conservation Act 2016* (NSW)
- *Environment Protection and Biodiversity Conservation Act 1999* (Cth)
- *Biosecurity Act 2015* (NSW)
- Biodiversity Assessment Method (BAM) (DPIE 2020a)
- Biodiversity Offset Scheme.

The assessment includes:

- a desktop review of previous assessments and information
- field surveys
- consultation with government agencies
- assessment of impacts and mitigation.

Desktop review

The desktop review primarily consisted of reviewing and summarising previous technical and Proposal-related reports, as provided in Appendix H. This has been supplemented with new data and information sourced from database searches as well as conducting additional field surveys.

Information about flora and fauna species, populations, communities and habitats from the locality (within 10 km of the Proposal) was obtained from the following databases:

- NSW BioNet (DCCEEW 2024b) for:
  - BioNet Atlas of NSW Wildlife for threatened species records
  - threatened species profiles
  - threatened biodiversity data collection
  - vegetation classification database for information on plant community types (PCTs)

- Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool (PMST) for matters of national environmental significance (MNES) (DCCEEW 2023b) likely to occur within the study area
- Commonwealth DCCEEW Species Profile and Threats Database (DCCEEW 2022a)
- national flying-fox monitoring viewer (DCCEEW 2022b)
- New South Wales Flora Online (PlantNET) (Royal Botanic Gardens and Domain Trust n.d.)
- Fisheries Spatial Data Portal (DPI n.d. (a)) for:
  - key fish habitat (KFH) mapping
  - threatened species distributions
- NSW Weedwise (DPI n.d. (b)).

Mapping undertaken during the field assessment was conducted using a hand-held GPS unit, mobile tablet computers running Collector for ArcGIS™ and Survey123 for ArcGIS™, and aerial photo interpretation.

Field surveys

Survey history

Tweed Shire Council has been working to assess the impacts of the Proposal for 8 years. Over this period, the Proposal area and adjacent lands have undergone significant survey effort, with biodiversity field studies for the Proposal commencing in 2016 and continuing until 2024.

Numerous technical reports have been prepared by various organisations. A list of these documents which were used throughout the preparation of the BDAR, is provided in Appendix H (section 1.9.2).

The survey data obtained from the various surveys over the years has been collated by Council and supplemented with further survey work completed in 2023 and 2024 by EMM Consulting. The survey effort has therefore been described cumulatively.

In accordance with the BAM Operation Manual – Stage 1 (OEH 2018), survey data collected more than 5 years prior to EIS submission can be used to inform the biodiversity assessment. However, it cannot be applied to the assessment in place of more recent targeted survey data.

Due to the long survey history, some of the fauna survey effort was conducted more than 5 years before the time of EIS submission (September 2024). Approval has been granted by the North East Branch of the Biodiversity and Conservation Division (BCD) to utilise all fauna survey data collected for the BDAR, which is to be submitted before 30 September 2024. This approval was granted as the vegetation in the Proposal area has remained relatively unchanged since the commencement of ecological surveys and continues to provide comparable habitat values for native fauna. Where environmental conditions had changed, such as occurred in a portion of vegetation in the north-west of the Proposal area that was subject to a low-intensity bushfire in 2019, additional surveys were conducted.

Vegetation

Vegetation surveys were conducted across the Proposal area on the dates shown in Table 6-31.

Table 6-31 Vegetation surveys completed

Surveys completed	Dates
Vegetation mapping, rapid vegetation assessments	31 October to 3 November 2016
	8 to 11 November 2016
	14 and 16 to 18 November 2016
	29 November to 2 December 2016
	7 to 8 June 2017
BAM plots, rapid vegetation assessments	16 to 18 January 2020
	13 to 17 April 2020
	8 to 12 June 2020
BAM plots	24 May 2021
Vegetation mapping and verification	17 to 22 September 2023
BAM plots	15 to 19 January 2024
	25 January 2024
	15 February 2024

As shown in Table 6-31, vegetation mapping and PCT alignment were undertaken across the Proposal area between 2016 and 2024. The Proposal area was traversed on foot and by vehicle, with vegetation mapped and aligned with NSW PCTs. Where there was some uncertainty about correct PCT alignment, or to justify PCT alignment, a series of rapid vegetation assessments (RVAs) were undertaken, and the 3 dominant species in the overstorey, midstorey and groundcover were recorded.

PCTs were stratified into vegetation zones based on broad condition state using the definitions shown in Table 4.2 of Appendix H.

Following the stratification of vegetation zones within the Proposal area, native vegetation integrity was assessed using data obtained via a series of plots, as per the methodology outlined in sections 4.2.1, 4.3.3 and 4.3.4 of the BAM (DPIE 2020a). Plot data was collected between 2020 and 2024. At each plot location the following was undertaken:

- one 20 x 20 m plot for assessment of composition and structure
- one 20 x 50 m plots for assessment of function, including a series of five 1 x 1 m plots to assess average leaf litter cover.

Several plots were excluded from the assessment owing to adjustments in vegetation mapping throughout the life of the Proposal and being superseded with more recent plots in the case of those areas affected by the 2019 bushfire.

Surveys for flora and vegetation communities conducted by EMM were completed under the authority of Scientific License (SL100409). A list of flora species was compiled for each plot and PCT. Records of all flora species would be submitted to BCD for incorporation into the Atlas of NSW Wildlife.

Revised PCTs for Eastern NSW were introduced to the Biodiversity Offset Scheme (BOS) and BAM (DPIE 2020a) in 2023. The revised PCTs were publicly released on 24 June 2022 and were made available to the BAM Calculator (BAM-C) on 14 April 2023. For assessments that had commenced a BAM-C case prior to the introduction of revised PCTs, transitional arrangements were made available. The transitional arrangements allowed assessments the option to opt in to use the

revised PCTs or continue to use the legacy PCT data. In order to meet the requirements of the transitional arrangements, BAM-C assessments must be finalised before 14 April 2025.

As the BAM-C case associated with the Proposal was initiated prior to the introduction of the revised Eastern NSW PCTs, the transitional arrangements are applicable. The legacy PCTs have been selected within the BAM-C case for the Proposal owing to the substantial amount of work progressed prior to June 2022.

Detailed vegetation survey methods and effort are provided in Appendix H (section 4.3).

Threatened species

The presence of threatened species was assessed according to Section 5.2 of the BAM (DPIE 2020a) as shown in Table 6-32.

Table 6-32 Summary of methodology for assessment of threatened species

Step	Summary of methodology and reference to further details in Appendix H
Step 1: Identify the threatened species considered for assessment	This step includes predicted species assessed for ecosystem credits and candidate species assessed for species credits. This step was completed based on a review of the following data sources: • species predicted by the BAM-C (these are species that are associated with the PCTs recorded; the species distribution is within the IBRA subregion of the Proposal area; the Proposal area is within any specific geographic limitations for a species; and the Proposal area meets the species' requirements for vegetation class and patch size) • threatened species that have been previously recorded in the locality • species predicted to occur by the EPBC Act PMST (DCCEEW 2023b).
Step 2: Assess habitat constraints listed for each species in the BioNet Atlas Threatened Biodiversity Data Collection (DCCEEW, 2024a) (TBDC) based on field assessment of habitat constraints present and eliminate species that are vagrant in the IBRA subregion	This step results in a list of confirmed predicted species to be assessed for ecosystem credits (see Appendix H, section 5.3, Table 5.1) and a list of confirmed candidate species credit species (see Appendix H, section 5.4, Table 5.2).
Step 3: Further assess habitat for candidate species credit species	This step was conducted following a field assessment of the habitat present in the Proposal area. The likelihood of each threatened species occurring in the Proposal area was assessed, based on the quality of habitat and the presence of microhabitats required by each species. Species without suitable habitat do not require further assessment. See Appendix H, section 5.4.2 for more details.
Step 4: Determine the presence of candidate species through targeted surveys, assumption of presence, or expert reports	The step involved planning the survey methodology as provided in Appendix H, section 5.4.3, and the survey results in Appendix H, section 5.4.4.
Step 5: Define a species polygon for threatened species present in the Proposal area	This step is discussed in Appendix H, section 5.4.6.

Step	Summary of methodology and reference to further details in Appendix H
Step 6: Determine the habitat condition within the species polygon (for species assessed by area) or the count of individuals (for species assessed by count)	This step is discussed in Appendix H, section 5.4.6.

Substantial survey effort has been undertaken across the Proposal area to date, with targeted flora and fauna surveys occurring between 2016 and 2024.

Targeted flora surveys

Threatened flora surveys were conducted between November 2016 and February 2024. A summary of the survey effort and approach is provided in Table 6-33, with details provided in Appendix H (section 5.4.3). Surveys were developed with consideration of NSW guidelines, including the NSW guide to surveying threatened plants (OEH 2016a) and the NSW survey guide for the Biodiversity Assessment Method titled Surveying threatened plants and their habitats (DPIE, 2020).

Table 6-33 Targeted flora survey effort summary

Technique	Targeted areas	Effort	Timing
Transects	Rainforest and wet sclerophyll forest in gullies (16 locations)	7 days (2 ecologists)	6–7 November 2016 13–16 November 2016 22 December 2016
Adapted large area method (first phase)	Entire Proposal area	9 days (4 ecologists)	26 October – 3 November 2020
Parallel transects	Entire Proposal area (except from discrete rainforest gullies as outlined in the first row of this table)	4.5 days (4 ecologists)	13–17 November 2023
		4.5 days (4 ecologists)	27 November – 1 December 2023
		4 days (4 ecologists) 0.5 days (3 ecologists)	11–15 December 2023
		4.5 days (2 ecologists)	22–26 January 2024
		3 days (4 ecologists) 1.5 days (3 ecologists)	12–16 February 2024
Combined effort		129 person days	

Flora survey sites are shown in Figure 6-37.

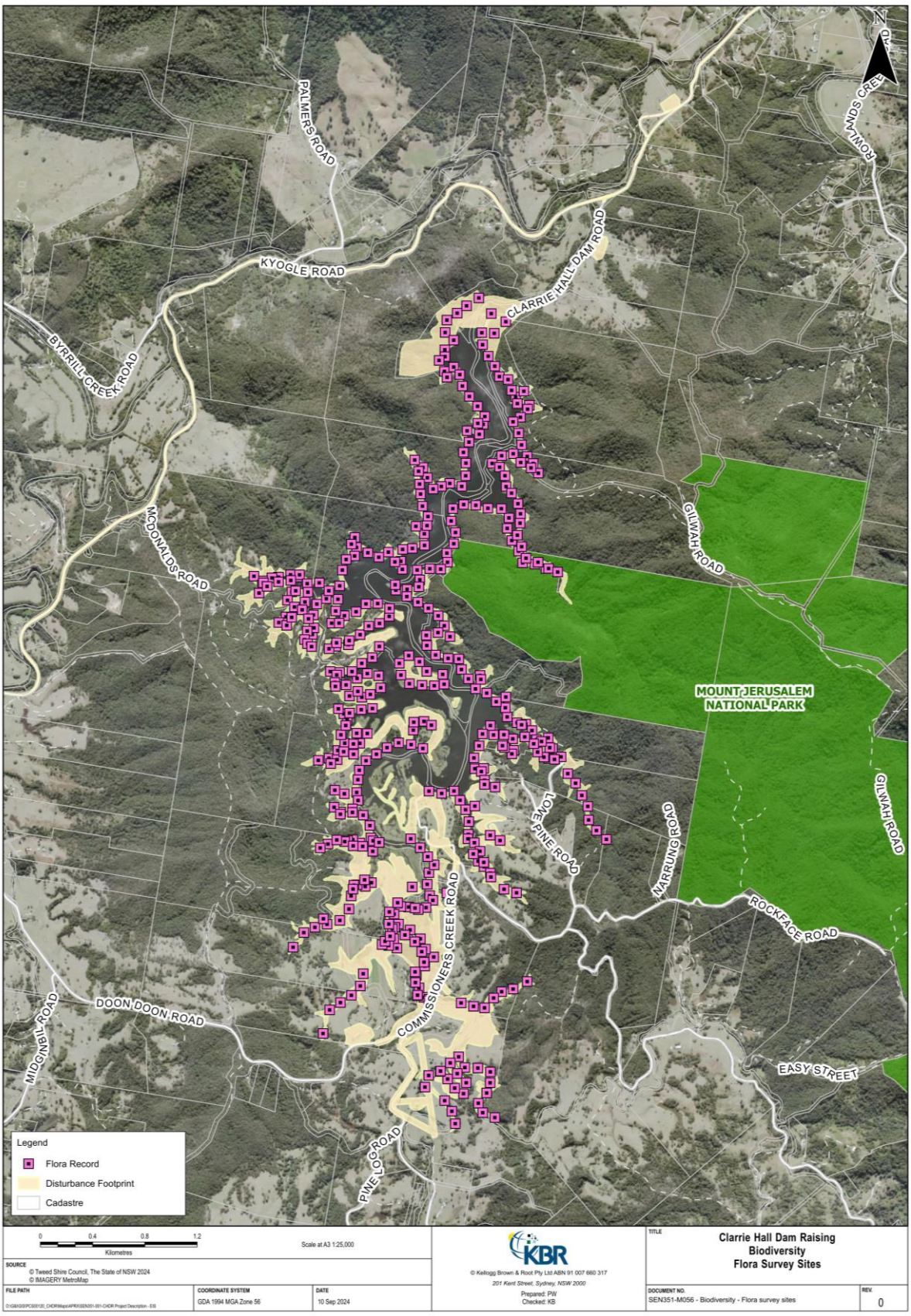


Figure 6-37 Flora survey sites

Targeted fauna surveys

Targeted fauna surveys were undertaken between 2016 and 2024 in accordance with various NSW and Commonwealth guidelines and are described in detail in Appendix H (Section 5.4.3).

Survey methods and effort were broadly developed based on vegetation stratification within the Proposal area (see Appendix H, Table 5.7).

A total of 32 fauna survey sites were established, as shown in Figure 6-38.

Threatened fauna surveys were undertaken by Tweed Shire Council between 21 November 2016 and 18 January 2017 aiming to detect a wide range of taxa as detailed in the flora and fauna survey and preliminary impact assessment for the proposed raising of Clarrie Hall Dam (TSC 2017d). The survey locations were divided into core and ancillary sites and used a range of techniques, shown in Table 6-34.

Table 6-34 Fauna survey techniques used at each survey site

Method	Effort	Ancillary	Core
Diurnal bird survey (100 m x 200 m), 20 minutes; repeated 3 times.	60 person minutes	✓	✓
Koala scat searches (100 m x 200 m)	30 trees	✓	✓
Camera trap (terrestrial) with universal and carnivore baits	16 nights	✓	✓
Reptile and amphibian searches 200 m x 100 m area 30 minutes; repeated 3 times 2 observers at core sites 1 observer at ancillary sites	180 minutes core 90 minutes ancillary	✓	✓
One Havahart® 80 cm cage trap (universal bait)	4 nights		✓
10 Elliot A traps – terrestrial (universal bait)	40 trap nights		✓
Five 20 L pitfall buckets with drift fence over four nights	20 trap nights		✓
Four funnel traps (associated with the drift fencing above)	16 nights		✓
Spotlighting, two people 200 m x 100 m area for 20 minutes; repeated 3 times	120 minutes		✓
Call playback prior to spotlighting	20 minutes		✓
Recording of tree hollows			✓

A summary of the number of survey sites within each of the vegetation stratification units is provided in Table 6-35.

Table 6-35 Survey sites per stratification unit

Stratification unit	Ancillary site	Core site	Total
North Coast wet sclerophyll forests (including moderate, burnt and high condition)	5	10	15
Subtropical rainforests (high condition)	1	2	3
Pasture	2	4	6
Subtotal			24
Disjunct from the Proposal area (>100 m) and excluded from the assessment	5	3	8
Total			32

Since 2017, Council has engaged various biodiversity specialists to conduct targeted surveys for a range of species.

EMM was engaged in 2023 to conduct a gap analysis and complete any residual survey effort required to satisfy the requirements of the BAM (DPIE 2020a). A summary of fauna species surveyed between 2016 and 2024 is provided in Table 6-36 with reference to where details on the survey methods is provided for the target taxa.

Consultation with government agencies

Throughout development of the survey methodology and BDAR preparation, consultation with the North East Branch of the BCD and the BOS Helpdesk was conducted. Key consultation items that were discussed and the outcomes are summarised in Chapter 5.

Assessment of impacts

The BAM 2020 establishes a transparent, consistent and scientifically based approach for assessing impacts to, or improvements in, biodiversity. It outlines how an accredited person (assessor) assesses impacts on biodiversity at development sites and stewardship sites.

The BAM 2020 is operationalised by the Biodiversity Assessment Method Calculator (BAM-C), which is an online interactive tool. Assessors (persons accredited to apply the BAM under the BC Act) must use the BAM-C for the purpose of carrying out an assessment using the BAM 2020.

The NSW Biodiversity Offsets Scheme (BOS) is the framework for offsetting unavoidable impacts on biodiversity from development with biodiversity gains achieved at biodiversity stewardship sites. The scheme is supported by the BAM 2020.

Additional assessment of impacts under the EPBC Act was completed, as summarised in section 6.2.3 and detailed in Appendix H (section 9).

Table 6-36 Fauna species surveyed

Fauna type	Species surveyed	Details of methods and survey effort in Appendix H (BDAR)
Diurnal birds	• Glossy black-cockatoo (Calyptorhynchus lathami lathami) • White-eared monarch (Carterornis leucotis) • Coxen's fig-parrot (*Cyclopsitta diophthalma coxeni*) • Red goshawk (*Erythrotriorchis radiatus*) • White-bellied sea-eagle (*Haliaeetus leucogaster*) • Little eagle (*Hieraaetus morphnoides*) • Square-tailed kite (*Lophoictinia isura*) • Albert's lyrebird (*Menura alberti*) • Black-breasted button-quail (*Turnix melanogaster*).	Section 5.4.3 (b)
Nocturnal birds	• Powerful owl (*Ninox strenua*) • Barking owl (*Ninox connivens*) • Masked owl (*Tyto novaehollandiae*) • Sooty owl (*Tyto tenebricosa*).	Section 5.4.3 (c)
Terrestrial mammals	• Rufous bettong (*Aepyprymnus rufescens*) • Parma wallaby (*Macropus parma*) • Common planigale (*Planigale maculata*) • Long-nosed Potoroo (*Potorous tridactylus*).	Section 5.4.3 (d)

Fauna type	Species surveyed	Details of methods and survey effort in Appendix H (BDAR)
Arboreal mammals	• Eastern pygmy-possum (*Cercartetus nanus*) • Southern greater glider (*Petauroides volans*) • Squirrel glider (*Petaurus norfolcensis*) • Koala (*Phascolarctos cinereus*).	Section 5.4.3 (e)
Bats	• Large-eared pied bat (Chalinolobus dwyeri) • Little bent-winged bat (Miniopterus australis) • Large bent-winged Bat (Miniopterus orianae oceanensis) • Eastern cave bat (*Vespadelus troughtonii*) • Southern myotis (*Myotis Macropus*) • Grey-headed flying-fox (*Pteropus poliocephalus*).	Section 5.4.3 (f)
Amphibians	• Pouched frog (*Assa darlingtonia*) • Fleay's frog (*Mixophyes fleayi*) • Giant barred frog (*Mixophyes iteratus*) • Loveridge frog (*Philoria loveridgei*).	Section 5.4.3 (g)
Reptiles	• White-crowned snake (*Cacophis harriettae*) • Three-toed snake-tooth skink (*Coeranoscincus reticulatus*) • Pale-headed snake (*Hoplocephalus bitorquatus*) • Stephens banded snake (*Hoplocephalus stephensii*).	Section 5.4.3 (h)
Invertebrates	• Mitchell's rainforest snail (*Thersites mitchellae*) • Southern pink underwing moth (*Phyllodes imperialis smithersi*).	Section 5.4.3 (i)

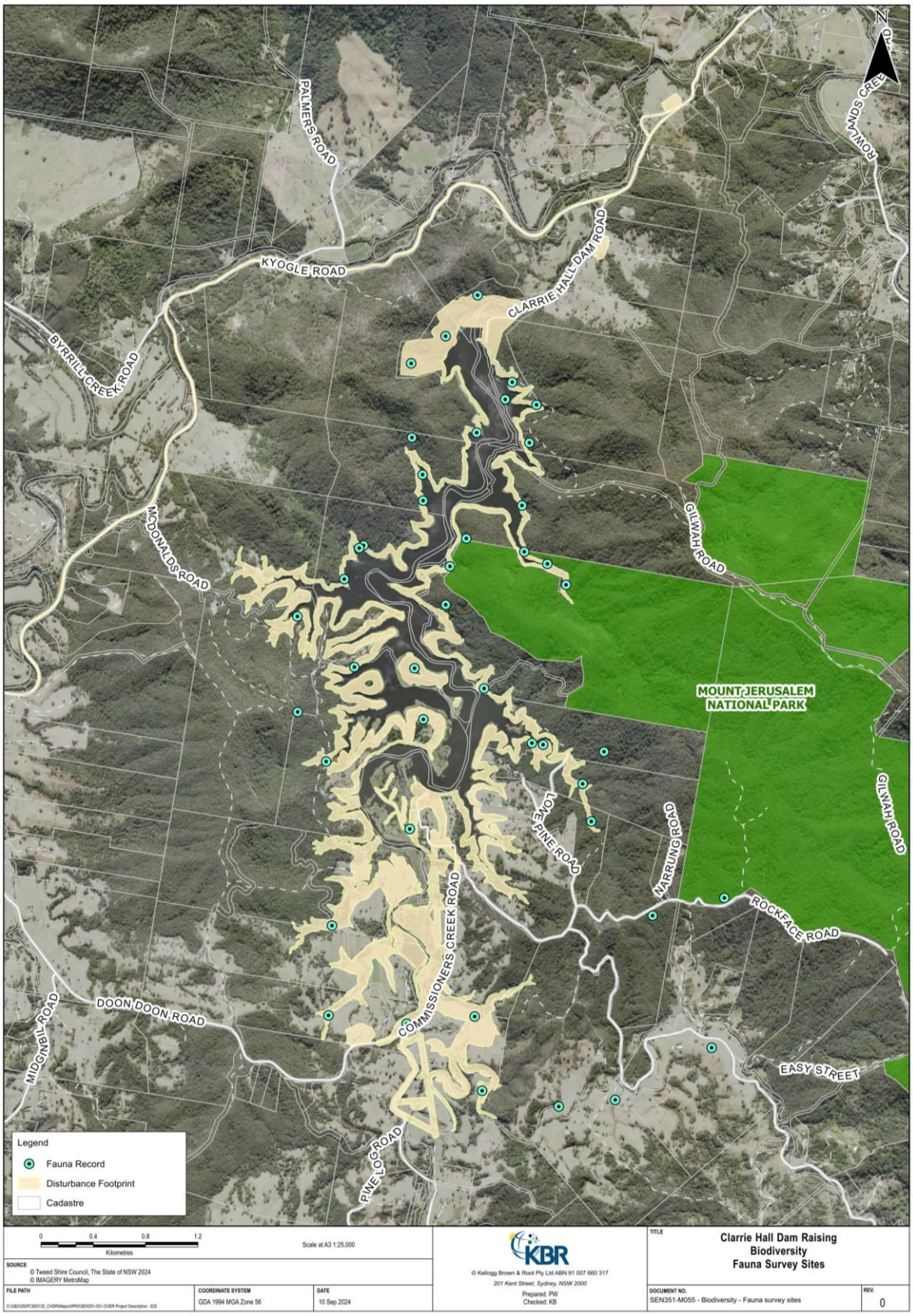


Figure 6-38 Fauna survey sites

6.2.2 Existing environment

Landscape

The Proposal area is located wholly within the Scenic Rim Interim Biogeographic Regionalisation of Australia (IBRA) subregion and the Mount Warning exhumed slopes NSW Landscape.

Rivers and streams within the Proposal area are discussed in detail in sections 6.1 and 6.3.

The Proposal area does not contain any Ramsar wetlands, or nationally important wetlands listed in the Directory of Important Wetlands (DCCEEW 2019).

The predominant vegetation within the Proposal area is wet sclerophyll forest with smaller patches of lowland rainforest. Historically, the vegetation surrounding the dam has been subject to vegetation clearance and forestry activities, with the more recent fires in 2019 subjecting the vegetation in the northwest extent of the dam to more recent fire-related disturbance. At the southern end of the dam, much of the vegetation is highly modified, with areas of maintained pasture, patches of regrowth forest as well as historical tree plantations.

The vegetation is in mostly moderate to good condition, with patches of cleared and modified vegetation. Owing to past and ongoing disturbance, exotic species are found throughout the Proposal area, inclusive of several high threat weed (HTW) species. Exotic and HTW species are particularly prevalent towards the southern end of the Proposal, where paddocks are maintained for recreational and agricultural purposes, and as such, are subject to continuing and frequent disturbance. Areas of the Proposal that adjoin current and historical private land holdings also exhibit a higher cover and composition of exotic and HTW species, likely as the result of plantings and garden escapees.

The area of revoked land from Mount Jerusalem National Park is undifferentiated from the surrounding vegetation, containing both wet sclerophyll forest and patches of lowland rainforest, consistent with the adjacent areas of the Proposal. The revoked land is currently vested in the Minister administering the *National Parks and Wildlife Act 1974*, pending transfer to Tweed Shire Council upon subdivision, land title registration and the transfer of compensatory land. At the time of publishing this EIS, the negotiations with National Parks and Wildlife Services are in progress.

There are no karst, caves, crevices, cliffs, or other areas of geological significance within the Proposal area.

Connectivity

The Proposal area is highly connected to surrounding vegetation, with the region consisting of large remnants of intact and mostly contiguous vegetation interspersed with existing roads, farmland and cleared pastures.

The northern, western and eastern banks of the dam are substantially vegetated with habitat connectivity to surrounding national parks. Mount Jerusalem National Park located to the east of the Proposal area extends south to Nightcap National Park, Goonengerry National Park and Whian Whian State Conservation Area. Vegetation along the western bank of the dam connects to the Wollumbin National Park and Mebbin National Park extending westward into the Border Ranges.

The southern portion of the Proposal area consists of mostly cleared pastures within Crams Farm maintained by Tweed Shire Council for recreational purposes and surrounding private landholdings utilised for agricultural practices. There is limited vegetation connectivity in these areas.

Regional fauna corridors occur within and adjacent to the Proposal area, extending in both the north-south and east-west directions. These fauna corridors connect the broader vegetation surrounding the dam, facilitating movement within and between areas of habitat (DECCW NSW 2010a).

No areas of outstanding biodiversity value (AOBVs) occur within the Proposal area.

Stotts Island Nature Reserve located approximately 33 km downstream of the Proposal, is declared by the NSW Minister for the Environment as critical habitat for the Mitchell's Rainforest Snail (*Thersites mitchellae*) on the register for AOBV (DCCEEW 2024c). Mitchell's Rainforest Snail is listed as endangered under the BC Act and as critically endangered under the EPBC Act and has been deemed as an entity at risk of serious and irreversible impacts (SAII).

Native vegetation

The extent of native vegetation was calculated by applying a 1,500 m buffer area in accordance with section 3.2 of the BAM (DPIE, 2020) as 3,339.1 ha, representing approximately 67.2% of the total assessment area.

The patch size was assumed to be larger than 100 ha for every vegetation zone as a conservative approach to threatened species assessment. This enabled the BAM Calculator (BAM-C) to filter in the maximum number of candidate species for consideration. Candidate threatened species are assessed in section 5.

Plant community types

PCTs were identified through analysis of data collected during vegetation mapping surveys and were verified using floristic data collected during plot surveys. Three PCTs were identified within the disturbance footprint. PCTs and other vegetation types are provided in Table 6-37 and shown in Figure 6-39.

Table 6-37 PCTs in the Proposal area

Plant community types	Vegetation formation	Vegetation class	Percentage cleared (NSW)	Direct impacts (ha)
PCT 827 – Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	Wet sclerophyll forests (shrubby sub-formation)	North Coast Wet sclerophyll forests	55	221.67
PCT 1073 – Pink Bloodwood – Tallowwood moist open forest of the far northern ranges of the NSW North Coast bioregion	Wet sclerophyll forests (shrubby sub-formation)	North Coast Wet sclerophyll forests	40	2.67
PCT 1302 – White Booyong – Fig subtropical rainforest of the NSW North Coast bioregion	Rainforest	Subtropical rainforest	75	8.77
Plantations	–	–	–	11.98
Planted native vegetation	–	–	–	1.02
Exotic trees	–	–	–	0.24
Cleared	–	–	–	5.69
Water	–	–	–	0.23
Total				252.27

PCT 1302 conforms to the final determinations for the lowland rainforest in the NSW North Coast and Sydney Basin bioregions endangered ecological community (EEC) listed under the BC Act and the lowland rainforest of subtropical Australia critically endangered ecological community (CEEC) listed under the EPBC Act.

Vegetation zones

Vegetation zones were delineated by the presence/absence of canopy and the condition of various strata, as detailed in Table 4.2 of Appendix H. Vegetation zones associated with each PCT are provided in Table 6-38, and descriptions of the PCTs are presented in Tables 4.4 to Table 4.7 of Appendix H.

Table 6-38 Vegetation zones within the disturbance footprint

PCT ID	Plant community types	Condition	Extent in direct impact area (ha)	Vegetation integrity score
827	Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	High	72.13	68.9
827	Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	Moderate	31.27	60.5
827	Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	Burnt	19.04	92.3
827	Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	Low	25.5	56.1
827	Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	Planted	5.08	84.3
827	Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	Pasture	64.06	6.2
827	Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	Derived sedgeland	4.58	1.1
PCT 1073	Pink Bloodwood – Tallowwood moist open forest of the far northern ranges of the NSW North Coast bioregion	High	2.67	79.5
PCT 1302	White Booyong – Fig subtropical rainforest of the NSW North Coast bioregion	High	5.78	63.7
PCT 1302	White Booyong – Fig subtropical rainforest of the NSW North Coast bioregion	Moderate	2.99	54.7

The vegetation zones identified and assessed in the BAM-C are summarised in Table 4.13 of Appendix H and mapped on Figure 6-39.

Planted native vegetation

Areas to the south of the dam contain historical plantations of Dunn's White Gum (E*ucalyptus dunni*) and Hoop Pine (*Araucaria cunninghamii*).

There are also areas of planted native vegetation mapped in the Crams Farm recreational area. Some of this planted vegetation includes threatened species that will require offsets.

Planted native vegetation and plantations described above do not conform to any PCTs and are most appropriately assessed in accordance with the streamlined assessment module for planted native vegetation (DPIE 2020a).

An assessment of the plantations against the decision-making key in Appendix D of the streamlined assessment module was conducted in the BDAR (Appendix H, Table 4.12).

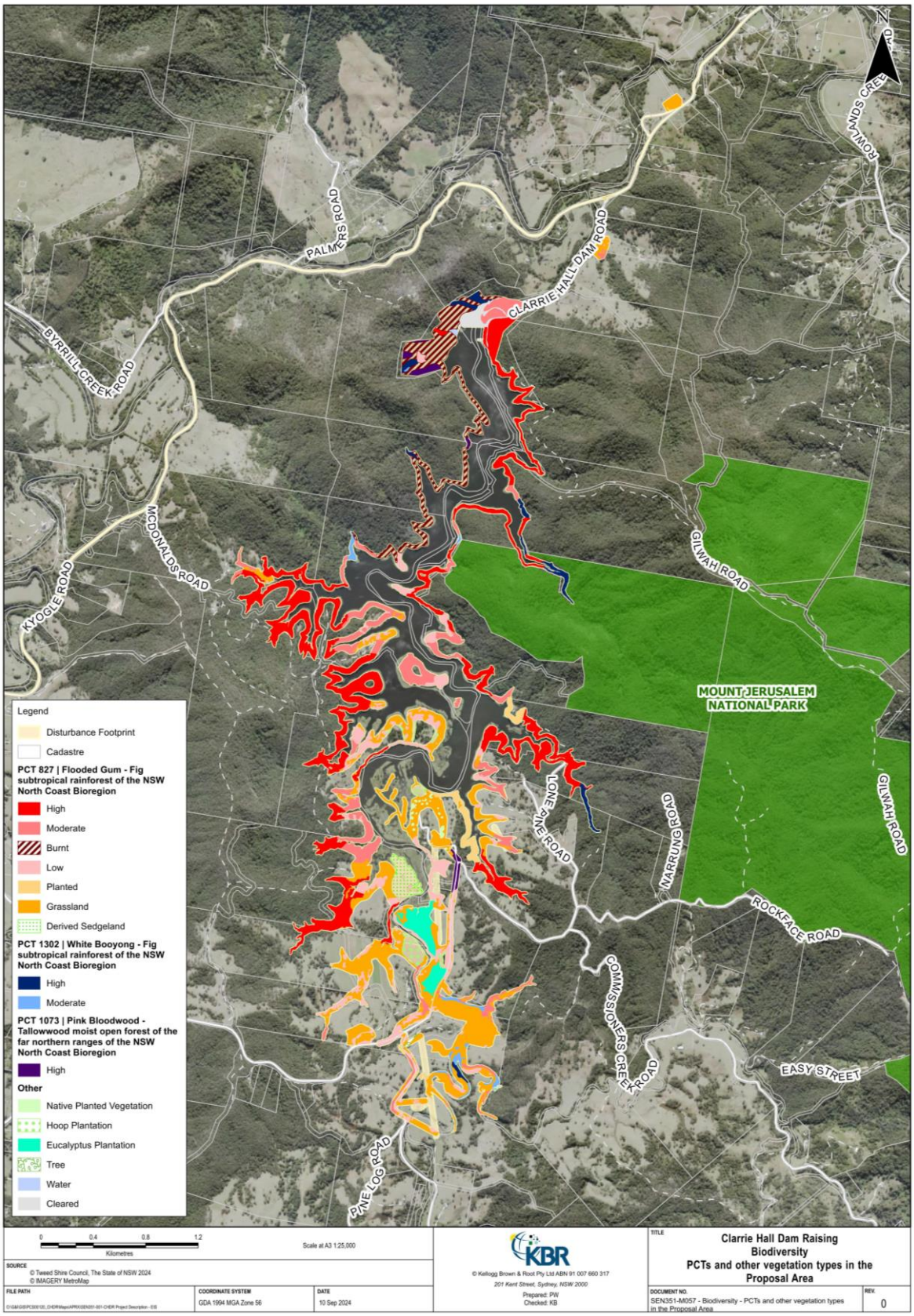


Figure 6-39 PCTs and other vegetation types in the Proposal area

Threatened species

Targeted surveys confirmed the presence of the following species credit species in the Proposal area (see Appendix H, section 5.4.4 for further details):

- Pouched Frog (*Assa darlingtoni*)
- White-eared Monarch (*Carterornis leucotis*)
- Corokia (Corokia whiteana)
- Thorny Pea (Desmodium acanthocladum)
- Basket Fern (Drynaria rigidula)
- Rusty Rose Walnut (*Endiandra hayesii*)
- Green-leaved Rose Walnut (Endiandra muelleri subsp. bracteata)
- Narrow leaf Finger Fern (*Grammitis stenophylla*)
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
- Red Boppel Nut (Hicksbeachia pinnatifolia)
- Fine-leaved Tuckeroo (*Lepiderema pulchella*)
- Rough-shelled Bush Nut (*Macadamia tetraphylla*)
- Slender Marsdenia (*Marsdenia longiloba*)
- Albert's Lyrebird (*Menura alberti*)
- Giant Barred Frog (*Mixophyes iteratus*)
- Southern Myotis (*Myotis macropus*)
- Koala (Phascolarctos cinereus)
- Loveridge's Frog (*Philoria loveridgei*)
- Scrub Turpentine (*Rhodamnia rubescens*)
- Native Guava (Rhodomyrtus psidioides)
- Red Lilly Pilly (Syzygium hodgkinsoniae)
- Durobby (Szygium moorei)
- Mitchell's Rainforest Snail (*Thersites mitchellae*)
- Masked Owl (Tyto novaehollandiae)
- Sooty Owl (Tyto tenebricosa).

The presence of the Southern Pink Underwing Moth (*Phyllodes imperialis smithersi*) was assumed at 2 locations within the Proposal area due to the presence of the larval food plant *Carronia multisepalea*.

Species recorded within the revoked portion of Mount Jerusalem National Park are included in the list above.

Species polygons

For species identified as present in Step 4 of Table 6-32, the following was undertaken:

- For plant species assessed by a count of individuals, as per the TBDC, targeted surveys were used to estimate the number of individuals and their location on the Proposal area, and a species polygon was established by adding a 30 m buffer around the individuals or groups of individuals on the Proposal area.
- For plant and animal species assessed by area of habitat, as per the TBDC, areas of vegetation zone(s) in which the species is predicted to occur based on habitat constraints and condition. Such areas are contiguous with recorded locations, were used to define the species polygon.
- In individual cases, the species polygon for areas of habitat was modified to represent areas in which microhabitats for the species are present and represent the most likely habitat for the species.
- For animal species assessed by breeding habitat, a buffer was applied in accordance with the specific guidelines as per the TBDC.

Species polygons were developed for the calculation of species credit requirements based on the results of targeted surveys and the habitat present within and adjacent to the Proposal area. Detailed descriptions of the species polygons are provided Appendix H, section 5.4.6.

Groundwater dependent ecosystems

The potential occurrence of groundwater dependant ecosystems (GDEs) within the Proposal area is discussed in section 6.1 and Appendix G. There are no 'high priority' GDEs listed in the Water Sharing Plan. The BoM GDE Atlas (BoM) indicates low potential of GDEs across the majority of the site, with 3 small patches of moderate potential GDE, mapped as wet Bangalow brushbox forest, and subtropical and warm temperate rainforest. Field verification, outlined in section 4.3.2 of Appendix H, found that these vegetation types do not differ substantially from other areas of the same vegetation types within the Proposal area, with no indication of groundwater utilisation in these areas. One vegetation type, wet heath – which is certainly a GDE – is mapped in the south of the development area; however, field survey found the area is dominated by wet sclerophyll forest, disturbed and partially cleared, and this vegetation is unlikely to be groundwater dependent.

6.2.3 Impact assessment

Impact avoidance and minimisation

Sections 2 and 3 of the EIS outline how avoidance and minimisation of impacts were considered during development of water security options for the Tweed Shire. This is also detailed in the BDAR (Appendix H, section 7.1).

Direct and indirect impacts

The direct impact of the Proposal on biodiversity values constitutes the loss of 246 ha of native vegetation – including 8.77 ha of a TEC and 13.00 ha of timber plantations and planted native vegetation – and the habitat values that this vegetation provides to some threatened species. Specifically, the Proposal would result in the loss of:

- 12 Corokia (*Corokia whiteana*) individuals, listed as endangered under the BC Act and EPBC Act
- 50 Rusty Rose Walnut (*Endiandra hayesii*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 457 Green-leaved Rose Walnut (*Endiandra muelleri subsp. bracteata*) individuals, listed as endangered under the BC Act

- 4 Red Boppel Nut (*Hicksbeachia pinnatifolia*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 15 Fine-leaved Tuckeroo (*Lepiderema pulchella*) individuals, listed as vulnerable under the BC Act
- 12 Rough-shelled Bush Nut (*Macadamia tetraphylla*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 709 Scrub Turpentine (*Rhodamnia rubescens*) individuals, listed as critically endangered under the BC and EPBC Act
- 105 Red Lilly Pilly (*Syzygium hodgkinsoniae*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 16 Durroby (*Szygium moorei*) individuals, listed as vulnerable under the BC Act and EPBC Act
- 2.21 ha of habitat for Thorny Pea (Desmodium acanthocladum), listed as vulnerable under the BC Act and EPBC Act
- 0.50 ha of habitat for Basket Fern (*Drynaria rigidula*), listed as endangered under the BC Act
- 1.03 ha of habitat for Narrow-leaf Finger Fern (*Grammitis stenophylla*), listed as endangered under the BC Act
- 78.96 ha of habitat for Slender Marsdenia (*Marsdenia longiloba*), listed as endangered under the BC Act and vulnerable under the EPBC Act
- 95.53 ha of habitat for Native Guava (*Rhodomyrtus psidioides*), listed as critically endangered under the BC and EPBC Act.

The Proposal would also lead to the loss and degradation of some threatened fauna species habitats, including hollow bearing trees, rocky areas and creeks.

For area-based species, the methods for calculation of habitat areas (that is, species polygons) are provided in section 5.4.6 of Appendix H.

Loss of native vegetation due to construction and operation

A total area of 246 ha of native vegetation and planted native vegetation would be directly impacted due to construction and operation of the Proposal.

Areas of each vegetation zone that would be directly impacted by the Proposal are shown in Table 6-39.

All vegetation zones of PCT 1302 totalling 8.77 ha represents the EPBC Act-listed lowland rainforest of subtropical Australia critically endangered ecological community (CEEC), and the BC Act-listed lowland rainforest in NSW North Coast and Sydney Basin bioregion EEC.

A substantial amount (68.64 ha) of the impacted vegetation constitutes pasture or sedgeland in low condition, where the vegetation integrity offset in these areas is below the condition thresholds that require offsets – as per section 9.2.1 of BAM (DPIE 2020a) – and so would not require ecosystem offsets. A further 13.00 ha of planted native vegetation would also not require offsets. The remaining native vegetation in the disturbance footprint would generate an ecosystem credit offset requirement as described in Appendix H (section 8.3). Impacts to habitat for species-credit species would also generate a species credit offset requirement, as described in Appendix H (section 8.3).

Table 6-39 areas of vegetation zones directly impacted

PCT ID	PCT name	Vegetation zones	Extent in Proposal area (ha)
827	Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast	827_High	72.13
		827_Mod	31.27
		827_Burnt	19.04
		827_Low	25.50
		827_Planted	5.08
		827_Pasture	64.06
		827_Derived_sedgeland	4.58
		Total area of PCT	**221.66**
1073	Pink Bloodwood – Tallowwood moist open forest of the far northern ranges of the NSW North Coast bioregion	1073_High	2.67
		Total area of PCT	**2.67**
1302	White Booyong – Fig subtropical rainforest of the NSW North Coast bioregion	1302_High	5.78
		1302_Mod	2.99
		Total area of PCT	**8.77**
N/A	Eucalyptus plantation	N/A	7.34
N/A	Hoop Pine plantation	N/A	4.64
N/A	Planted native vegetation	N/A	1.02
		Total area of planted native vegetation	**13.00**
Total native vegetation			**246.11**

Loss of native fauna habitat due to construction and operation

The 246.11 ha of vegetation that would be directly lost also comprises habitat for native fauna. The threatened fauna habitat to be lost as a result of construction and operation of the Proposal includes:

- 165.61 ha of habitat for White-eared Monarch (*Carterornis leucotis*), listed as vulnerable under the BC Act
- 19.99 ha of habitat and one nest tree for White-bellied Sea-Eagle (*Haliaeetus leucogaster*), listed as vulnerable under the BC Act
- 14.49 ha of habitat for Albert's Lyrebird (*Menura alberti*), listed as vulnerable under the BC Act
- 32.16 ha of habitat for Pouched Frog (*Assa darlingtoni*), listed as vulnerable under the BC Act and the EPBC Act
- 6.09 ha of habitat for Giant Barred Frog (*Mixophyes iteratus*), listed as vulnerable under the BC Act and EPBC Act
- 0.16 ha of habitat for Loveridge's Frog (*Philoria loveridgei*), listed as endangered under the BC Act

- 136.92 ha of habitat for the Southern Myotis (*Myotis macropus*), listed as vulnerable under the BC Act
- 160.87 ha of habitat for Koala (*Phascolarctos cinereus*), listed as endangered under the BC Act and EPBC Act
- 0.10 ha of habitat for Southern Pink Underwing Moth (*Phyllodes imperialis smithersi*), listed as endangered under the BC Act and EPBC Act
- 2.20 ha of habitat for Mitchell's Rainforest Snail (*Thersites mitchellae*), listed as endangered under the BC Act and Critically Endangered under the EPBC Act
- 52.65 ha of habitat for Masked Owl (*Tyto novaehollandiae*), listed as vulnerable under the BC Act
- 52.65 ha of habitat for Sooty Owl (*Tyto tenebricosa*), listed as vulnerable under the BC Act
- 46 hollow bearing trees.

Indirect impacts

The indirect impacts on native vegetation, threatened ecological communities and threatened species habitats that may occur due to the Proposal include:

- edge effects
- introduction and spread of weed species, resulting in degradation of retained native vegetation and habitat
- introduction and spread of imported red fire ants
- temporary increase in noise, dust, vibration and artificial lighting levels associated with construction
- temporary inundation of retained native vegetation and habitats during extreme flood events
- temporary erosion and sedimentation impacts to the dam and downstream receivers sociated with construction
- minor increase in groundwater recharge in southern areas of the dam.

Details on these potential indirect effects are provided in Appendix H (section 7.1.3 (a)).

Prescribed impacts

The assessment of prescribed impacts concluded:

- there is potential for an increased incidence of vehicle strikes upon fauna
- there is potential for impacts due to changes in hydrology.

Vehicle strikes

There would be the potential for an increased incidence of vehicle strikes upon fauna during the construction phase of the Proposal because of increased traffic volumes.

Once construction is completed, the risk posed by vehicle strike to threatened fauna would return to current levels. Hence, the potential risk posed during operation is not beyond that at present. Increased traffic expected during construction may result in increased mortality of native animals and would be minimised by the construction traffic driving rules in high-risk sections of road including speed limits (refer to section 6.2.4). Construction vehicle movements would predominantly occur during daylight hours when fauna movements are typically lower, consequently reducing the risk of strike.

Hydrology

Impacts due to raised FSL

Threatened flora submerged during the dam filling has been assumed to be a direct loss. It is anticipated that filling of the dam would occur slowly, so that all fauna species would be able to move upslope, thereby avoiding loss of individuals.

Impacts due to upstream flooding

To assess upstream flooding impacts, the BDAR (Appendix H) did not use the PMF as it is highly unlikely to occur. The 0.2% AEP or once in 500-year event was used to assess impacts as follows:

- an area of 166.55 ha (any areas overlapping with construction areas or ancillary impact areas of the Proposal were removed)
- the maximum water level of approximately 73.8 m at 24 hours (3 m above FSL)
- a reduction to 2 m above FSL after 32 hours
- a reduction to 1 m above FSL after 32 hours.

Based upon the current lack of any observable flood impacts at the current FSL, it is anticipated that once the dam raising is complete, plant communities, fauna habitats and threatened flora already established above FSL would remain intact, with no discernible flooding impacts. This is due to any flooding being an occasional occurrence with relatively short inundation periods.

Fauna is likely to be able to move upslope away from the floodwaters, given the relatively steep gradient and good connectivity of habitat.

Fauna that is the most vulnerable to flooding impact is anticipated to be the least mobile species, and those preferring lower-lying habitat adjacent to watercourses. The critically endangered Mitchell's Rainforest Snail therefore has the potential to be impacted by flooding. However, it is anticipated that the snail is able to persist in this environment and may seek refugia during periods of heavy rainfall, moving upslope and also climbing trees to escape flood events (Parkyn 2014).

Downstream hydrological impacts

In addition to water regulation, Doon Doon Creek is also impacted by historic clearance of vegetation, impacts from agriculture weed invasion and adjacent road building and earthworks.

The vegetation immediately adjacent to Doon Creek and impacted by high-flow events include River Oak (*Casuarina cunninghamiana*) and, to a lesser extent, Water Gum (*Tristaniopsis laurina*). Exotic species are prevalent, with Cockspur Coral Tree (*Erythrina crista-galli*), Wild Tobacco Bush (*Solanum mauritianum*) and Camphor Laurel among the most notable. Herbaceous exotic species are also prevalent as groundcover.

Changes to the downstream flow regime, as described in section 6.1, indicate that the magnitude of geomorphological effect is likely to be relatively small. Therefore, impacts would be minimal.

The reduction in the maximum peak flow during flood events as a result of the Proposal may lead to Doon Doon Creek being slightly less disturbed by extreme events. That would allow persistence of some trees and other vegetation during extreme events, which would otherwise be removed by the water velocity under the current situation. This change is not anticipated to be of a significant enough magnitude to result in change of vegetation community and would relate only to the vegetation within the watercourse itself and immediately adjacent bankside vegetation.

Serious and irreversible impacts

Additional assessments were conducted for threatened species that are considered at risk of a serious and irreversible impact (SAII), in accordance with section 9.1 of the BAM (DPIE 2020a). An

impact is to be regarded as SAII if it is likely to contribute significantly to the risk of a threatened species (including endangered populations) or an ecological community becoming extinct, in accordance with the 4 principles outlined in clause 6.7 of the NSW BC Regulation:

- Principle 1: The impact will cause a further decline of a species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline.
- Principle 2: The impact will further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size.
- Principle 3: The impact is made on the habitat of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution.
- Principle 4: The impacted species or ecological community is unlikely to respond to measures to improve its habitat and vegetation integrity, and therefore its members are not replaceable.

Section 9.1.1 of the BAM (DPIE 2020a) also requires additional impact assessment for threatened ecological communities that are also listed as candidate entities for SAII.

PCT 1302 aligns with 2 TECs:

- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion EEC (BC Act)
- Lowland Rainforest of Subtropical Australia CEEC (EPBC Act).

Neither TEC is included in the current list of entities at risk of SAII, and therefore, no SAII assessment has been conducted for these TECs.

Candidate SAII species are listed in Table 6-40 along with the relevant principles for the listing of the SAII entity, based on information from the TBDC.

Actions to avoid and minimise impacts to these species are discussed in Appendix H (section 7.1), and mitigation and management measures are outlined in section 6.2.4.

Table 6-40 Candidate SAII species

Scientific name	Common name	Principle that applies
Chalinolobus dwyeri	Large-eared Pied Bat (breeding)	4
Corokia whiteana	Corokia	2
Drynaria rigidula	Basket Fern	2 and 3
Endiandra muelleri subsp. bracteata	Green-leaved Rose Walnut	1
Lepiderema pulchella	Fine-leaved Tuckeroo	2
Miniopterus australis	Little Bent-wing Bat (breeding)	4
Miniopterus orianae oceanensis	Large Bent-winged Bat (breeding)	4
Rhodamnia rubescens	Scrub Turpentine	1 and 4
Rhodomyrtus psidioides	Native Guava	1 and 4
Syzygium moorei	Durobby	1
Thersites mitchellae	Mitchell's Rainforest Snail	1 and 3
Tyto tenebricosa	Sooty Owl	4
Vespadelus troughtoni	Eastern Cave Bat (breeding)	4

Biodiversity offsets

Impacts not requiring offsets

A summary of the vegetation zones that do not trigger the offset thresholds and therefore do not require ecosystem credits is provided in Table 6-41. This includes exotic vegetation, vegetation below the vegetation integrity threshold and planted native vegetation.

Table 6-41 Native vegetation that does not require offsets

Vegetation zone	PCT ID	Condition	Area (ha)	Change in vegetation integrity score
827_derived_sedgeland	827	Derived sedgeland	4.58	–1.1
827_pasture	827	Pasture	64.06	–6.2
Hoop_plantation	N/A	Hoop Pine plantation	4.64	N/A
Euc_plantation	N/A	Eucalyptus plantation	7.34	N/A
Planted native vegetation	N/A	N/A	1.02	N/A
Exotic trees	N/A	Exotic	0.24	N/A

Impacts requiring offsets

Impacts to native vegetation requiring offsets include:

- direct impacts to 221.66 ha of PCT 827 – Flooded Gum – Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast
- direct impacts to 2.67 ha of PCT 1073 – Pink Bloodwood – Tallowwood moist open forest of the far northern ranges of the NSW North Coast Bioregion
- direct impacts to 8.77 ha of PCT 1302 – White Booyong – Fig subtropical rainforest of the NSW North Coast Bioregion.

A summary of ecosystem credits required for all vegetation zones, including changes in vegetation integrity score, is provided in Appendix H (Table 8.2).

A summary of the species credits required for all vegetation zones occupied by threatened species is provided in Appendix H (Table 8.3).

To compensate for the residual impacts of the Proposal, 4,994 ecosystems credits are required to compensate for impacts on native PCTs and ecosystem credit species. In addition to ecosystem credits, the Proposal also requires a total of 35,133 species credits. Tweed Shire Council would compensate for these residual impacts through the implementation of a biodiversity offset strategy.

Typically, offset liabilities need to be met before construction commences; however, section 7.14 of the BC Act allows for the staged retirement of credits in line with the stages of development, and Tweed Shire Council will be seeking to separate offsets for 2 stages as outlined in Appendix H section 8.3.2).

Options under the BOS include:

- Like for like credits
  - may be purchased from the credits market and used to retire all or a portion of the credit liability for the Proposal
  - using Council owned land – Council has conducted preliminary assessments of indicative PCTs within Council-owned lands that indicate there is potentially suitable land to generate

at least the required ecosystem credits. Further detailed assessment of this land is required to more accurately estimate the potential credit yields for ecosystem credits

- Credits under the variation rules – see Appendix H (section 8.5.2) for further details.

Prior to construction, a detailed Biodiversity Offset Package will be prepared that is consistent with the Biodiversity Offset Strategy provided in Appendix H (section 8.3). This will provide certainty that the residual impacts of the Proposal can be adequately offset.

Assessment under the EPBC Act

Assessments of significance were conducted to assess potential impacts to species and communities listed under the EPBC Act. The findings provided in Table 6-42.

Table 6-42 Outcomes of assessments of significance

Scientific name	Common name	EPBC status	Likelihood of occurrence	Outcome of significant impact assessment
Lowland Rainforest of Subtropical Australia	Lowland rainforest of Subtropical Australia	Critically endangered	Known	Likely
Assa darlingtoni	Pouched Frog	Vulnerable	Known	Possible
Calyptorhynchus lathami lathami	South-eastern Glossy Black-Cockatoo	Vulnerable	Known	Possible
Chalinolobus dwyeri	Large-eared Pied Bat	Endangered	Known	Unlikely
Corokia whiteana	Corokia	Endangered	Known	Likely
Desmodium acanthocladum	Thorny Pea	Vulnerable	Known	Likely
Endiandra hayesii	Rusty Rose Walnut	Vulnerable	Known	Unlikely
Gallinago hardwickii	Latham's Snipe	Vulnerable, Migratory	Known	Unlikely
Hicksbeachia pinnatifolia	Red Boppel Nut	Vulnerable	Known	Unlikely
Hirundapus caudacutus	White-throated Needletail	Vulnerable, Migratory	High	Unlikely
Macadamia tetraphylla	Rough-shelled Bush-nut	Vulnerable	Known	Unlikely
Marsdenia longiloba	Slender Marsdenia	Vulnerable	Known	Likely
Mixophyes iteratus	Giant Barred Frog	Vulnerable	Known	Likely
Monarcha melanopsis	Black-faced Monarch	Migratory	Moderate	Unlikely
Phascolarctos cinereus	Koala	Endangered	Known	Likely
Phyllodes imperialis southern subspecies	Southern Pink Underwing Moth	Endangered	Known	Unlikely
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Known	Possible
Rhipidura rufifrons	Rufous Fantail	Migratory	Moderate	Unlikely
Rhodamnia rubescens	Scrub Turpentine	Critically endangered	Known	Likely

Scientific name	Common name	EPBC status	Likelihood of occurrence	Outcome of significant impact assessment
Rhodomyrtus psidioides	Native Guava	Critically endangered	Known	Likely
Symposiachrus trivirgatus	Spectacled Monarch	Migratory	Moderate	Unlikely
Syzygium hodgkinsoniae	Red Lilly Pilly	Vulnerable	Known	Likely
Syzygium moorei	Durobby	Vulnerable	Known	Unlikely
Thersites mitchellae	Mitchell's Rainforest Snail	Critically endangered	Known	Likely

As the Proposal is being assessed in accordance with the bilateral agreement between the Commonwealth and the NSW Government, impacts to MNES will be compensated through the implementation of the Biodiversity Offset Strategy.

Weeds

All plants in NSW are regulated with a general biosecurity duty under the Biosecurity Act. There is an obligation for the Proposal to ensure that the biosecurity risks of all weed species recorded on the Proposal site are prevented, eliminated or minimised, as far as practicable.

Six weed species detected in the Proposal area, shown in Table 6-43, are listed as regional priority weeds for the North Coast region, and 4 are listed as weeds of national environmental significance under the National Weed Strategy.

Table 6-43 Regional priority weeds and biosecurity duty

Species	Biosecurity duty*	Weeds of national environmental significance
Madeira vine *(Anredera cordifolia)*	**Prohibition on certain dealings** Must not be imported into the state, sold, bartered, exchanged or offered for sale.	**Regulated by a prohibition on dealings** Cannot be imported into the state, bartered exchanged or offered for sale.
Climbing Asparagus Fern *(Asparagus plumosus)*	**Prohibition on certain dealings** Must not be imported into the state, sold, bartered, exchanged or offered for sale.	**Regulated by a prohibition on dealings** Cannot be imported into the state, bartered exchanged or offered for sale.
Groundsel bush *(Baccharis halimifolia)*	**Regional recommended measure** Tweed Shire LGA is part of the core infestation (containment) zone for this species. Whole of region: Land managers should mitigate the risk of the plant being introduced to their land. A person should not buy, sell, move, carry or release the plant into the environment. Exclusion zone: Notify local control authority if found. Land managers should eradicate the plant from the land and keep the land free of the plant. Core infestation: Land managers should mitigate spread of the plant from their land. Land managers should reduce the impact of the plant on assets of high economic, environmental and/or social value.	–

Species	Biosecurity duty*	Weeds of national environmental significance
Green Cestrum (*Cestrum parqui*)	**Regional recommended measure** Tweed Shire LGA is part of the core infestation (containment) zone for this species. Whole of region: Land managers should mitigate the risk of the plant being introduced to their land. A person should not buy, sell, move, carry or release the plant into the environment. Exclusion zone: Notify local control authority if found. Land managers should eradicate the plant from the land and keep the land free of the plant. Core infestation: Land managers should mitigate spread of the plant from their land. Land managers should reduce the impact of the plant on assets of high economic, environmental and/or social value.	–
Lantana (*Lantana camara*)	**Prohibition on certain dealings** Must not be imported into the state, sold, bartered, exchanged or offered for sale.	**Regulated by a prohibition on dealings** Cannot be imported into the state, bartered, exchanged or offered for sale.
Fireweed (*Senecio madagascariensis*)	**Prohibition on certain dealings** Must not be imported into the state, sold, bartered, exchanged or offered for sale.	**Regulated by a prohibition on dealings** Cannot be imported into the state, bartered, exchanged or offered for sale.

** Source: DPI n.d.*

6.2.4 Mitigation measures

The mitigation actions provided in Table 6-44 have been prepared to address the management of the uncertain, temporary, indirect and prescribed impacts of the Proposal on native flora and fauna.

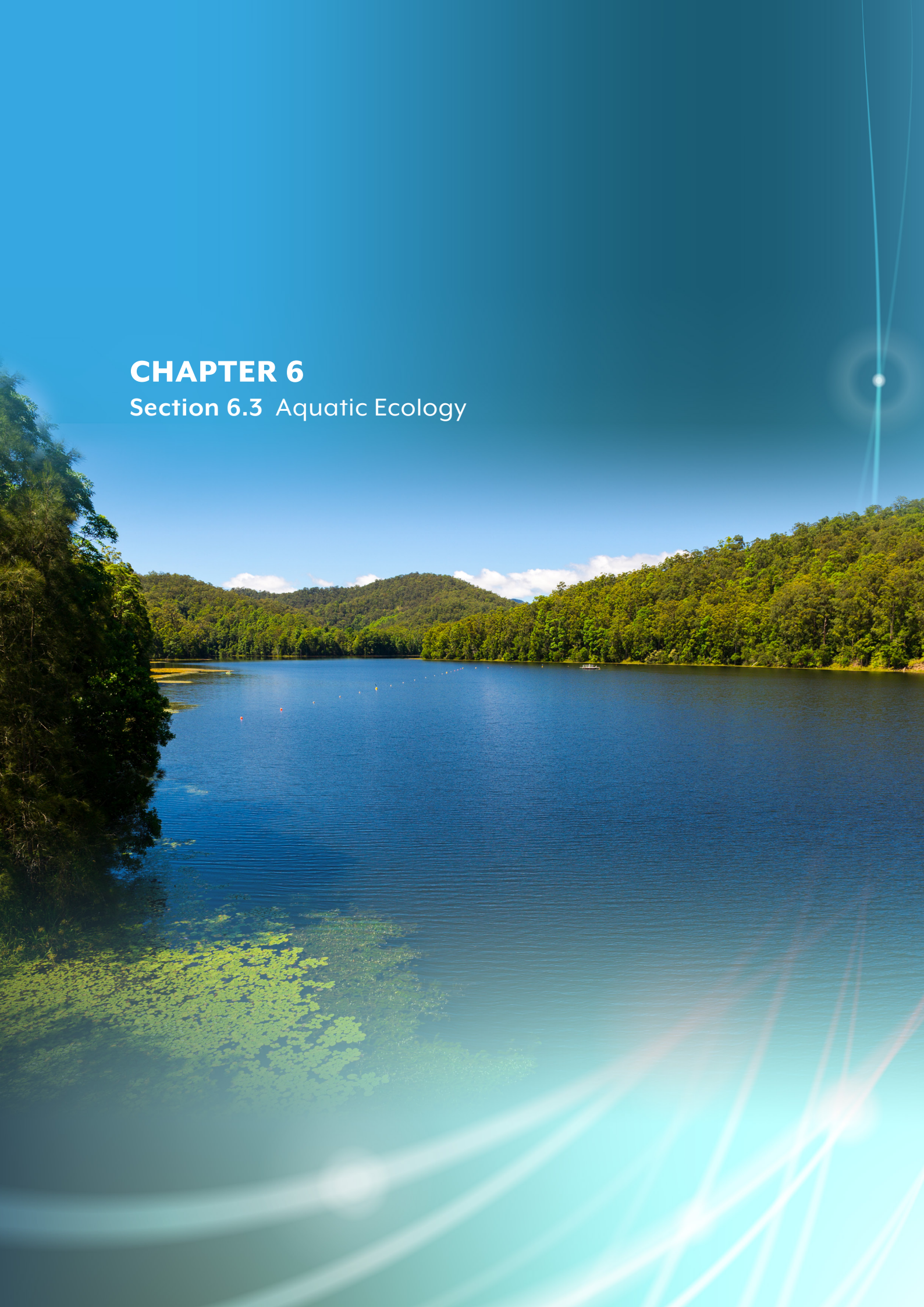
A detailed Biodiversity Offset Package would be prepared prior to construction that is consistent with the Biodiversity Offset Strategy provided in Appendix H (section 8.3).

Table 6-44 Terrestrial biodiversity mitigation measures

Reference	Impact	Mitigation measures	Responsibility	Timeframe
BIO1	General	A Biodiversity Management Plan (BMP) would be implemented for retained vegetation and habitat adjacent to the Proposal area that includes (but is not limited to): • biosecurity protocols to control and manage weeds that may be exacerbated, spread or otherwise affected by the construction and operation of the Proposal • protocols to monitor the vegetation condition and habitat values of retained vegetation • provisions for corrective actions, should a decline in vegetation or habitat condition be detected. The BMP would also include protocols to remove weeds within the Proposal area prior to inundation.	Contractor	Pre-construction, construction, operation
BIO2	General	A Site Plan would be included in a Construction Environmental Management Plan (CEMP) and/or an Operational Environmental Management Plan (OEMP) and would include (but is not limited to): • the extent of approved clearing and disturbance • any relevant sensitive areas • locations of approved stockpile and material laydown areas and site compounds. This Site Plan would be placed in an accessible location to be viewed by all site personnel. Construction crew would undertake an induction prior to commencement of work to inform them of sensitive biodiversity areas, including threatened species habitat and ecological communities. They would be informed of the areas bound to work in, delineated no-go areas and what to do in the case of an unexpected threatened species find.	Contractor	Pre-construction, construction, operation
BIO3	Fire	Fire extinguishers would be accessible onsite. There would be limits to some works undertaken during hot, dry and windy conditions, to reduce the risk of fire.	Contractor	Pre-construction, construction, operation
BIO4	Waterways	A Water Management Plan (WMP) would be established in consultation with DPE Water, the Environment Protection Authority (EPA) and Tweed Shire Council, and would include (but is not limited to): • a surface water monitoring program • spill management and response • water quality trigger levels • corrective actions and contingencies • reporting requirements. Responsibilities for all management actions would be detailed within the WMP.	Contractor	Pre-construction, construction, operation

Reference	Impact	Mitigation measures	Responsibility	Timeframe
BIO5	Imported Red Fire ants	As part of the BMP, biosecurity measures would be implemented in accordance with the Biosecurity (Fire Ant) Emergency Order (No 8) 2024 made under the Biosecurity Act to minimise the potential for introduction of fire ant infestations. These measures would include (but would not be limited to): • restrictions to the movement of vehicles, equipment and materials originating from Fire Ant Infested Areas or travelling through Fire Ant Movement Control Areas • washdown of vehicles prior to entering the Proposal area.	Contractor	Pre-construction, construction, operation
BIO6	Vehicle strike	A Construction Traffic Management Plan (CTMP) would be implemented to minimise the potential for animal strike during the construction phase, and would include (but is not limited to): • the location and design of approved roadways • speed limits • education of staff during induction about abiding by above driving rules to reduce fauna strike, including periods when vehicle strikes are more likely, based on animal behaviour (e.g. sunrise and sunset).	Contractor	Pre-construction, construction
BIO7	Sediment	Sediment and erosion controls would be established as part of the CEMP, OEMP and/or WMP. These controls would include (but are not limited to): • installation of sediment fencing and traps in areas in which construction would be conducted in proximity to waterways or low-lying vegetation.	Contractor	Pre-construction, construction
BIO8	Dust	Dust suppression would be established as part of the CEMP or OEMP and would be implemented as required. Dust suppression methods may include (but are not limited to): • wetting down of unsealed roads and stockpiles • reducing vehicle speeds in adverse climatic conditions • use of dust sprays on crushing or screening plant at the quarry site.	Contractor	Pre-construction, construction
BIO9	Disease	Hygiene measures should be implemented as part of the CEMP to minimise the risk of pathogen and diseases spread on site (including Chytrid fungus), and should include procedures for equipment, footwear and clothing. Works vehicles would be washed down prior to entering the works area.	Contractor	Pre-construction, construction
BIO10	Fauna injury	Implementation of pre-clearing protocols would be conducted by a suitable qualified ecologist, including (but not limited to): • inspection of hollows, buildings and other artificial structures for fauna occupancy (to be conducted immediately prior to clearance activities) • removal of fauna individuals if found • relocation of fauna to suitable habitat in adjacent and similar vegetation outside of the Proposal area.	Contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
BIO11	Fauna injury	Implementation of clearing protocols, including (including but not limited to): • the presence of a suitably qualified ecologist throughout all clearing works • clearing to be conducted sequentially, moving outward, towards areas of retained vegetation to facilitate fauna refuge and prevent the creation of vegetation fragmentation • hollow bearing trees that are felled to be inspected once on the ground, and if injured fauna is found, the individual is to be removed and taken to a veterinarian or wildlife clinic. Hollow bearing trees that are felled to be placed in proximity to retained vegetation and positioned with the hollows facing upward to allow fauna to escape overnight • if temperatures exceed 35°C, clearing works will be reassessed by a suitably qualified ecologist to evaluate whether works should be postponed for animal welfare.	Contractor	Pre-construction, construction
BIO12	Fauna habitat loss	Logs of removed trees are to be installed within retained, adjacent vegetation to provide fauna habitat, where practical.	Contractor	Pre-construction, construction
BIO13	Loss of threatened flora species	Collection and replanting of seeds from threatened flora species and/or translocation of the individuals of threatened flora species within the Proposal area will be undertaken in adjacent vegetation.	Contractor	Pre-construction, construction
BIO14	Loss of Mitchell's Rainforest Snail	Where possible, individuals of the Mitchell's Rainforest Snail species will be translocated to similar, adjacent vegetation to maintain the local population. As per the expert report, collecting of Rainforest Snail individuals for translocation would require a concentrated effort conducted over several nights in and around wet weather. Collection may also be conducted diurnally to supplement the nocturnal effort, by targeting known microhabitats. Translocation would be to similar habitat/microhabitat within the Tweed River drainage.	Contractor	Pre-construction, construction
BIO15	Impacts to adjacent vegetation	Rehabilitation of the construction laydown areas following the completion of construction works if the area is not required for operational purposes. This would include the removal of any materials brought onto the site, such as gravel and building materials.	Contractor	Post-construction



CHAPTER 6

Section 6.3 Aquatic Ecology

6.3 AQUATIC ECOLOGY

This section provides a summary of potential impacts to aquatic ecology from the Proposal. The summary is based on the detailed Aquatic Ecology Assessment prepared to assess potential impacts due to construction and operation of the Proposal, including impacts on Doon Doon Creek, Clarrie Hall Dam, the Tweed River and associated tributaries and waterways. The Aquatic Ecology Assessment is provided in Appendix I. The relevant SEARs and where in the EIS they are addressed are provided in Table 6-45.

Table 6-45 Relevant SEARs – aquatic ecology

Relevant key issue requirement/s	Where addressed
The proponent must undertake a test of significance as required by Part 7A of the *Fisheries Management Act 1994* for relevant threatened fish species, including the Southern Purple Spotted Gudgeon (*Mogurnda adspersa*), with known or expected distributions within areas impacted by the proposal.	Appendix G of Appendix I Section 6.3.3
The proponent must undertake an assessment of suitable opportunities within the Tweed catchment to offset the impact of the proposed dam upgrade on fish passage and the potential impacts to fish associated with water releases and overtopping of the dam.	Section 10 of Appendix I Sections 6.3.3 and 6.3.4

6.3.1 Methodology

The aquatic ecology assessment for the Proposal included desktop and field components.

Desktop assessment

The desktop assessment included searches of the following databases for information on species relevant to aquatic ecology and groundwater-dependent ecosystems (GDEs):

- Freshwater threatened species distribution maps (DPI-Fisheries, January 2023)
- Threatened species lists (DPI-Fisheries, January 2023)
- Key Fish Habitat maps (DPI-Fisheries, January 2023)
- Fish stocking (DPI-Fisheries, January 2023)
- Fisheries NSW Spatial Data Portal (DPI-Fisheries, January 2023)
- BioNet Atlas (DPE, January 2023)
- Australian Museum (September 2023)
- Protected Matters Search Tool (PMST) (DCCEEW, January 2023)
- Provisional list of animals requiring urgent management intervention (DCCEEW, January 2023)
- Australian Ramsar Wetlands: Internationally Important Wetlands (DCCEEW, September 2022)
- Directory of Important Wetlands: Nationally Important Wetlands (DCCEEW, September 2022)
- Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology, September 2023)
- NSW Fish Passage Database (DPI-Fisheries, January 2023)
- WaterNSW Continuous water monitoring network data
- Climate data online (Bureau of Meteorology, January 2023).

A review of publicly available literature relating to aquatic and subterranean environments in the region of the Proposal was undertaken to investigate the occurrence of communities and taxa of conservation significance. Information was compiled from reports, books, journals and relevant government, university or regulatory publications.

Information was also taken from the Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2023, where applicable:

A summary of the results of the literature review is provided in Appendix B of Appendix I.

The review of the above data and documents provided information on historical conditions so an assessment of the likelihood of occurrence of threatened species and/or populations that have the potential to occur within the vicinity of the Proposal) could be undertaken.

The criteria for assessing the likelihood of occurrence of threatened species are summarised in Table 3 of Appendix I, and the likelihood of occurrence assessment is presented in Table 44 (Appendix C) of Appendix I. Threatened habitats and/or communities that have the potential to be indirectly impacted by downstream effects were included in the assessment, as were threatened species and/or populations that have the potential to occur within the Tweed River catchment. The results of the likelihood of occurrence assessment are provided in Table 4 of Appendix I for all species identified during the desktop assessment.

The identification of potential aquatic GDEs was undertaken via a desktop assessment.

Field surveys

Field surveys were undertaken in mid-September 2023 to assess key fish habitat, water and sediment quality, aquatic flora, macroinvertebrates and aquatic vertebrates. Survey methods involved direct observation of key fish habitat, laboratory analysis of water, sediments and algae, macroinvertebrate analysis, eDNA analysis, electrofishing and netting. A total of 15 sites (see Figure 6-40) were assessed within Clarrie Hall Dam, Doon Doon Creek, the Tweed River, Commissioners Creek and Big Creek. The focus was mainly on the tributaries and creeks, as Department of Primary Industries – Fisheries (DPI-Fisheries) agreed to provide results of the fish surveys it was undertaking in Clarrie Hall Dam during September 2023.

A follow-up survey was undertaken in January 2024 targeting Oxleyan pygmy perch (*Nannoperca oxleyana*) at 14 sites throughout the Proposal area.

Field sampling was undertaken in accordance with Department of Primary Industries – Fisheries Section 37 Permit for Scientific Collection under the Fisheries Management Act 1994 (FM Act) (Permit No P19/0050-1.0).

Details of the field survey methodology is provided in section 4.2 of Appendix I.

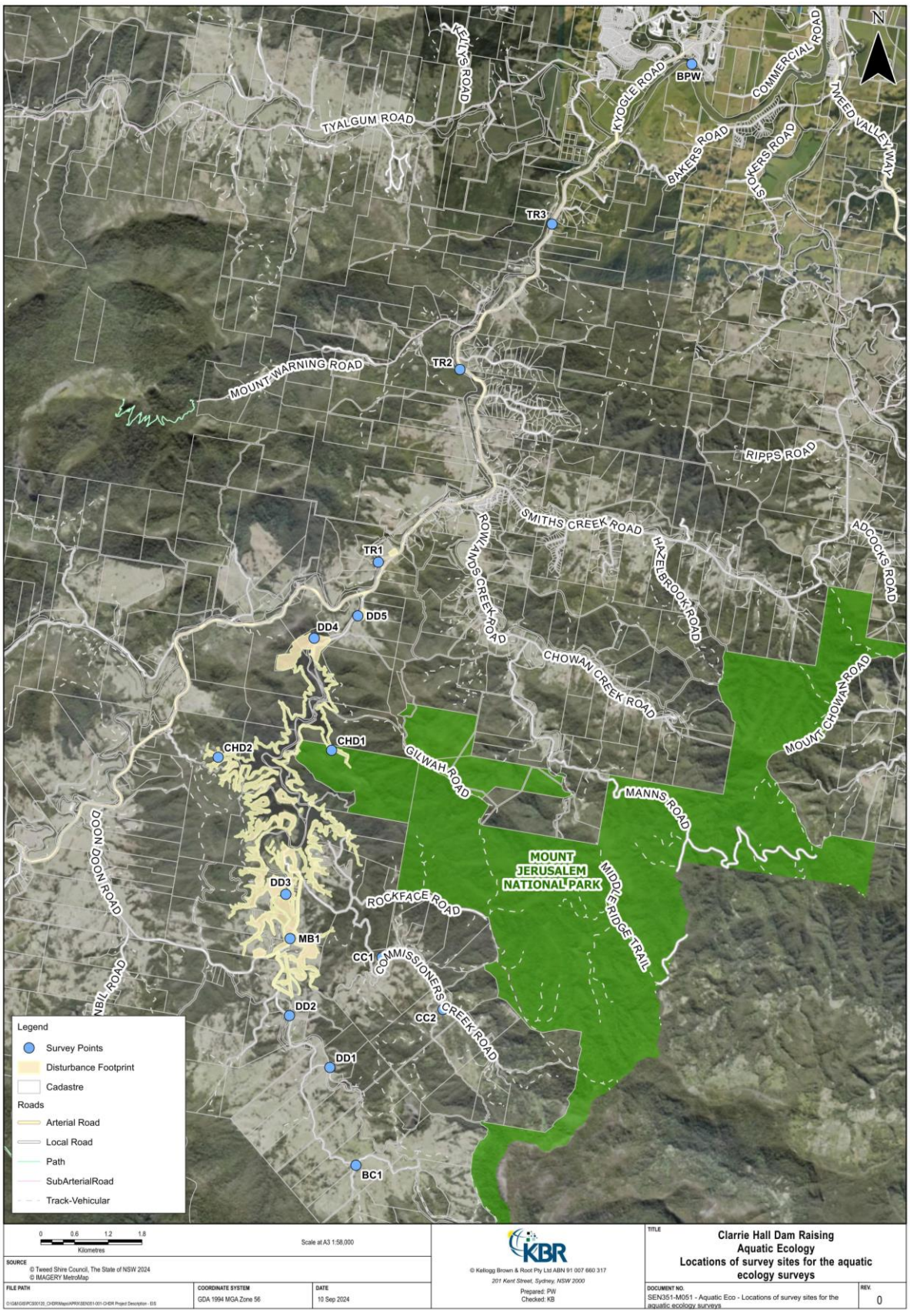


Figure 6-40 Locations of survey sites for the aquatic ecology surveys

At each survey site, waterway type and waterway class assessments were completed, and broad habitat characterisation was undertaken to document attributes of the local ecosystem including:

- habitat and substrate types
- riparian vegetation condition and presence of weeds
- vegetation cover and presence of native species
- waterway morphology and presence/absence/flow of surface water
- refuge availability (snags, aquatic vegetation, rocks, etc.)
- amount of erosion and bank incision
- livestock impact.

A record of habitat conditions at the time of assessment is provided in Appendix D – Site photographs of Appendix I. Each waterway assessed had previously been ranked by the DPI according to the Strahler (1952) method of waterway ordering, and only waterways ranked as third order and above have been included in the aquatic ecology assessment.

A risk assessment approach was utilised to assess the degree of impact an event or action will have on a species, or a species' habitat. Both consequence criteria and likelihood descriptors were developed, and the risk outcomes ranked as low, medium, high or extreme.

6.3.2 Existing environment

Biogeography

Clarrie Hall Dam is located on Doon Doon Creek, a tributary of the Tweed River that lies in the South East Queensland bioregion. The existing dam has a catchment area of 60 km2 and a storage capacity of 16,000 ML. Doon Doon Creek is fed by Commissioners Creek and Big Creek before flowing into the southern end of Clarrie Hall Dam. Unnamed tributaries contribute to the water balance of Clarrie Hall Dam. Water spills out of Clarrie Hall Dam into Doon Doon Creek from the northern end of the dam before joining the Tweed River. A major portion of the upper Tweed catchment remains under forest cover. Clarrie Hall Dam is partially bordered by the Mount Jerusalem National Park to the east, and the Wollumbin National Park lies less than 3 km to the northwest.

Land use

The North Coast bioregion (prior to partial reclassification as the South East Queensland bioregion) had the second-highest area of conservation of the NSW bioregions (NSW National Parks and Wildlife Service 2003). The combined area of conservation within the North Coast bioregion occupies approximately 1,061,710 ha (18.65% of the bioregion).

The Tweed Shire has developed a viable agricultural industry based on its highly productive alluvial flats, basalt derived uplands, subtropical climate and high rainfall (DCCEEW 2023a). Sugar, dairy farming and horticulture are the main types of agricultural produce, while beef and timber production are predominant in those areas of lower fertility soils of sandstone and shale. These industries have significantly impacted the landscape's natural attributes. However, a major portion of the upper Tweed catchment still remains under forest cover, often protected either as national park or state forest (DCCEEW 2023a).

Climate

The nearest BoM weather station to Clarrie Hall Dam is at Uki (Uki (Tweed River: 058167) for rainfall data (Bureau of Meteorology 2023b) and Murwillumbah (Murwillumbah (Bray Park: 058158) for temperature data (Bureau of Meteorology 2023c). Annual rainfall in the 12 months

(September 2022 to August 2023) before the September 2023 field survey totalled 1,099.5 mm, 473.7 mm less than the long-term average of 1,573.2 mm (Figure 6 of Appendix I) (Bureau of Meteorology 2023b).

Over the 10 years leading up to the 2023 field surveys, 4 years have recorded rainfall lower than the long-term annual average; however, 3 years had incomplete data resulting in no annual rainfall for that year (Bureau of Meteorology 2023b). Despite the high rainfalls in 2022, long-term lower-than-average rainfall and low monthly rainfalls leading up to the September 2023 sampling event resulted in low flows at the time of the September 2023 sampling event.

Geology and topography

The North Coast bioregion supports significant diversity with regard to geology, geomorphology and biota. In addition to this diversity, there are a number of special features, as follows:

- The Tweed volcano complex and Mount Warning are one of the best exposed remnant volcanos in Australia.
- Ebor Plateau and Comboyne Plateau are central volcanoes about 18 million years old.
- A large number of economic mineral deposits are present, including extended deposits of heavy minerals in beach and dune sands, most of which have associated heritage items.
- The Great Escarpment is well developed in the North Coast bioregion, with deep gorges on every major river.
- Areas of serpentine are evidence of deep-sea sediment accretion on the Australian mainland through time. These rocks weather to soils with toxic levels of some metals, which is known to impact the vegetation they support.

Soils and vegetation patterns across and along the North Coast bioregion are considered complex because of the different substrates, the topographic variation and the climatic difference across the bioregion (NSW National Parks and Wildlife Service 2003; DCCEEW 2023a). Typically, rainforests are only supported by the most fertile soils (typically basalt), but exceptions to this are found in numerous protected areas where plant nutrients have accumulated over time.

A review of the available literature revealed that the groundwater aquifer systems in the Northern Rivers catchment are generally in ‘good’ to ‘very good’ condition (DECCW 2010c Specifically, the Tweed River Coastal Sands regional groundwater levels are considered ‘very good’. Local groundwater levels are also considered ‘very good’, and the aquifer integrity is considered ‘very good’. For the Tweed River alluvium, the regional groundwater levels are considered ‘very good’, local groundwater levels are considered ‘very good’, and the aquifer integrity is considered ‘very good’ (DECCW 2010c).

Catchment and hydrology

Clarrie Hall Dam is located within the Tweed River Catchment within the broader Northern Rivers catchment (Figure 6-41). The Tweed River catchment covers an area of 1,303 km2 (DPE 2023). Upstream of Murwillumbah, the Tweed and Oxley rivers are the main drainage lines for the caldera that encircles Mt Warning, which was previously the main volcanic vent (DCCEEW 2023a). Below Murwillumbah, the Tweed River flows across an extensive floodplain and is joined by the Rous River, which drains the dissected mid-northern areas of the catchment, and the Oxley River. Shallow tidal waterways join the Tweed River near the mouth via the Terranora Inlet before the river discharges to the ocean at Point Danger, immediately south of the Queensland–NSW border (DCCEEW 2023a).

Tidal influence penetrates up the Tweed River to the Bray Park Weir, which is located approximately 5 km upstream of Murwillumbah and regulates the river levels except during flood

events. The two major pieces of infrastructure that impact flows in the Tweed River are the Bray Park Weir and Clarrie Hall Dam.

Clarrie Hall Dam is classified a 5th order Strahler stream, Doon Doon Creek ranges from a 3rd order stream to a 5th order stream, Commissioners Creek ranges from a 3rd order stream to a 4th order stream, Big Creek is classified a 3rd order stream, and the Tweed River ranges from a 5th order stream to a 7th order stream (Strahler 1952).

Aquatic habitat

The Northern Rivers catchment supports a number of endangered wetland communities, including montane peatlands and swamps in the New England Tableland, NSW North Coast and other regions (Bell, et al. 2008).

Key fish habitat

Key fish habitat sensitivity was assessed at the 15 sites surveyed in accordance with Policy and guidelines for fish habitat conservation and management (DPI 2013a) – refer to section 4.2.1 of Appendix I for details.

Key fish habitat mapping indicates that most of the waterways within the Proposal area are considered to contain key fish habitat, including Clarrie Hall Dam, Doon Doon Creek, Big Creek, Commissioners Creek, and the Tweed River, as shown in Figure 6-42.

All 15 sites were classified as Type 1 highly sensitive key fish habitat and Class 1 major key fish habitat. Type 1 highly sensitive key fish habitat classifications for all sites were assigned due to the sites containing in-stream snags or native aquatic plants, and the potential for the waterway to provide habitat for threatened aquatic species (e.g. southern purple-spotted gudgeon).

Fish habitat was present at all sites and included instream woody debris (snags), macrophytes, trailing bank vegetation, hard substrate (boulders) and undercut banks (Table 20 in Appendix I).

Many sites were subject to pressures from surrounding land use, with the dominant pressures being agricultural in nature. Examples of pressures observed during the September 2023 surveys include clearing of the riparian zone, grazing, and uncontrolled stock access. (Table 20 in Appendix I).

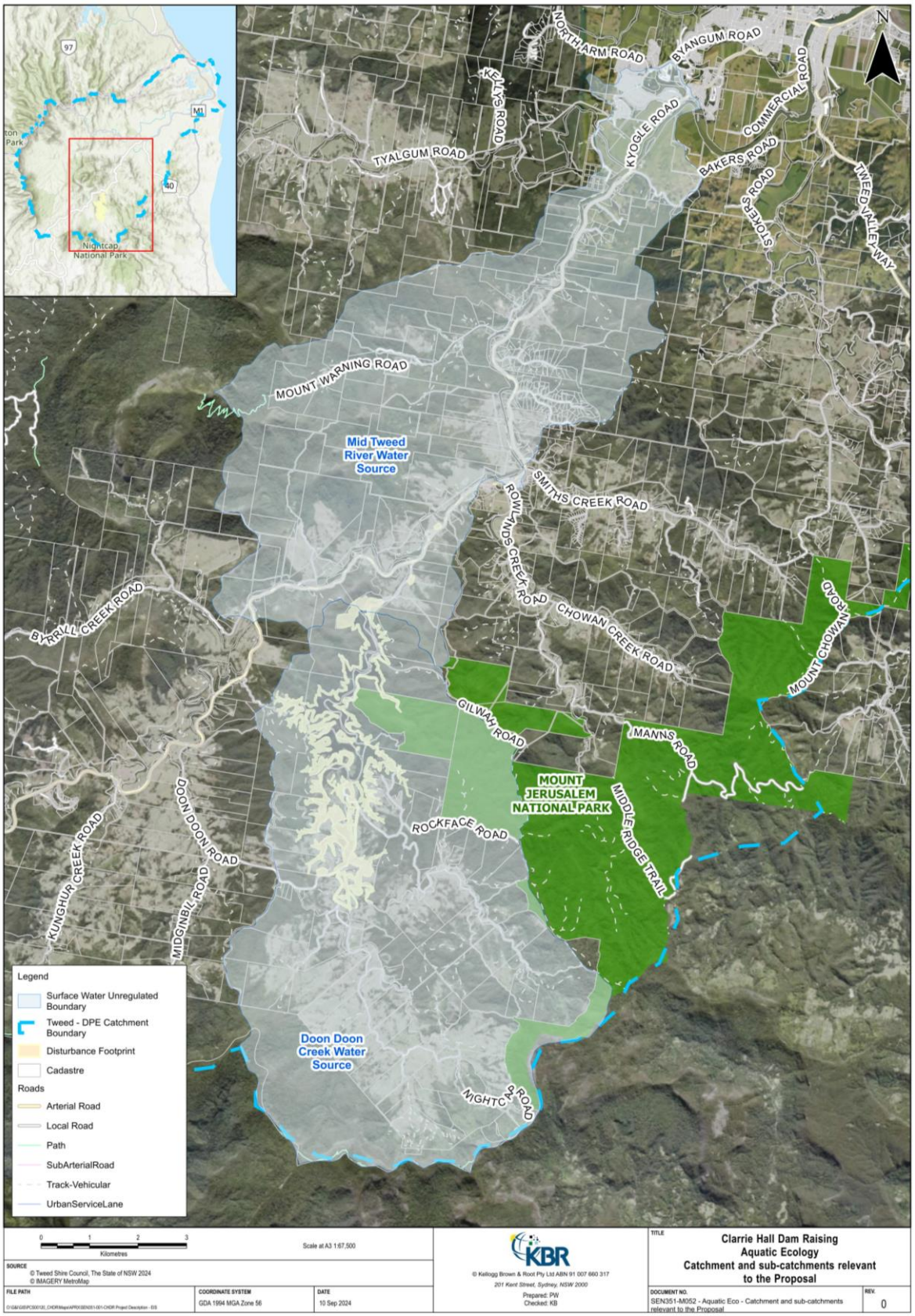


Figure 6-41 Catchment and sub-catchments relevant to the Proposal

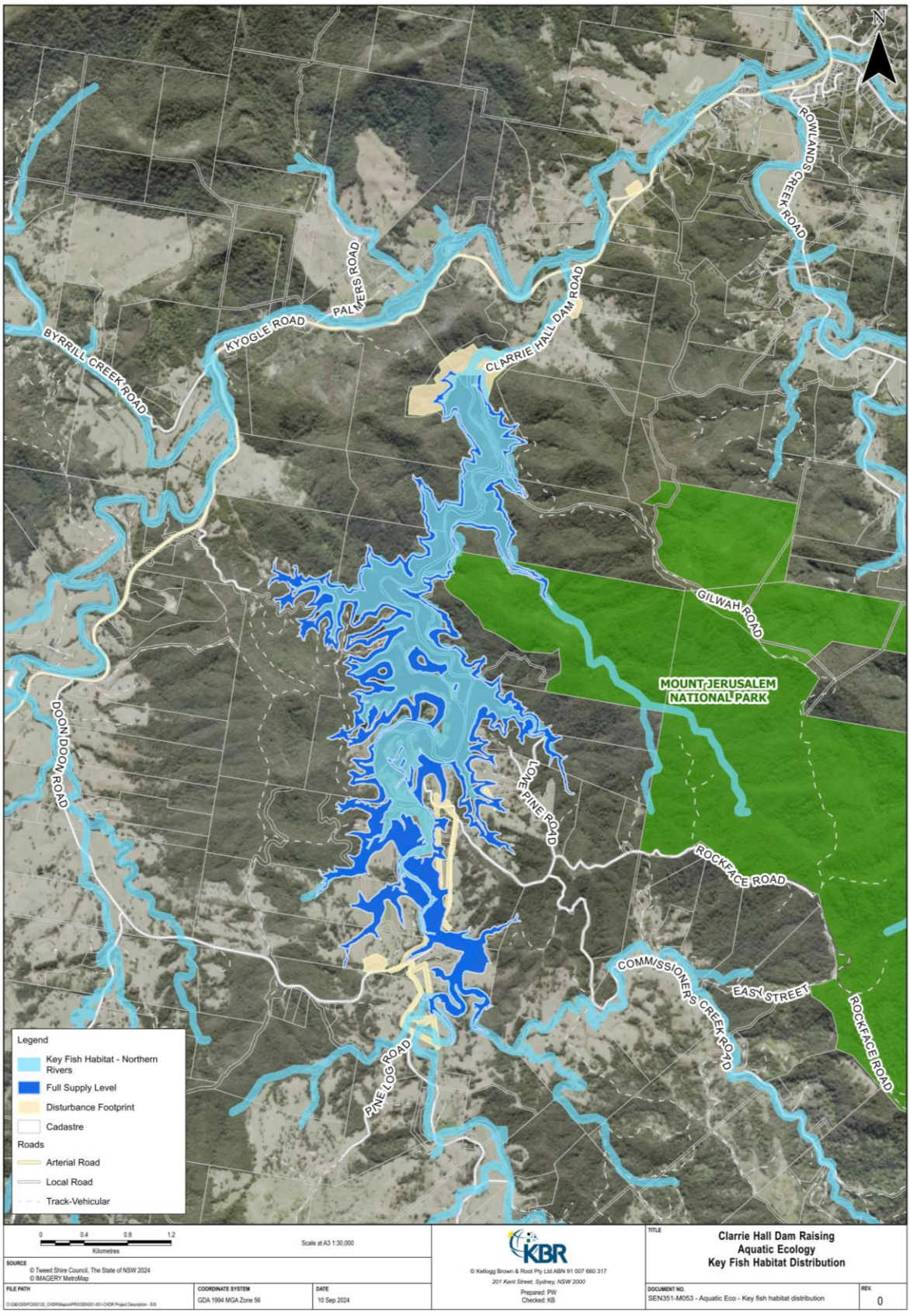


Figure 6-42 Key fish habitat distribution within the Proposal area

Water and sediment quality

Long-term water quality monitoring has been undertaken by Council as part of the ongoing management of Clarrie Hall Dam. The results show variation between dates, sites and depths within the dam and locations downstream, with frequent exceedances of relevant ANZECC & ARMCANZ (2000) triggers for dissolved and total nutrients, several total metals (including manganese and aluminium), chlorophyll-a, conductivity and dissolved oxygen, pH and turbidity. Water quality results from surveys conducted in September 2023 found similar results.

Surface water and surface sediment (top 2 to 3 centimetres) samples were collected, and in situ water quality parameters measured at the 15 survey sites to provide an indication of water quality during the September 2023 survey. Further details on the methodology for assessing water and sediment quality is provided in section 4.2.2 and 4.2.3 of Appendix I.

In-situ water quality results are provided in Appendix I section 6.2; water quality sampling results are provided in Appendix X section 6.3; and sediment sampling results are provided in Appendix I section 6.4.

Sediment quality results from surveys conducted in September 2023 identified a number of metals to be exceeding ANZECC & ARMCANZ (2000) default trigger values for the protection of 80% of species (representative of highly disturbed systems) at one or more sites assessed.

Water quality is discussed in detail in section 6.1 of the EIS.

Algae and macrophytes

A study on phytoplankton that included Clarrie Hall Dam reported that the dam supported a large range of phytoplankton species, with chlorophytes dominating. Low concentrations of cyanoprokaryotes were recorded at the time of the study and included Dolicospermum circinale, Microcystis aeruginosa, Chrysosporum ovalisporum and Geitlerinema amphibian. These species are considered potentially toxic (Everson 2013).

Algal data was collected by Council from sites X and Z within Clarrie Hall Dam between 2001 and 2023 (refer to section 5.1.10, Figure 12 and Table 17 of Appendix I).

Samples of phytoplankton, periphyton and macrophytes were collected from surface water during the September 2023 survey (refer to section 4.2.4 of Appendix I for details of the methodology for sampling).

The results identified a diverse phytoplankton population including a portion of taxa that have the potential to be toxic, bloom-forming algae. None of the taxa recorded during the survey were considered to be threatened or of restricted distribution. No macrophyte taxa considered to be threatened or of restricted distribution were identified in the Proposal area. Exotic macrophyte species were more common in Clarrie Hall Dam; however, all waterways except Commissioners Creek and Big Creek supported exotic species. Weeds of national significance were detected in multiple waterways during surveys, including Cabomba (*Cabomba caroliniana*) and Salvinia (*Salvinia molesta*).

Aquatic macroinvertebrates

Microinvertebrate and macroinvertebrate samples were collected from 13 sites (refer to Figure 3 and Table 4 of Appendix I), with a total of 52 taxa identified from the aquatic invertebrate assemblage within edge habitat within the Tweed River, Big Creek, Doon Doon Creek and Commissioners Creek during the September 2023 field survey (section 6.6.1, Table 28 Appendix I).

A total of 52 taxa were identified from the aquatic invertebrate assemblage within riffle habitat within the Tweed River, Doon Doon Creek and Commissioners Creek during the September 2023 field survey (Table 30 of Appendix I).

Overall, none of the taxa recorded were considered to be threatened or of restricted distribution. Results indicated that assessed waterways were relatively healthy.

Aquatic vertebrates

The DPI-Fisheries Spatial Data Portal revealed that the freshwater fish community status in Commissioners Creek is considered 'poor'. The freshwater fish community status in Doon Doon Creek ranges from 'poor' to fair', is considered 'poor' in Clarrie Hall Dam and is 'fair' to 'good' in the Tweed River (DPI n.d. (a)).

Further review of publicly available desktop databases and a comprehensive literature review revealed that Clarrie Hall Dam provides habitat for a range of common fish species, both native and exotic.

Aquatic vertebrates were sampled at the 15 sites during September 2023 using a number of methods including boat and backpack electrofishing, bait traps, fyke nets and environmental deoxyribonucleic acid (eDNA) sampling, following the *Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999* (Department of Sustainability, Environment, Water, Population and Communities, 2011). Further details of aquatic vertebrate sampling are provided in section 4.2.6 of Appendix I.

A total of 18 fish species and 2 invertebrate species were recorded during the surveys (section 6.7.1 and Table 32 in Appendix I). Fish species consisted of 3 exotic species (common carp, eastern gambusia and pearl cichlid (*Geophagus brasiliensis*)), with the remainder all native species (Table 32 in Appendix I). Abundance, but not diversity, was highest at McCabes Bridge, primarily due to the presence of large numbers of an unknown gudgeon species (Table 32). Abundance and diversity were observed to increase in the lower reaches of Doon Doon Creek and the Tweed River.

DPI-Fisheries undertook fish surveys at 8 sites within Clarrie Hall Dam (Figure 16 of Appendix I) in September 2023, funded by the Recreational Fishing Trust. The results of the surveys are presented in Table 34 in Appendix I. Surveys undertaken by DPI-Fisheries in September 2023 identified 10 fish species or species complexes including 9 native species or species complexes and 1 exotic species (Table 34 in Appendix I). The carp gudgeon species complex was the most abundant, with 4,855 individuals recorded from 5 out of 8 sites (Table 34 in Appendix I). Carp gudgeons are widespread and common at mid to lower altitudes and are frequently found in coastal streams throughout coastal NSW (Murray-Darling Basin Authority 2009). Firetail gudgeons were also highly abundant at the time of the surveys, with 3,416 individuals recorded from 3 out of 8 sites (Table 34 in Appendix I). The firetail gudgeon is found in coastal drainages of eastern Australia from central Queensland to the Georges River, central NSW. The species prefers coastal freshwater streams, large rivers, floodplains, coastal wetlands, dune lake systems and dams and weirs, often around aquatic vegetation (Gomon & Bray 2022). Australian smelt were detected at 5 out of 8 sites, with 199 individuals recorded (Table 34 in Appendix I). The abundance of exotic species was low, with Eastern gambusia detected at 5 out 8 sites, and 55 individuals were recorded (Table 34 in Appendix I). Australian bass are stocked within Clarrie Hall Dam by DPI-Fisheries (DPI 2024c). During the September 2023 surveys in Clarrie Hall Dam, Australian bass were detected in low to moderate numbers at 7 out of 8 sites. Australian bass were last stocked in Clarrie Hall Dam in 2020–21 and appear to be persisting well (DPI 2024c).

Threatened aquatic fauna

The results of the desktop assessment and literature review indicate that 4 threatened aquatic species listed under the FM Act and/or the EPBC Act, and the platypus have the potential to occur in waterways within 50 km of Clarrie Hall Dam (refer to section 5.1.13 in Appendix I).

These species include:

- eastern freshwater cod (*Maccullochella ikei*)
- Mary River cod (*Maccullochella mariensis*)
- southern purple-spotted gudgeon (*Mogurnda adspersa*)
- Oxleyan pygmy perch (*Nannoperca oxleyana*)
- platypus (*Ornithorhynchus anatinus*).

Of these species, the platypus, Oxleyan pygmy perch and eastern freshwater cod are included on the DCCEEW (2020) provisional list of animal species identified as requiring urgent management intervention following the 2019–2020 bushfire season.

The eastern freshwater cod is listed as 'endangered' under both the EPBC Act and FM Act, while the Mary River cod is listed as 'endangered' under the EPBC Act only. The southern purple-spotted gudgeon is listed as 'endangered' under the FM Act, while the Oxleyan pygmy perch is listed as an endangered population under both the EPBC Act and FM Act.

While the platypus is not currently listed under the FM Act or the EPBC Act, there is a lack of knowledge regarding species abundance at a local catchment level, and the species is subject to similar impacts as threatened fish, including waterway bank erosion, channel sedimentation, regulated waterways, barriers to water flow (e.g. dams and weirs), riparian zone degradation and loss of riparian vegetation (Grant & Temple-Smith 2003; Hawke, et al. 2021).

An assessment was undertaken to evaluate the likelihood of each of these threatened aquatic species (including the platypus, although not listed as threatened) occurring within waterways intersecting the Proposal, or downstream of the Proposal, based on the aquatic habitats likely to be present, as well as existing literature and DPI-Fisheries datasets. Of the 5 species, only the platypus has been recorded in Clarrie Hall Dam, Doon Doon Creek, Commissioners Creek or the Tweed River in the last 20 years (Department of Environment and Heritage 2023). However, DPI-Fisheries data indicates that the southern purple-spotted gudgeon has the potential to occur within, immediately upstream, or downstream of Clarrie Hall Dam, and therefore has the potential to be impacted by the Proposal. The likelihood of occurrence assessment is provided in Appendix C of Appendix I.

The platypus was detected during the initial surveys and was considered prevalent throughout the Proposal area. All other species were considered common or exotic. eDNA analysis revealed one detection for an unidentified *Nannoperca* sp. (pygmy perch) considered likely to be Oxleyan pygmy perch given their historical distribution. However, Oxleyan pygmy perch was not detected during subsequent DPI Fishery surveys or targeted field surveys in January 2024 (refer to sections 4.2.7 and 6.7.3 of Appendix I for further details). All species recorded during the targeted surveys were considered common or exotic.

Aquatic flora

A wide range of aquatic flora is reported to occur within the Northern Rivers region. Wetland vegetation in the coastal floodplains is frequently dominated by Eleocharis spp.; swales in coastal dune systems are typically dominated by *Baumea* spp. In the tablelands of the Northern Rivers region, bogs are dominated by *Sphagnum* spp. and other *Cyperaceae* spp. A highly diverse mangrove community located in the Tweed River supports 5 species of mangrove including grey mangrove (*Avicennia marina*), stilt-rooted mangrove (*Rhizophora stylosa*), black mangrove (*Bruguiera gymnorhiza*), river mangrove (*Aegiceras corniculatum*) and milky mangrove (*Excoecaria agallocha*) (Department of Environment, Climate Change and Water NSW, 2010b).

Invasive species such as willow (*Salix* spp.), alligator weed (*Alternanthera philoxeroides*), Salvinia (*Salvinia* spp.) and water hyacinth (*Eichhornia crassipes*) are all reported to occur with the Northern Rivers catchment (Department of Environment, Climate Change and Water NSW 2010b).

A total of 22 macrophytes from 13 families were recorded across 15 sites during the September 2023 survey (section 6.5.2, Table 27 of Appendix I). A total of 17 native species of macrophyte and 5 exotic species of macrophyte were recorded across all sites. All sites supported macrophytes, with diversity and abundance varying between sites.

Threatened ecological communities

No purely aquatic EPBC Act listed threatened ecological communities occur in the vicinity of Clarrie Hall Dam. Clarrie Hall Dam does not occur within the bounds of any aquatic endangered ecological communities listed under the FM Act.

6.3.3 Impact assessment

The assessment of aquatic ecology detailed in Appendix I found the Proposal does not pose a significant impact to aquatic ecological values. A summary is provided below in the context of construction and operation of the Proposal.

Assessments of significance

Southern purple-spotted gudgeon

An assessment of significance was completed in accordance with the FM Act for the Southern purple spotted gudgeon (see Appendix G of Appendix I) and is summarised below.

The southern purple-spotted gudgeon is extremely rare in inland NSW and has no public records in the Northern Rivers catchment. Despite the presence of suitable habitat and adherence to survey guidelines, this species was not detected in Clarrie Hall Dam or associated waterways. Additionally, exotic species known to impact or compete with the southern purple-spotted gudgeon have been recorded in these areas. It is unlikely that Clarrie Hall Dam or associated waterways support populations of southern purple-spotted gudgeon.

The assessment of significance found that construction and operation of the Proposal is unlikely to significantly impact the southern purple-spotted gudgeon.

Platypus

The platypus is not currently listed as threatened under the EPBC Act. However, it has been nominated for listing as critically endangered. An assessment was therefore conducted under Matters of National Environmental Significance –Significant impact guidelines 1.1 (DEWHA 2013) to determine if a significant impact was likely (see Appendix H of Appendix I).

The assessment found that construction and operation of the Proposal is unlikely to significantly impact on the platypus given that changes to flows resulting from the Proposal are modelled to be minimal, and cold water pollution is modelled to improve marginally with the raised dam in place.

Construction

The construction of the dam wall will result in the direct loss of key fish habitat, including areas affected by the construction of ancillary infrastructure. It is estimated that 260 m² of key fish habitat will be lost during construction, along with an additional 23,200 m² due to the increased capacity of Clarrie Hall Dam. This results in a total loss of 23,460 m² of Type 1 Class 1 key fish habitat due to the Proposal. However, this potentially expands the habitat for aquatic biota, including the platypus.

Construction activities may degrade water quality within and downstream of the dam, and increased water levels may temporarily decrease water quality as inundated vegetation decomposes. Unlisted aquatic biota may be affected, but listed species under the EPBC Act and/or FM Act are unlikely to be present within Clarrie Hall Dam or downstream in Doon Doon Creek or the Tweed River. Overall, the construction is not expected to significantly impact listed species, and impacts on non-listed species can be minimised through management measures listed in Section 6.3.4. The Proposal will not introduce new impacts on fish passage.

Indirect impacts from raising Clarrie Hall Dam may include erosion and sedimentation smothering non-listed aquatic biota due to earthworks, overflows from site water treatment systems entering Clarrie Hall Dam or Doon Doon Creek, and changes to surface hydrology affecting water flow and pooling, potentially impacting aquatic biota emergence and/or persistence. Spilled contaminants could enter waterways or groundwater, affecting aquatic biota and riparian vegetation, while dust from blasting may decrease water quality, impacting aquatic flora and fauna. However, with the implementation of appropriate mitigation measures before and during construction, impacts on aquatic biota and habitat are expected to be minimal.

Operation

The raising of Clarrie Hall Dam will result in the direct loss of aquatic and riparian habitat due to the increased inundation area. Offsets are required for the direct loss of key fish habitat as a result of the Proposal – discussed further in section 6.3.4 of the EIS. Fish passage offset requirements are discussed below and in section 6.3.4.

The aquatic ecology assessment included determining the impacts of the depth of water in pools within Doon Doon Creek, which may vary by ± 0.1 m due to alterations to the flow regime as a result of the Proposal. Average flow velocities are expected to remain below 1 m/s almost 100% of the time (see section 8.5.2 in Appendix I).

Downstream impacts resulting from operation of the Proposal are considered to be nil to negligible and are limited to the following:

- a possible 10 cm increase in depth in riffle habitat within Doon Doon Creek, due to a predicted increased frequency of minimum releases from the raised dam
- no material changes in depth within riffle habitat in the Tweed River
- no material changes in depth within pool habitat in the Tweed River
- cold water pollution that would decrease in magnitude by 2 degrees celsius (i.e. a temperature increase) and increase in frequency by 10%
- nil to negligible impacts to platypus
- no impacts to the southern purple-spotted gudgeon as a result of the Proposal
- nil to negligible impacts to groundwater dependent ecosystems .

Direct impacts on aquatic biota are likely to be minimal; however, changes to flows and water levels (~10 cm) in Doon Doon Creek due to more frequent minimum releases from the dam, may negatively impact non-listed aquatic fauna, flora and the platypus. Alterations to the thermal profile in these waterways (modelled to increase by 2°C) could also adversely affect non-listed fauna, flora and the platypus. Additionally, overtopping of Clarrie Hall Dam during high flow events may lead to the loss and mortality of native fish washed over the outlet, in which is also the case for the current Clarrie Hall Dam.

Fish passage

The raising of the Clarrie Hall Dam triggers section 218 (Fishways to be provided in construction of dams and weirs) of the FM Act, which requires Council to notify the Minister of any proposal to

construct, alter or modify a dam, weir or reservoir on a waterway. Council notified DPI-Fisheries on 28 October 2021 regarding the Proposal and DPI-Fisheries responded on 14 July 2023, recommending the application of section 218, which requires the provision of suitable fish passage, be transferred to the construction of suitable fish passage at Bray Park Weir under section 4.8 (Fish Passage Trade-offs) of the *NSW Policy and guidelines for fish habitat conservation and management* (DPI 2013a).

Australian bass

Reduced flows downstream into Doon Doon Creek may have indirect impacts, including an increase in existing fish mortality events. Flows from Clarrie Hall Dam are thought to induce Australian bass to migrate up Doon Doon Creek. However, the dam's presence restricts the species to the lower 1.5 km of Doon Doon Creek, with the dam wall forming an impassable barrier. When flows from Clarrie Hall Dam cease, Australian bass may become trapped in pool refugia in high densities and must endure decreasing water quality over time.

The temperature assessment for Doon Doon Creek and Tweed River conducted as part of the hydrology assessment (section 6.1) states that moderate flow releases from Clarrie Hall Dam of more than 5 days are supportive of upstream Australian bass migrations. Currently, overtopping occurs in 86% of years (section 6.1). With the raised dam wall, the frequency of these types of flows is predicted to increase to 87% of years. If Australian bass are in fact cued to migrate upstream when these flows are released, the frequency of upstream migrations is likely to increase only marginally. As such, it is considered that the raising of the dam wall will create no new negative impacts to Australian bass.

It may be possible to stop the upstream migration of Australian bass into Doon Doon Creek by installing a barrier to fish passage at the mouth of Doon Doon Creek. However, this is considered undesirable and would have the effect of impeding the movement of all fish into Doon Doon Creek. This option would also generate costs associated with the loss of key fish habitat between the mouth of Doon Doon Creek and Clarrie Hall Dam. This option may also impact the downstream migration of Australian bass coming over the spillway, essentially interrupting the breeding cycle of the species.

There may be the potential to minimise large flows through management of water releases from Clarrie Hall Dam; however, this option will not entirely stop Australian bass entering Doon Doon Creek given the nomadic behaviour of the species.

Ultimately, even if access to Doon Doon Creek were blocked, it would not be possible to exclude Australian bass from the waterway. It is considered unlikely that mortality events can be completely avoided while the species is present within the catchment.

6.3.4 Mitigation measures

Table 6-46 identifies the mitigation measures that would be implemented during construction and operation of the Proposal to manage potential impacts to aquatic ecology due to the Proposal.

Offsets

Offsets are required for the direct loss of key fish habitat as a result of the Proposal. The NSW Biodiversity Offsets Policy for Major Projects states that offsets for aquatic biodiversity must have a relationship to the biodiversity values being lost and that offsets can be targeted to a higher conservation priority but must still relate to the biodiversity being lost.

The fish passage along Doon Doon Creek is currently impaired by the existing structure of Clarrie Hall Dam. There are no plans to install a fish ladder or lift on Clarrie Hall Dam, so the ability of fish to freely move between the upstream and downstream reaches would remain as it is now.

Consultation with DPI-Fisheries has been conducted on potentially improving the fish passage at Bray Park Weir to offset impacts to the fish passage at Clarrie Hall Dam.

DPI-Fisheries may require habitat-related offsets to compensate additional fish habitat-related impacts of the dam raising proposal beyond the FM Act fish passage provisions.

Table 6-46 Aquatic ecology mitigation measures

Reference	Impact	Mitigation measures	Responsibility	Timeframe
AQB1	General	An Aquatic Biodiversity Management Plan (AQBMP) would be prepared and implemented as part of the CEMP. The AQBMP would address the applicable regulations of the BC Act, FM Act and EPBC Act and the following guidelines: • Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull & Witherridge 2003) • NSW DPI-Fisheries Fishway Design Guidelines 2015 (DPI 2015) - as relevant to any proposed offsetting • Aquatic Ecology in Environmental Impact Assessment - EIA Guideline (DoP/Marcus Lincoln Smith 2003) • Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013 (DPI 2013a). The AQBMP will include but not be limited to: • measures to avoid and minimise adverse effects on biodiversity associated with the construction activities • measures to minimise the impact of construction on aquatic ecology • measures to avoid the introduction of weed and pest species • measures to protect riparian land in order to maintain current integrity of water resources.	Construction contractor	Pre-construction, construction
AQB2	Aquatic flora and fauna	Measures that would be included in the AQBMP and implemented are: • avoiding the platypus nesting period (October to March), if possible • using qualified ecologists to inspect construction areas along creek banks for platypus burrows before riparian vegetation clearing • using qualified ecologists to salvage and translocate aquatic fauna if dewatering is required (inclusive of acquiring specific permits and animal ethics approval) • minimising construction periods to reduce disruption to aquatic fauna, scheduling work during low flow periods • conducting daily inspections of the worksite, especially around the water's edge, to check for entrapped aquatic fauna • avoiding where possible removal of native riparian vegetation and ensuring bed, banks and riparian zone is progressively rehabilitated as soon as practicable following disturbance.	Design contractor, construction contractor	Detailed design, pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
AQB3	Offsets	Fish passage offsets will be provided by works, designed in consultation with DPI-Fisheries, undertaken at Bray Park Weir must be completed prior to the completion of Clarrie Hall Dam raising. DPI-Fisheries may require further habitat-related offsets to compensate the loss of key fish habitat. The extent of impacts to fish habitats documented in this EIS will be used in determining suitable habitat offsets.	Council	Pre-construction, construction



CHAPTER 6

Section 6.4 Protected and Sensitive Lands

6.4 PROTECTED AND SENSITIVE LANDS

This section describes the protected and sensitive lands surrounding Clarrie Hall Dam, identifies potential impacts during construction and operation of the Proposal, and provides measures to mitigate and manage the impacts identified.

The assessment of protected and sensitive lands has been undertaken in accordance with the SEARs shown in Table 6-47 and Appendix A.

Table 6-47 Relevant SEARs – protected and sensitive lands

Relevant key issue requirement/s	Where addressed
1. The Proponent must assess the impacts of the proposal on environmentally sensitive land including, but not limited to:	-
a) Protected areas (including land and water) managed by NPWS, DPI Fisheries under the *National Parks and Wildlife Act 1974*	Sections 6.4.2 and 6.4.3
b) Key Fish Habitat as mapped and defined in accordance with the *Fisheries Management Act 1994* (FM Act)	Sections 6.4.2 and 6.4.3 Section 6.3
c) Land or waters identified as Critical Habitat under the FM Act	Section 6.4.2 Section 6.3
d) Waterfront land as defined in the *Water Management Act 2000*	Section 6.4.2
e) Matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), or other Commonwealth legislation	Sections 6.4.2 and 6.4.3 Section 6.2
f) Areas of outstanding biodiversity value under the BC Act	Section 6.4.2 Section 6.2
g) Biodiversity stewardship sites, private conservation lands and other lands identified relating to offsets and biodiversity credits under the BC Act, or statutory schemes for biodiversity and conservation management.	Section 6.4.2
2. Maps must be included in the assessment that clearly indicate the project's proposed full supply level (FSL) and protected and sensitive lands which indicate the: (a) Areas indicated by backwater flooding upstream of the dam wall (for a range of flood conditions) (b) Flood storage zone (FSZ), if proposed (c) Flood mitigation zone (FMZ), if proposed	Figure 6-43 to Figure 6-45 FSZ and FMZ are not applicable as Clarrie Hall Dam (current and proposed) is not used for flood mitigation storage.

6.4.1 Assessment methodology

The protected and sensitive lands assessment has been conducted in accordance with applicable legislation and guidelines, as discussed below.

The assessment involved:

- identifying protected and sensitive lands
- reviewing specialist assessments prepared for this EIS
- assessing the potential impacts of the Proposal on protected and sensitive lands
- identifying measures to mitigate the potential impacts identified.

6.4.2 Existing environment

Protected and sensitive lands relevant to the Proposal are discussed in this section.

Protected areas

The regional study area contains a number of protected lands managed by the NSW NPWS under the NPW Act, as shown in Figure 6-43. The nearest protected areas are:

- Mount Jerusalem National Park – directly adjacent to the Proposal to the south-east
- Nightcap National Park – 2.4 km to the south
- Wollumbin National Park – 2.3 km to the north-west.

Mount Jerusalem National Park is listed on the state heritage register as High Conservation Value Old Growth Forest (SHR no. 01487).

Wollumbin National Park is listed on the state heritage register as an item of Gondwana Rainforests of Australia (SHR no. 01002). The Gondwana Rainforests is also listed on the National and World Heritage Lists.

These Nationals Parks are managed under the Parks and Reserves of the *Tweed Caldera: Plan of Management* (NPWS 2004).

The Proposal operational footprint would extend into a portion of Mount Jerusalem National Park. As discussed in section 4.2.1, approximately 1.91 hectares of Mount Jerusalem National Park has been revoked through the National Parks and Wildlife Legislation Amendment (Reservations) Bill 2020. This was passed by the NSW Government on 25 November 2020. The revoked land is currently vested in the Minister administering the NPW Act, pending transfer to Tweed Shire Council upon subdivision, land title registration and the transfer of compensatory land. At the time of publishing this EIS, negotiations with NPWS are in progress.

The revoked portion of Mount Jerusalem National Park is shown in Figure 6-44.

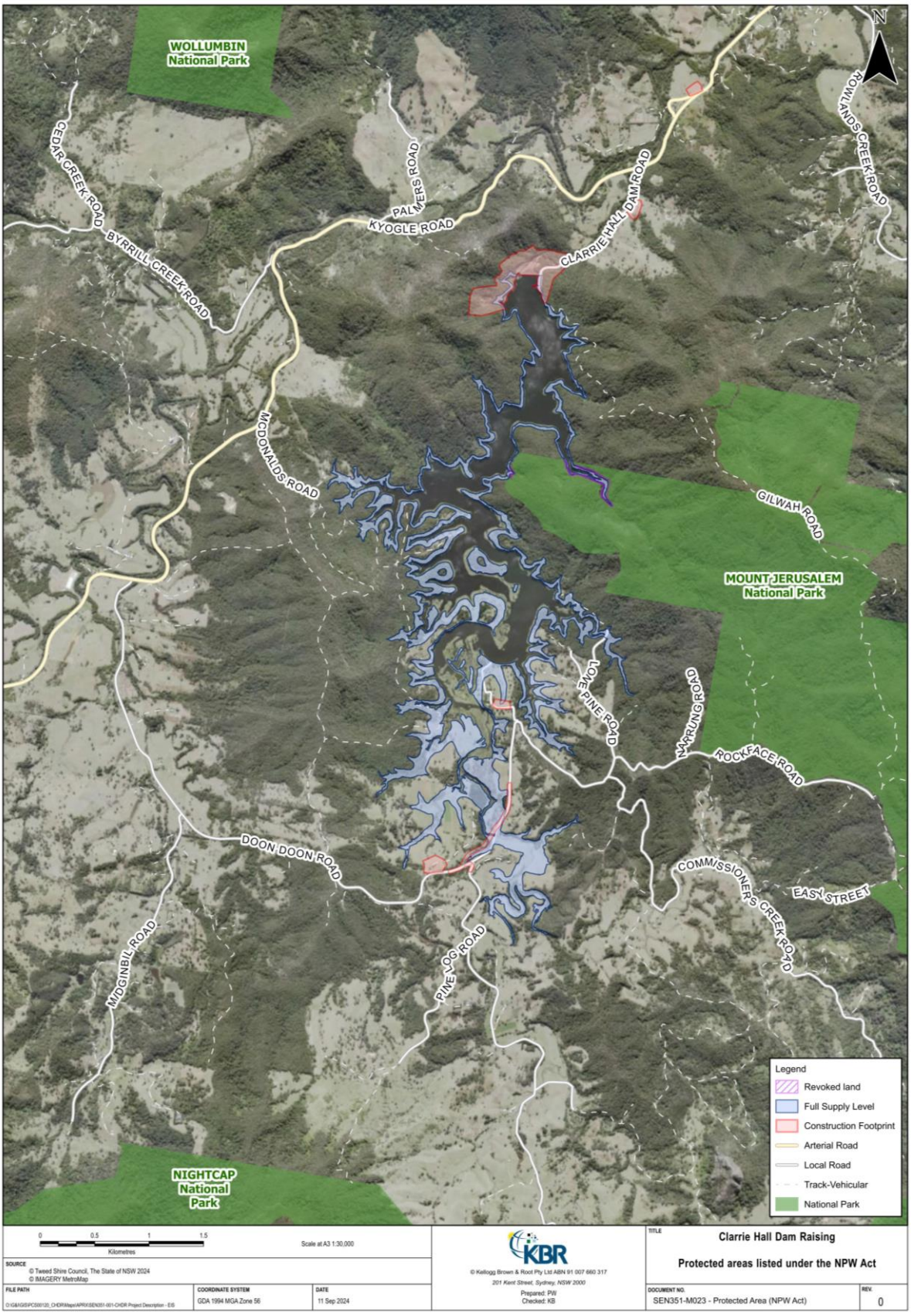


Figure 6-43 Protected lands managed under the NPW Act



Figure 6-44 Revoked portion of Mount Jerusalem National Park

No marine parks or aquatic reserves are listed under the NPW Act and the *Marine Estate Management Act 2014* that have the potential to be affected by the Proposal. Areas of NSW Crown land occur throughout the Proposal site and surrounds, as discussed in section 4.2 and shown in Figure 2-2 to Figure 2-4.

Key fish habitat

To achieve the objectives of the FM Act, DPI- Fisheries has identified 'Key Fish Habitats' as:

> those aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally, and the survival and recovery of threatened aquatic species.

Key fish habitat includes all marine and estuarine habitats up to highest astronomical tide level (the level reached by 'king' tides) and most permanent and semipermanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank.

Of the waterways in the Proposal area, the majority are considered to contain Key fish Habitat as mapped by the Department of Primary Industries. As discussed in section 6.3, the majority of waterways in the Proposal area are classified as Type 1 highly sensitive key fish habitat and Class 1 major key fish habitat.

These waterways include:

- Clarrie Hall Dam
- Doon Doon Creek
- Big Creek
- Commissioners Creek
- Tweed River.

Key fish habitat is shown in Figure 6-45.

Sites surveyed for the Aquatic Ecology assessment (section 6.3) found fish habitat including instream woody debris (snags), macrophytes, trailing bank vegetation, boulders and undercut banks. There was also the potential for the waterway to provide habitat for threatened aquatic species (such as the southern purple-spotted gudgeon).

Many sites, however, were found to be subject to pressures from surrounding land use such as riparian zone clearing, grazing, uncontrolled stock access and forestry activities.

The aquatic values identified at the Proposal site, including key fish habitat, is discussed further in section 6.3.

Critical habitat

The FM Act lists threatened species, populations and ecological communities; key threatening processes (KTPs); and declared critical habitat.

No land or waters identified as critical habitat under the FM Act are located in the Proposal area (refer to section 6.3).

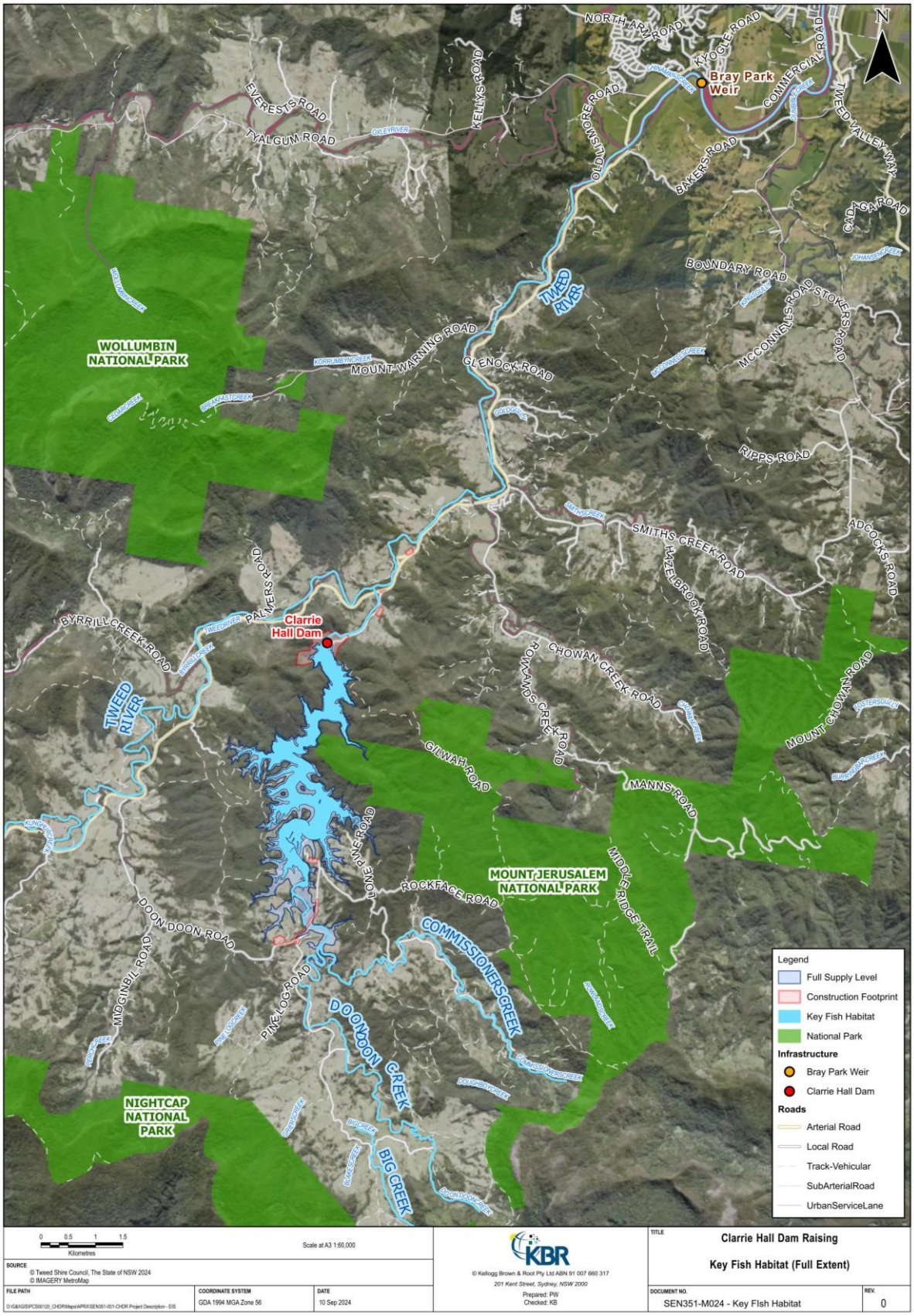


Figure 6-45 Key fish habitat within the Proposal area

Waterfront land

Under the WM Act, waterfront land includes the bed of rivers, lakes or estuaries, as well as land on each side within 40 metres of a riverbank. The Proposal includes waterfront land as defined by the WM Act.

The waterfront land surrounding the majority of Clarrie Hall Dam is densely vegetated, with the exception of the upstream extent of the dam, where vegetation has been cleared for agriculture.

Controlled activities refer to work or action done on waterfront land and usually require approval under the WM Act. However, as this Proposal is being assessed under Division 5.2 of the EP&A Act, a separate approval under the WM Act is not required.

Matters protected under Commonwealth legislation

As discussed in Chapter 1, the Proposal is a controlled action (2018/8339) under the EPBC Act due to the potential for significant impacts to Matters of National Environmental Significance (MNES) on the following controlling provision listed threatened species and communities (sections 18 and 18A).

This EIS has been prepared in accordance with the bilateral agreement between the NSW and Australian governments, so it includes an assessment of MNES.

MNES protected under the EPBC Act and potential impacts have been assessed and are discussed in sections 6.2 and 6.3.

Wollumbin National Park is listed on the National and World Heritage Lists as Gondwana Rainforests of Australia. Further details are provided in section 6.6.

The application of the NT Act is discussed in terms of water access in section 6.1 and in terms of native title claim in section 6.5.

Areas of outstanding biodiversity value

No areas of outstanding biodiversity value (AOBVs) under the BC Act are located in the Proposal area.

Areas of declared critical habitat under the Threatened Species Conservation Act 1995 became the first AOBVs in NSW with the commencement of the BC Act.

The nearest area of outstanding biodiversity value to the Proposal is Stotts Island Nature Reserve, located approximately 17 km downstream of Bray Park Weir within the alluvial flood plain system of the Tweed River (DCCEEW 2019). In 2001, this Nature Reserve was declared critical habitat for the Mitchell's rainforest snail (*Thersites mitchellae*). As this site is downstream of Bray Park Weir, impacts to Stotts Island Nature Reserve are not anticipated, as hydrology modelling shows that impacts beyond Bray Park Weir would not occur (refer to section 6.1 and Appendix G).

Biodiversity stewardship sites

There are no biodiversity stewardship sites, private conservation lands or other lands identified relating to offsets and biodiversity credits under the BC Act, or statutory schemes for biodiversity and conservation management within close proximity to the Proposal.

There are several private land conservation agreements locally. However, the exact locations are not publicly available information. The nearest Biodiversity Conservation Trust Wildlife Refuge and In Perpetuity lands are approximately 2 km north-west of the Proposal.

There is the potential for Council to develop stewardship sites as part of the offset strategy to be prepared if the Proposal is approved.

Flooding

Clarrie Hall Dam's purpose is to capture and store rainfall and runoff and then release water when needed into Doon Doon Creek, which flows into the Tweed River and Bray Park Weir.

Clarrie Hall Dam has been designed and built with an open and un-gated spillway. This means Council has no control over water spilling from the dam once the water level of the dam reaches the FSL.

Clarrie Hall Dam's open, un-gated spillway is not built to mitigate flooding, for the following reasons:

- The dam's location on Doon Doon Creek means the dam's catchment area takes in just 5.7% of the overall catchment area of the Tweed River and its upstream creeks and rivers. If a flood mitigation dam was built at Clarrie Hall Dam's location, even the closest downstream villages would continue to flood during high-rainfall events.
- To mitigate flooding, a larger dam would be needed. However, the proposed Clarrie Hall Dam upgrade for water supply purposes is the maximum feasible size for a dam at this location.
- The proposed upgrade will increase the storage capacity from 16,000 ML to 42,300 ML. Hydrology modelling shows up to 117,000 ML of rainfall will flow into the dam's catchment in one day during a PMF. That is 7.3 times the capacity of the current dam, or 2.8 times the capacity of the proposed dam. During the February 2022 floods, Council estimated that 70,000 ML, or 4.5 times the volume of the existing dam, passed through the dam spillway in just 2 days.
- One dam would offer little protection. To have even a minor flood-mitigation impact throughout the Tweed Valley, several very large dams would be needed to capture rainfall that feeds the Tweed, Oxley and Rous rivers. Previous flood studies have shown large dams at those locations would not be practical.
- Clarrie Hall Dam, like all open, un-gated spillway dams, may help mitigate against flooding to some minor extent. Dams do that by reducing the peak height of a flood. This happens even when a dam is full and water is spilling.
- Water flowing into Clarrie Hall Dam during periods of intense rainfall flows over the dam's open, un-gated spillway. Because the dam is wider than the river and has a large surface area and a narrow outlet (the spillway), it slows the flow of water. If the dam did not exist, these large flows would make their way very quickly to the Tweed River, resulting in higher river-flow peaks downstream.

Clarrie Hall Dam therefore does not have a flood storage zone or a flood mitigation zone. The FSL is the crest level of the spillway.

6.4.3 Impact assessment

As discussed above, Clarrie Hall Dam does not have a flood mitigation zone or a flood storage zone. However, the assessment has considered backwater flooding upstream of the dam wall, for a range of flood conditions.

Potential construction and operational impacts to protected and sensitive lands are discussed below.

Construction impacts

Protected areas

Due to the distance to Nightcap National Park and Wollumbin National Park, impacts from the Proposal on these protected areas are not anticipated during construction or operation.

Mount Jerusalem National Park is adjacent to the Proposal area, as shown in Figure 6-43. The dam wall construction area is about 1.6 km to the north, and the works associated with McCabes Bridge and Commissioners Creek Road are approximately 1.8 km away. Therefore, construction impacts are not anticipated, as water levels would not increase until the dam wall is raised.

Notwithstanding, Table 6-48 considers potential impacts on the national park during construction in accordance with *Development adjacent to National Parks and Wildlife Service lands: Guidelines for consent and planning authorities* (DPIE 2020c).

Table 6-48 Consideration of construction impacts on Mount Jerusalem National Park

Key issue	Consideration
Erosion and sediment control	There would be limited erosion and sedimentation impact on the national park given the distance to the dam wall construction. Erosion and sediment control measures would be implemented during construction. Refer to sections 6.1 and 6.8.
Stormwater runoff	A surface water assessment has been undertaken A summary is provided in section 6.1. Impacts to the National Park during construction would be minimal. Erosion and sediment control measures would be implemented during construction. Refer to sections 6.1 and 6.8.
Wastewater	Wastewater collection would be required during construction near the dam wall. The potential impacts to the national park are considered negligible, as wastewater would be collected via a plumbed storage tank for road tanker collection and exported to a centralised wastewater treatment facility. Refer to Chapter 3 for further information.
Pest, weeds and edge effects	The potential impacts from pests, weeds and edge effects are considered negligible due to the distance from the main construction area to the national park. There is also a vegetative buffer between the Proposal and the national park. This is discussed further in section 6.2.
Fire and the location of asset protection zones	Refer to section 6.13 for information on bushfire risk and asset protection zones.
Boundary encroachments and access through NPWS land	During construction, there would be no access to NPWS land. The transfer of revoked land is discussed in section 6.4.2.
Visual, odour, noise, vibration, air quality and amenity impacts	During construction, there is the potential for the Proposal to result in amenity impacts on the national park. However, the dam wall construction is about 1.6 km and Commissioners Creek Road construction is about 1.8 km from the national park at their nearest points. Any amenity impacts during construction are considered minimal. Refer to sections 6.12 and 6.13 for further information.
Threats to ecological connectivity and groundwater-dependent ecosystems	There would be no additional threats to ecological connectivity and groundwater-dependent ecosystems due to construction activities.
Cultural heritage	There would be no impacts to cultural heritage in the national park during construction. Refer to section 6.5 for a discussion of Aboriginal heritage.
Access to parks	The Proposal would not compromise public and NPWS access to the national park.

Some areas of NSW Crown land would also be impacted by the Proposal. Potential impacts on Crown land are considered in section 6.7.

Key fish habitat

Direct loss of key fish habitat would occur as a result of the Proposal. These losses are associated with the construction of the Proposal. The extent of the impact and associated offsets are discussed in section 6.3.

Other construction activities that may indirectly impact on key fish habitat are also discussed in section 6.3. These include water quality, loss of riparian habitat, contaminants, changes to surface hydrology and dust impacts.

Matters protected under Commonwealth legislation

MNES protected under the EPBC Act and potential impacts have been assessed and are discussed in section 6.2 and 6.3.

Wollumbin National Park is not anticipated to be impacted during construction.

The application of the NT Act is discussed in terms of water access in section 6.1 and in terms of native title claim in section 6.5.

Operational impacts

Protected areas

Once the proposed Clarrie Hall Dam is operational and at FSL, the dam would impact Mount Jerusalem National Park. However, approximately 1.91 hectares of Mount Jerusalem National Park has been revoked and is currently pending transfer to Council once subdivision, land title registration and the transfer of compensatory land is finalised, as discussed in section 6.4.2.

Council has been negotiating with NPWS regarding the transfer of compensatory land.

Once the transfer has been completed, no impacts to Mount Jerusalem National Park are anticipated. The impacted portion of the existing national park would be owned by Council and be subject to Council management and maintenance. The ongoing administrative requirements would be agreed and managed by NPWS and Council as required.

In accordance with *Development adjacent to National Parks and Wildlife Service lands: Guidelines for consent and planning authorities* (DPIE 2020c), Table 6-49 considers potential impacts on the national park during operation.

Table 6-49 Consideration of operational impacts on Mount Jerusalem National Park

Key issue	Consideration
Erosion and sediment control	The Proposal may lead to erosion. This is discussed in section 6.8 (Soils and Contamination).
Stormwater runoff	Stormwater runoff is expected to continue to flow via existing channels.
Wastewater	The Proposal would not result in adverse impacts on NPWS land due to wastewater issues during operation.
Pest, weeds and edge effects	The Proposal is unlikely to result in pests, weeds and edge effects on NPWS land. This is discussed in section 6.2.
Fire and the location of asset protection zones	Refer to section 6.13 for information on bushfire risk and asset protection zones.
Boundary encroachments and access through NPWS land	The transfer of NPWS is in progress, subject to subdivision, land title registration and the transfer of compensatory land. This is anticipated to be completed prior to construction. During operation, there would be no access or boundary encroachments through NPWS land.

Key issue	Consideration
Visual, odour, noise, vibration, air quality and amenity impacts	The Proposal would not result in a reduction of amenity on NPWS land.
Threats to ecological connectivity and groundwater-dependent ecosystems	Ecological connectivity may improve due to the compensatory land provided to NPWS.
Cultural heritage	An assessment of cultural heritage is provided in section 6.5.
Access to parks	The Proposal would not compromise public and NPWS access to the national park.

Key fish habitat

The Proposal would negatively impact key fish habitat. There would be minor alterations to flows downstream of Clarrie Hall Dam due to the increased capacity, as discussed in section 6.3. There may also be changes to the thermal profile within Doon Doon Creek and the Tweed River. Direct impacts on aquatic fauna are considered likely to be minimal.

The operational impacts are discussed further in section 6.3, in addition to the proposed offset approach.

Flooding upstream of the dam wall may also impact key fish habitat, as discussed in section 6.3 and shown in Figure 6-46.

Matters protected under Commonwealth legislation

MNES protected under the EPBC Act and potential impacts have been assessed and are discussed in section 6.2 and 6.3.

As Wollumbin National Park is listed on the National and World Heritage Lists as Gondwana Rainforests of Australia, an assessment has been conducted, which is discussed in section 6.6.

The application of the NT Act is discussed in terms of water access in section 6.1 and in terms of native title claim in section 6.5.

Cumulative impacts

The cumulative impacts of the Proposal on protected and sensitive lands are considered in sections 6.2 and 6.3 of this EIS.

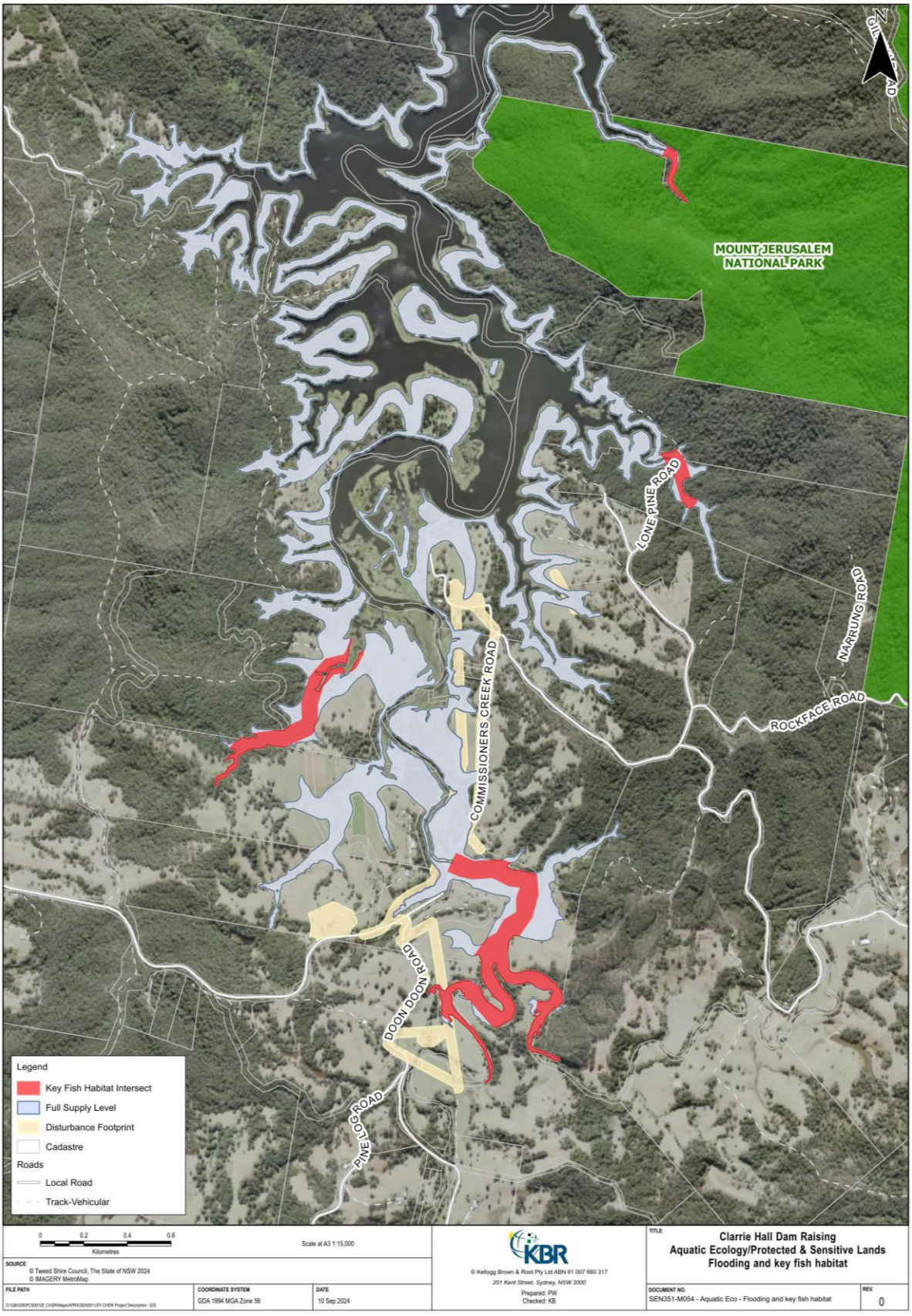


Figure 6-46 Flooding and key fish habitat

6.4.4 Mitigation measures

Approach to mitigation and management

The overall approach to managing impacts on protected and sensitive lands is, in order of importance, to:

- avoid impacts through the planning and design process
- mitigate impacts using a range of mitigation measures
- offset any residual impact that could not be avoided or mitigated as required by relevant legislation.

The main impacts associated with the Proposal during construction are confined to the dam wall area, McCabes Bridge and Commissioners Creek Road, and ancillary facilities. Once the dam is operational, the FSL is not expected to impact on protected and sensitive lands associated with Mount Jerusalem National Park.

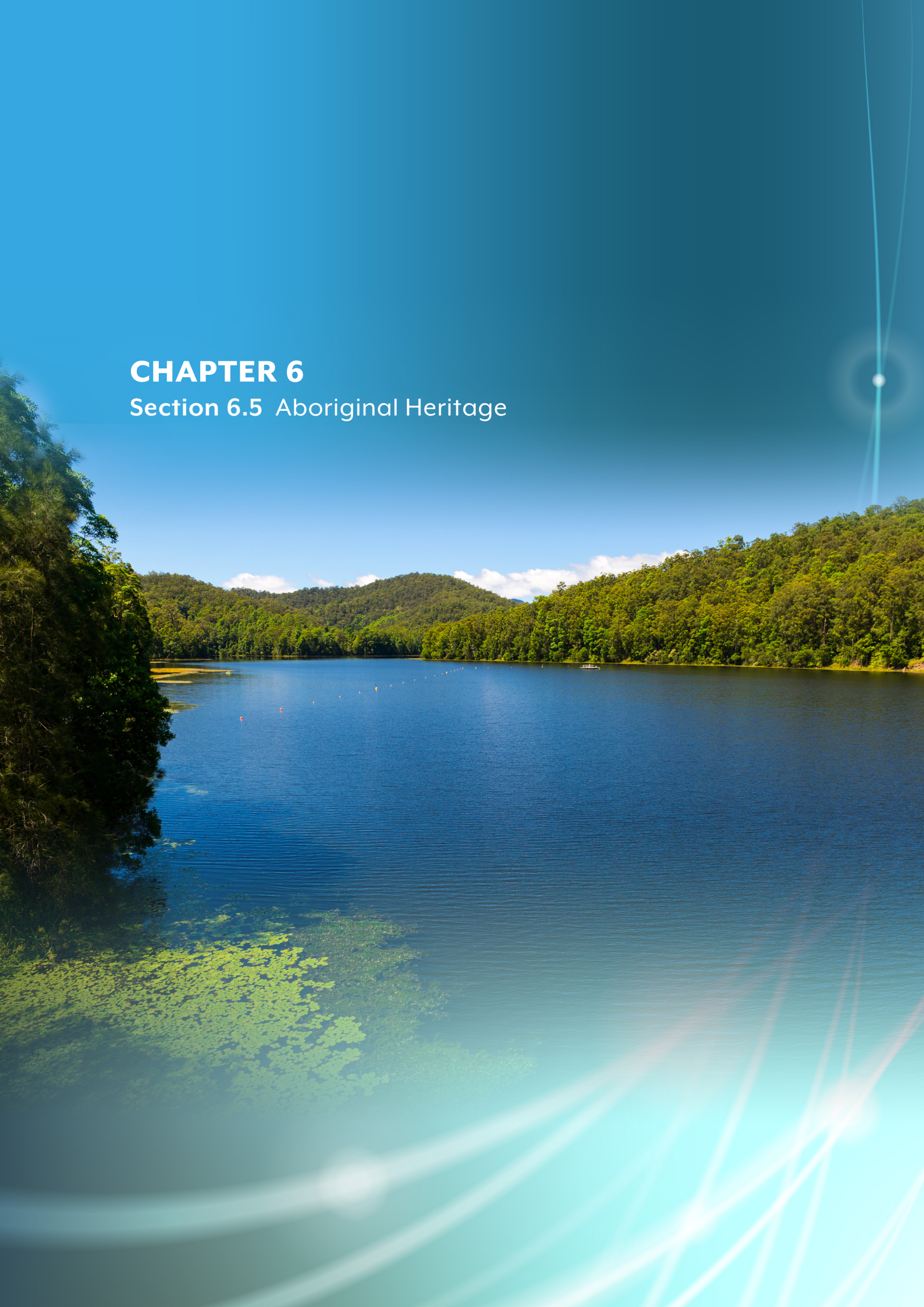
Measures to mitigate impacts that cannot be avoided are provided in Table 6-50 and Appendix E.

Mitigation measures

An additional mitigation measure to be implemented to address potential impacts on protected and sensitive land is provided in Table 6-50.

Table 6-50 Protected and sensitive land mitigation measures

Ref	Impact/issue	Mitigation measures	Stage	Responsibility
PS1	Impacts to Mount Jerusalem National Park	Revoked portion of Mount Jerusalem National Park is to be transferred to Tweed Shire Council pending subdivision, land title registration and the transfer of compensatory land.	Detailed design / pre-construction	Council



CHAPTER 6

Section 6.5 Aboriginal Heritage

6.5 ABORIGINAL HERITAGE

This section provides a summary of potential impacts to Aboriginal heritage during construction and operation of the Proposal, as detailed in the Aboriginal Cultural Heritage Assessment Report (ACHAR) provided in Appendix J.

A summary of the relevant SEARs and where they are addressed is included in Table 6-51.

Table 6-51 Relevant SEARs - Aboriginal heritage

Relevant key issue requirement/s	Where addressed
The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: (a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines (b) Aboriginal places of heritage significance, as defined in the Standard Instrument - Principal Local Environmental Plan (c) Environmental heritage, as defined under the Heritage Act 1977 (d) Items listed on the National and World Heritage lists.	Section 6.5.3 Section 8 and Appendix A of the ACHAR (Appendix J) Number 1(c) is addressed in the historical heritage assessment section 6.6 and Appendix Y.
The EIS must identify and describe the Aboriginal cultural heritage values that exist across the whole area that will be affected by the proposal and document these in an Aboriginal Cultural Heritage Assessment Report (ACHAR). This may include the need for surface survey and test excavation. The investigation, assessment and reporting of Aboriginal cultural heritage values must be conducted in accordance with the current Code of Practice and Guide and in consultation with Heritage NSW regional branch officers. Impacts on Aboriginal cultural heritage values are to be assessed and documented in the ACHAR. The ACHAR must demonstrate attempts to avoid impact on cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, the ACHAR must outline measures proposed to mitigate impacts. Any objects recorded as part of the assessment must be documented and notified to Heritage NSW	Sections 6.5.2 and 6.5.3 Appendix J with specific reference in sections 6, 8 and 9
Consultation with Aboriginal people must be undertaken and documented in accordance with the current consultation requirements for proponents. The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be documented in the ACHAR.	Sections 6.5.1 to 6.5.3 Appendix J with specific reference in section 2

6.5.1 Methodology

The Aboriginal Cultural Heritage Assessment Report (ACHAR) has been undertaken in accordance with the requirements of the following NSW government guidelines:

- Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH 2011b)
- Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW 2010).

The ACHAR includes:

- desktop review of previous assessments and information
- Aboriginal consultation
- field survey
- assessment of impacts and mitigation.

Desktop review

The desktop review primarily consisted of reviewing and summarising previous Aboriginal cultural heritage assessments conducted, including by Navin Officer Heritage Consultants (NOHC) (2018) and Eco Logical Australia (ELA) (2021) which are discussed in Appendix J. This has been supplemented with new information where relevant. Other documents reviewed have been referenced throughout the ACHAR (Appendix J) and this section.

AHIMS search

The Aboriginal Heritage Information Management System (AHIMS) database provides the location and description of Aboriginal objects and sites recorded through academic research and cultural heritage management. The database is managed by Heritage NSW and provides a comprehensive overview of recorded cultural sites.

A search of the AHIMS database was conducted for the ACHAR on 17 November 2023 (ID 840897). The database displays the frequency and distribution of Aboriginal site types in the broader landscape.

Aboriginal consultation

The Aboriginal consultation for the assessment adopted the processes and methods outlined in Heritage NSW's Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (NSW DECCW 2010).

Aboriginal consultation for the Proposal has in various forms extended over 14 years, having been initiated by Council in 2009, followed by NOHC in July 2017, continued by ELA between 2020 and 2021 and most recently by EMM since mid-2023. Over this period, a core group of local Bundjalung traditional owners and the Tweed-Byron Local Aboriginal Land Council (LALC) have been involved. These activities highlighted several issues associated with the Proposal, including a general concern over potential impacts, the need to consider cultural and intangible values, and the further exploration of several rockshelters on the edge of the inundation area.

As a result of the length of the project, the consultation process was restarted in accordance with Heritage NSW guidelines in mid-2023. This included the re-registration of several of the local Aboriginal communities previously involved, and additional individuals. The re-registration process is detailed in Appendix J (Section 4.3).

Additional tasks to further explore the issues previously raised by NOHC (2018) and ELA (2021) were undertaken by EMM, and feedback on these issues has been generally positive. This includes undertaking a Proposal-specific cultural values mapping study and further consideration of key rockshelter sites. Overall sentiment for the Proposal remains mixed, with an acknowledgment of the need for water security but continued concerns over impacts to cultural heritage.

A summary of the consultation process undertaken by EMM is provided below, and full documentation of the consultation process is provided in Appendix J. As per the Aboriginal Cultural Heritage Consultation Requirements for Proponents (NSW DECCW 2010) consultation has been completed across a 5-stage process including:

1. pre-notification - identification of the Aboriginal individuals and/or communities relevant to the project area
2. notification - contacting all Aboriginal individuals and/or communities identified in Stage 1 to determine their interest in being consulted during the project. Those Aboriginal individuals and/or communities that wish to be consulted become a 'registered' Aboriginal party (RAP)
3. presentation of Proposal information/assessment methodology - briefing RAPs about the Proposal and scope of any Aboriginal heritage assessment and investigations
4. impacts and mitigation strategies - discussion of potential impacts to cultural materials and mitigation options with the RAPs prior to developing the ACHAR

5. report review - the RAPs are provided an opportunity to review and comment upon the draft ACHAR, to contribute input into the overall findings, significance and management of cultural heritage.

A range of other strategies to promote transparent and frequent two-way dialogue between the Aboriginal community and the Proposal and its earlier iterations have been implemented. Specifically, this included:

- face-to-face meetings - including specific exploration of key issues raised in ELA (2021) as part of recent interactions
- regular catch-ups - which enable ongoing consultation that has extended over the course of several years and enable regular liaison and discussion
- field investigation participation - all RAPs were offered the opportunity to attend a range of field survey and test excavation activities carried out across the Proposal as part of the 3 Aboriginal cultural heritage assessments
- cultural values mapping - a dedicated investigation of intangible and cultural places, stories and values by an experienced anthropologist in consultation with several Elders and/or knowledge-holders across the Tweed Shire region. This enabled a broader number of the local Aboriginal community members to provide input to the Proposal who would otherwise have been unable to provide input.

A summary of Aboriginal consultation activities undertaken for the Proposal since early 2023 is included in Table 6-52.

Table 6-52 Summary of Aboriginal consultation activities undertaken since early 2023

Stage	Description	Date initiated	Date completed
1	Government agency pre-notification	18 May 2023	
	Advertisement in the *Tweed Valley Weekly*	1 June 2023	
	Notification and registration of potential Aboriginal stakeholders	31 May 2023	14 June 2023
	Advising Heritage NSW and Tweed Byron LALC of RAPs	4 July 2023	
2/3	Presentation of information about the proposed project and additional tasks	18 July 2023	14 August 2023
	Invitation to a Cultural values mapping workshop	31 July 2023	
	Fieldwork - rockshelter management site visit	14-15 August 2023	
	Fieldwork - cultural values mapping	25 September 2023	26 September 2023
	Fieldwork - additional survey	17 January 2024	18 January 2024
4	Review of the draft ACHAR report	17 June 2024	19 July 2024

Field survey

Archaeological test excavation

NOHC (2018) identified several potential archaeological deposits (PADs) and stone artefact scatters with potential for subsurface deposits. Subsequently, ELA (2021) undertook test excavations to further characterise and refine these cultural deposits (Appendix A). These archaeological test excavations were undertaken between 29 June and 28 August 2020. The works focused on 19 sites identified by NOHC (2018) during the field survey, distributed across the Proposal area and

predominantly on crests and upper slopes adjacent to the current reservoir (Figure 5.1 in Appendix J). Commonly, these locales would have been in close proximity to Doon Doon Creek prior to its inundation.

ELA (2021) adopted Heritage NSW's Code of Practice for the Archaeological Investigations of Aboriginal Objects in NSW for the archaeological excavations.

Additional field survey

A small number of areas were subject to additional field survey by EMM as part of the Proposal for the ACHAR. This primarily included the locations of ancillary infrastructure sites (construction workers accommodation, concrete batching plant site, construction compounds and transmission lines to the south of the Proposal area), and further consideration of Doon Doon Creek downstream of the dam. While the hydrology assessment (section 6.1) indicated no visible or material changes to the creek, inspection of the banks was undertaken to ensure a comprehensive assessment.

The field survey was conducted by EMM archaeologists with the assistance of RAP representatives (Table 5.4 in Appendix J) between 17 and 18 January 2024. The survey was completed over a total of 2 field days and was directed by Mikhaila Chaplin with the assistance of Courtney Culley (EMM archaeologists).

The primary aims of the survey were to:

- identify Aboriginal archaeological sites and/or Aboriginal places with the assistance of Aboriginal knowledge holders
- characterise the landscape to aid predictions of archaeological potential
- identify sites or areas that would require further investigation if planned for development as part of the Proposal
- identify sites or areas to be avoided by development, where possible
- identify areas with minor or negligible Aboriginal cultural heritage values that are most suitable for development.

Assessment of impacts

All Aboriginal objects in NSW are protected under the *National Parks and Wildlife Act 1974*. It is recognised that the destruction of sites may be necessary to allow other activities or developments to occur. In order for the consent authority to make informed decisions on such matters, an important element of cultural resource management is determining the significance of cultural heritage places and objects to understand what may be lost and how best it can be mitigated.

Cultural significance is outlined in Article 1.2 of the Burra Charter - the best practice document for managing cultural heritage - as 'aesthetic, historic, scientific, social, or spiritual value for past, present or future generations' (Australia ICOMOS 2013). These values are reiterated in the NSW guidelines, which determine cultural significance of a place can be assessed by identifying the values that are present across the subject area and assessing what is important and why (OEH 2011). In assessing the scientific significance of sites, aspects such as rarity and representativeness and the integrity must be considered. Generally speaking, a site or object that is rare will have a heightened significance, although a site that is suitable for conservation as 'representative' of its type will also be significant. Conversely, an extremely rare site may no longer be significant if its integrity has been sufficiently compromised.

The assessment of significance and impacts was conducted according to the results of the data and information obtained as discussed above and the Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH 2011).

6.5.2 Existing environment

The Proposal area is situated within the tribal boundaries of the Bundjalung people and is associated with the dialects of the Nganduwal/Nagondowal language.

The region contains a number of significant Dreaming sites and stories including:

- the Ngunthungulli story about a supreme being that travelled from Byron Bay westwards, which included Wollumbin and Woodenbong
- the Sisters story about a cultural hero, Gwyala, a hunter who had two dogs important to him. The dogs were killed and buried at Wollumbin. Two peaks, Ningeroongun and Barrajanda, reflect the names of the dogs
- Black Bean trees story in relation to the use of the black bean tree (Castanospermum australe), which was considered a sacred plant. The story includes the death of a young man at the hands of witches that protected the trees.

Environmental context

The local landscapes consist of topography, hydrology, geology and soils suitable to provide natural resources that would be available to and sought after by Aboriginal people in the past. Natural resources including flora and fauna would have provided food, tools and ceremony (culturally modified trees), whilst the proximity to fresh water allowed for farming and life. Landscape features in the region including sandstone overhangs were used for shelter and stone artefacts, and tools were manufactured from raw stone material that was collected from quarry sites.

Key environmental features in the project area include:

- Lithic resources provide a suitable material for Aboriginal modification include outcrops of fine-grained volcanic rocks, quartz vein outcrops and fluvial pebble gravels.
- Distribution of river gravels has been determined by late tertiary and Quaternary river diversions that were preferred areas of Aboriginal camp sites.
- Doon Doon Creek is a fifth-order watercourse, located centrally within the project area with its lower order tributaries scattered in its surrounds.
- The topography around the site is characterised mostly by a range of landforms such as steep hills, undulating rolling hills, alluvial plains, terraces and major channels, with elevations ranging from 5 to 400 m AHD.
- Most of the original native eucalypt forest, with the exception of localised areas, has been cleared from the project area as a result of agricultural and timber getting activities. However, several culturally modified trees may suggest disparate remnant trees of patches of vegetation, particularly on the north-eastern side of the dam.
- Previous land use activities across the project area involved low-intensity farming and pastoral activities, primarily cattle grazing and dairying, and timber-getting activities involving logging, which resulted in localised clearing of vegetation across the region.

A detailed description of the environmental context of the project area is included in Appendix J.

Archaeological findings

The Proposal area includes a rich cultural landscape with evidence of extensive but unrelated human activity along Doon Doon Creek. Aboriginal objects and sites have been identified within the Proposal area and near Doon Doon Creek (Figure 6-47). A detailed description of these sites, summarised below, is included in Appendix J.

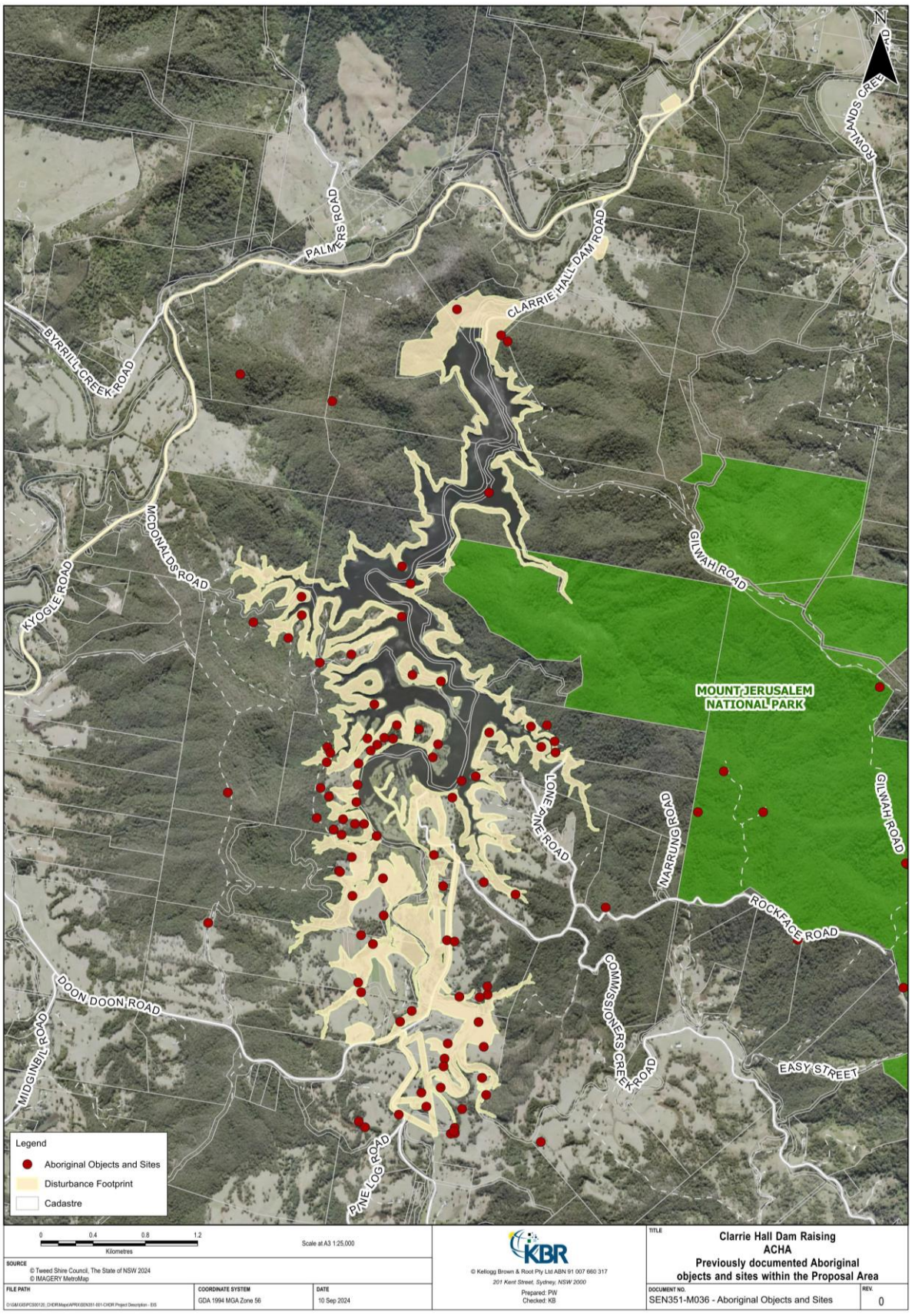


Figure 6-47 Previously documented Aboriginal objects and sites within the Proposal Area

Three archaeological assessments were completed prior to NOHC (2018) and ELA (2021). The findings of these assessments are summarised below:

- Eight Aboriginal objects and sites were recorded as part of the field survey undertaken by Sullivan and Dallas in 1978 across Doon Doon Creek. They noted, but typically did not record, isolated cultural materials. The project area for their assessment was located up to the current FSL. The sites identified by Sullivan and Dallas included 5 artefact scatters (DD1, DD2, DD3, DD4 and DD7), 2 rockshelters (DD5 and DD6) and a grinding groove site (DD8). All but DD5 (#04-1-0013), were located within the impact area. At the time of Sullivan and Dallas' assessment, DD6 (#04-1-0014) retained several flake stone artefacts across its ground surface and one flake stone artefact from subsurface investigations. Sullivan and Dallas 1978 assessment stated the rockshelter site DD6 had low archaeological significance and limited research potential.
- Another 3 sites were recorded by Piper in 1979 as part of its assessment for Doon Doon Creek after conducting an archaeological survey over the area. These sites included a culturally modified tree (DD9), an artefact scatter (DD10) and an isolated find (DD11). Little further information on these sites is available, and they do not appear to have been listed in the AHIMS database (section 3.2.3). It is likely that they would be beneath the current FSL, given that the study was undertaken, in part, to revisit Sullivan and Dallas' (1978) assessment.
- A preliminary archaeological overview of the proposed Clarrie Hall Dam was prepared by Southern Cross University (SCU) in 2008. The survey area included locales proposed to be permanently inundated with an FSL of up to 80 m AHD (compared with 70 m AHD proposed for this Proposal) and impacts from the construction of the dam wall. At the time of SCU's assessment, it noted that 21 Aboriginal sites were already previously recorded in the region, with 5 considered lost by the construction of the dam. Eight new Aboriginal sites were recorded as a result of SCU's field survey (CH1, CH2, CH3, CH4, CH5, CH6, CH7 and CH8). Six of these sites were identified as open artefact scatters, with the remaining 2 sites noted as isolated stone artefacts. None of these appear to be recorded within the AHIMS database, and information on their location is limited since the subsequent report is not available in public repositories.
- In 2006, the Aboriginal community in conjunction with Ian Fox and Southern Cross University (SCU) undertook radiocarbon dating across a selection of rockshelter sites in Tweed Valley. One site included the Byrill Ridge Rockshelter/DD5 (AHIMS #04-1-0013), located within the Doon Doon Creek catchment some 3.2 km east of the project area. Samples from this site returned dates up to ~3,000 years ago (ka). Comparatively, some of the earliest sites recorded in the Tweed region were recovered from the analysis of shellfish remains (7.4 km from Banora Point (Fox & Slabb 2016), although more recent work suggests Aboriginal activity by at least 13 ka in the coastal region (Appendix J).

AHIMS database search

A detailed description of the previous and updated AHIMS search results for the Proposal area is included in Appendix J.

The updated AHIMS search identified 107 previously registered Aboriginal sites within a 10 km search area. This included grinding grooves, artefact scatters, culturally modified trees, habitation structures, art sites, stone arrangement, potential archaeological deposits (PADs), Aboriginal resource and gathering, ceremonial sites, stone quarries, isolated finds and shell midden sites. Seventy-three of these sites had been identified by NOHC (2018) and ELA (2021) as part of earlier Aboriginal cultural heritage assessments of the Proposal. Thirty-two of the sites were located under the FSL and were likely to be impacted by the Proposal, with a further 33 sites located within the area between the FSL and PMF level. A total of 11 restricted sites were identified, of which 2 were located within the Proposal area. Discussions with Heritage NSW indicate that there are no other significant sites located within the Proposal area.

The location of Aboriginal sites in the project area seems to be largely influenced by the location of previous archaeological investigations centred on Doon Doon Creek and the various assessments of Clarrie Hall Dam. Most of the sites are located in areas where Doon Doon Creek and its associated tributaries would have flowed. Cultural materials have been mostly found nearby the original Doon Doon Creek alignment and where landforms are less steep. Cultural materials are more likely to be limited on the steep slopes that surround the current dam.

Field investigations

Various field works were undertaken over a 6-year period by various consultants. When combining and ratifying these findings, some 14 Aboriginal objects and sites were identified within the proposed FSL and other construction and ancillary development areas, amongst the continuous background distribution of surface and shallowly buried artefacts across the Proposal area. This increased to 17 when considering the area between the FSL and PMF level.

NOHC (2018) originally identified several stone artefact scatters with potential for subsurface deposits. This was further evaluated by test excavations undertaken by ELA in 2021.

The additional field surveys undertaken in this ACHAR by EMM identified one new Aboriginal site along a cattle-track exposure located on a hillslope landform south of the driveway on the property . The surrounding area included low-lying grass coverage with low visibility and appeared to have been subjected to a relatively low degree of historical disturbance.

When reviewing the results of the field assessments, 14 discrete Aboriginal objects and sites were identified within the proposed FSL, and 17 were identified between the FSL and the PMF level. These can be broken down as:

- 2 rockshelter sites located at closely spaced overhangs on the same sandstone outcropping and documented under the same AHIMS listing
- 2 culturally modified trees and a potential third tree that was identified during the rockshelter investigations for this
- one natural chalcedony outcropping identified as a potential quarry
- 9 areas of past foci and characterised by high densities of sub-surface artefacts ($\bar{x}$ = ≥24/m^2), which are considered to reflect extensive and/or repeated visitation and occupation by people over the last few thousand years. Based on field observations and previous archaeological fieldwork, the average size of these sites is between 0.12 and 1.5 ha
- a stone artefact background scatter that is predicted to occur intermittently across the project area and extending beyond its limits within which intermittent low to moderate artefact densities of 1-23/m^2 may be expected intermixed with culturally sterile zones. This includes many the previously recorded sites (n=65) currently documented across the project area and outlined in subsequent sections.

In the area between the proposed FSL and PMF (level (70-77 m AHD), an additional 3 Aboriginal objects and sites would be encompassed by the Proposal:

- 2 areas of past foci and activity characterised by a high density of sub-surface artefacts that reflect extensive and/or repeated visitation and occupation by people over the last several thousand years
- one grinding groove.

Continuation of the stone artefact background scatter is predicted to occur intermittently across the project area and extending beyond its limits within which disparate low to moderate artefact densities of 1-23/m^2 may be expected.

Cultural values mapping

In response to RAP concerns and to address the SEARs (Table 6-51), further exploration of cultural and intangible values was undertaken for the Proposal.

Project-specific cultural values mapping was undertaken for the ACHAR (Appendix J) with the participation of several identified Bundjalung Elders and/or knowledge-holders. The study was completed through interviews and on-Country activities, which identified intangible places and stories within or near the Proposal area.

The findings highlighted 2 areas of significant cultural value to the Aboriginal participants - Byrrill Creek and Commissioners Creek. It should be noted that Byrrill Creek, which is not located within the Proposal area, was an option for a proposed dam and was discontinued in favour of the Proposal in part due to cultural heritage reasons. Neither area is to be adversely affected by the Proposal.

A desktop review of cultural values was also undertaken and demonstrated a number of significant Dreaming places and stories to the Bundjalung people. Many of these stories involved the nearby Wollumbin. However, no discussion indicated the Proposal would have an adverse impact on Wollumbin, which is observable from several points of the project area.

The study found a desire for continued access to the Proposal area into the future to allow visitation and management of cultural materials.

Summary

The ACHAR has consolidated the various assessments, removing those areas that have been inundated and/or are outside the Proposal. The ACHAR adopted a threshold of ≥24/m^2 as reflecting past specific activity, and found the following cultural assemblage can be considered within the proposed FSL:

- 2 rockshelter sites (#04-1-0286 [CHD-RS1] and #04-1-0090 (CHD BMP- 05-0036]) - #04-1-0286 reflect 2 closely spaced overhangs on the same sandstone outcropping and documented under the same AHIMS listing
- 2 culturally modified trees (#04-1-0285 [CHD-ST1] and #04-1-0303 [CHD-ST2]); a potential third tree was identified during the rockshelter investigations for this report (section 2.4) but has been added to the listing of #04-1-0286
- one natural chalcedony outcropping identified as a potential quarry (#04-1-0284 [CHD-G1])
- 9 areas of past foci and activity (#04-1-0238 [CHD-AS36], #04-1-0239 [CHD-AS37], #04-1-0249 [CHD A48], #04-2-0264 [CHD-AS17], #04-1-0280 [CHD A1], #04-1-0281 [CHD-A55], #04-1-0288 [CHD-PAD9], #04-1-0291 [CHD-PAD6], and #04-1-0296 [CHD PAD1]) characterised by high densities of sub-surface artefacts (x ?= ?24/m^2), which are considered to reflect extensive and/or repeated visitation and occupation by people over the last few thousand years. Based on field observations and previous archaeological fieldwork, the average size of these sites are between 0.12 and 1.5 ha
- a stone artefact background scatter that is predicted to occur intermittently across the project area and extending beyond its limits within which disparate low to moderate artefact densities of 1-23/m^2 may be expected intermixed with culturally sterile zones. This includes a large number of the previously recorded sites (n=65) currently documented across the project area, including CHD24 AS1, #04-1-0289 (CHD PAD 8), #04-1-0302 (CHD-1), #04-1-0009 (Midginbill DD1 BMP-05-0029), #04-1-0010 (Midginbill DD2 BMP-05-0030), #04-1-0011 (Midginbill DD3 BMP-050031), #04-1-0130 (Clarrie Halll Dam 2 BMP-05-0112), #04-1-0230 (CHD-A52), #04-1-0231 (CHD A51), #04-1-0234 (CHD-A33), #04-1-0241 (CHD-A39), #04-1-0244 (CHD-A42), #04-1-0246 (CHD-A44), #04-1-0247 (CHD-A46), #04-1-0248 (CHD-A47), #04-1-0250 (CHD-A45), #04-1-

0251 (CHD-A53), #04-1-0252 (CHD-A29), #04-1-0253 (CHD-A28), #04-1-0256 (CHD-A25), #04-1-0257 (CHD-A24), #04-1-0260 (CHD-A21), #04-1-0263 (CHD-A18), #04-1-0266 (CHD-A15), #04-1-0267 (CHD-A14), #04-1-0268 (CHD-A13), #04-1-0269 (CHD-A12), #04-1-0270 (CHD-A11), #04-1-0271 (CHD-A10), #04-1-0272 (CHD-A9), #04-1-0274 (CHD-A7), #04-1-0276 (CHD-A5), #04-1-0278 (CHD-A3), #04-1-0279 (CHD-A2), #04-1-0282 (CHD-A54), #04-1-0258 (CHD-A23), #04-1-0259 (CHD-A22), #04-1-0229 (CHD-A50), #04-1-0232 (CHD-A31), #04-1-0233 (CHD-A32), #04-1-0235 (CHD-A30), #04-1-0236 (CHD-A34), #04-1-0237 (CHD-A35), #04-1-0240 (CHD-A38), #04-1-0242 (CHD-A40), #04-1-0243 (CHD-A41), #04-1-0245 (CHD-A43), #04-1-0255 (CHD-A26), #04-1-0262 (CHD-A19), #04-1-0273 (CHD-A8), #04-1-0277 (CHD-A4), #04-1-0292 (CHD PAD 5), #04-1-0294 (CHD PAD 4), #04-1-0297 (CHD-A49), #04-1-0301 (CHD-AS1), #04-1-0265 (CHD-A16), #04-1-0275 (CHD-A6), CH6, CH7, CH8, #04-1-0012 (Midginbill DD4), #04-1-0015 (Byill Range DD7 BMP-05-0037), #04-1-0025 (Mt Misery Byrrill, BMP-05-0070), #04-1-0027 (Mt Misery Byrrill BMP-05-0072) #04-1-0194 (Byrrill Ridge 4 Tweed ACH Artefacts)

When considering the area between the proposed FSL and PMF (70-77 m AHD), 3 further Aboriginal objects and sites would be encompassed within the Proposal:

- 2 areas of past foci and activity (#04-1-0254 [CHD-A27] and #04-1-0295 [CHD-PAD2]) characterised by a high density of sub-surface artefacts which reflect extensive and/or repeated visitation and occupation by people over the last several thousand years
- one grinding groove (#04-1-0261 [CHD-A20])
- a continuation of the artefact background scatter that is predicted to occur intermittently across the project area and extending beyond its limits within which disparate low to moderate artefact densities of 1-23/m^2 may be expected, intermixed with culturally sterile zones.

6.5.3 Impact assessment

Significance assessment

Impacts to cultural heritage have been assessed using the NSW guidelines. These outline that the cultural significance of a place can be assessed by identifying the values that are present across the subject area and assessing what is important and why (OEH 2011).

The criteria used for assessing cultural significance is included in Table 6-53.

Table 6-53 Criteria for assessing cultural significance

Criterion	Definition
Social value - does the place have a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons?	Social (or cultural) value refers to the spiritual, traditional, historical or contemporary associations and attachments the place or area has for Aboriginal people. Social or cultural value is how people express their connection with a place and the meaning that place has for them.
Historic value - is the place important to the cultural or natural history of the local area and/or region and/or state?	Historic value refers to the association of a place with a historically important person, event, phase or activity. Historic places do not always have physical evidence of their historical importance (such as structures, planted vegetation or landscape modifications). They may have 'shared' historic values with other (non-Aboriginal) communities.
Scientific (archaeological) value - does the place have potential to yield information that will contribute to an understanding of the cultural or natural history of the local area and/or region and/or state?	Scientific (archaeological) value refers to the importance of a landscape, area, place or object because of its rarity, representativeness and the extent to which it may contribute to further understanding and information.

Criterion	Definition
Aesthetic value - is the place important in demonstrating aesthetic characteristics in the local, regional, and/or State environment?	Aesthetic value refers to the sensory, scenic, architectural and creative aspects of the place. It is often linked with social value, and can consider form, scale, colour, texture and material of the fabric or landscape, and the smell and sounds associated with the place and its use.

The significance of Aboriginal objects and/or sites identified within the FSL and PMF is provided in Table 7.2 in Appendix J. When considering significance, a number of the sites can be considered to have local or regional significance. These sites can primarily be divided into 3 main categories:

1) Rockshelters that would have been used for habitation in the past. Commonly, they include art and other cultural deposits that make them extremely important to the local Aboriginal community. However, the 2 rockshelter sites within the project area, exhibit little evidence of cultural activity. The upper shelter was a small shelter, but contained numerous visible cultural materials, and has accordingly been considered of high value. Similarly, the lower shelter was a larger overhang with cultural deposits and is considered of high value.

2) Culturally modified trees indicate the use and manipulation of the cultural landscape by Aboriginal people in the past. While typically of limited scientific significance, they are increasingly rare in the region due to land clearance. They are also typically important to the local Aboriginal community. For these reasons, these sites have been assigned a moderate significance.

3) High and moderate density artefact scatters that indicate the occupation and/or repeat visitation of a locale by people in the past. The largest portion of the assemblage consisted of subsurface stone artefactual material. These sites are assigned either a moderate or high significance based on their potential to inform our understanding of past use and behaviour.

The remaining identified sites, including the broader background artefact scatter, are considered to have limited, if any, research potential (Table 7.2 in Appendix J). While important in demonstrating the longevity and continued use of the region by Aboriginal people in the past, it is considered that little further information can be obtained from additional investigation of these sites, places and objects.

All the sites have some level of aesthetic significance, but only few can be considered an intrinsic part of their significance. These include the grinding groove sites that require some form of running water usually (although various isolated pools following rain can also be used), and several of the high-density artefact scatter zones and areas adjacent creeks that were likely selected by people in the past, at least in part, due to their aesthetic appeal.

Site-specific cultural values have not been provided by the Aboriginal participants to date, and the values presented in Table 7.2 in Appendix J are based on discussions in the field and meetings (sections 2.3 and 2.4 in Appendix J). To date, discussions have focused on the identified rockshelters, culturally modified trees and rare or unique artefacts within the broader cultural assemblage. As part of the cultural values mapping, 2 places of value were identified. None of these are within the Proposal. These are all considered to have moderate cultural significance, clearly being of importance to the local Aboriginal community, but are not presented in Table 7.2 in Appendix J, since they are outside of the Proposal's potential impacts.

Assessment of impacts

The following avoidance and impact minimisation results have been achieved through Proposal refinements and discussion with the RAPs:

- CHD-ST1 (#04-1-0285) - a significant culturally modified tree - has been designed around as part of the ELA (2021) investigations and remains outside of the Proposal impact footprint.

- CHD-RS1 (#-04-1-0286) - a sandstone outcrop containing two overhangs. The upper overhang with visible cultural materials is on or just above the FSL by ~0.5 m. Council has committed to attempting to protect this site, as well as other parts of the sandstone outcrop that remain above the FSL.

Two types of potential impacts have been considered in the ACHAR - direct and indirect. These impacts include cumulative impacts to the regional cultural assemblage, notably to rockshelter and culturally modified tree sites. Of the 17 identified sites, 11 would be subject to direct impacts from inundation, resulting in their complete or partial loss; 4 would be unaffected, being outside of the FSL; and 2 are entirely within the inundation zone.

Construction

In the case of construction activities, it is expected that vegetation removal and ground disturbance >30 cm - the average depth of buried cultural materials - would be required. As such, any cultural materials within these areas would be expected to be impacted and/or destroyed. It is noted, however, that in the immediate vicinity of the dam itself and the quarry (which is existing) previous impacts to vegetation and soil profile have occurred as part of the 1970s construction.

The ancillary activities would require less disturbance, but even the installation of roads and temporary camps would typically undertake the removal of topsoil and compaction prior to establishment, and therefore impacts to the upper soil profile of at least 50 cm would be expected depending on site conditions and final detailed design. All of these activities would require removal of trees and other surface debris (loose stones, etc.) prior to establishment.

Operation

In the case of the inundation footprint, initial impacts would potentially include the removal of selected areas of vegetation (to stump level), and increased erosion to the upper reaches of the catchment as the reservoir fills and this may impact upper soil profiles in these locales. However, numerous academic studies of existing dams internationally have demonstrated that the drowned soil profile elsewhere is relatively unaffected by inundation, with only discolouration and the loss of the organic surface (O horizon) being evident (e.g. Félix-Faure et al. 2019). Rather, the greatest impact from inundation is increased erosion along the reservoir's edge (the FSL and PMF levels) from wave action (e.g. Fagherazzi & Wiberg 2009; Vilhena et al. 2019). Specifically, Félix-Faure et al. (2019) states:

- In the drawdown zone [comparable to a fluctuating FSL in this report], upper horizons of submerged soils are eroded, especially near the upper shore and on slopes. In the permanently drowned area, silty sediments cover drowned soils. Compared to reference soils, forest soils drowned for 84 years maintain their original morphological differentiation, but colours are dull, and the humus (O horizons) have virtually disappeared.

Based on these studies, it can be considered that areas that are permanently drowned by the inundation would have little impact on the soil profile and any associated buried cultural materials, nor would surface finds be affected, although they would potentially be buried in silt. However, areas along the edge of the eventual reservoir may be subject to localised erosion and slumping from water-level changes. Given the focus of the assessment in areas immediately above the current FSL and near the proposed FSL, it is probable that much of the cultural assemblage would be present within this fluctuation zone and may be subject to erosion.

Additional impacts may occur between the FSL and PMF level also in relation to wave action and temporary inundation of these zones. However, KBR (Appendix G2) indicates that flooding to the PMF would last less than a week when it occurs, while Ball et al. (2019) suggests that the annual exceedance probability (AEP) for this to occur may be as infrequent as once every 10 million years. As such, it is considered that potential impacts between the FSL and PMF are likely to be limited

and for the purposes of this report, it is not considered that the Proposal would adversely affect any cultural materials in this zone.

As discussed in section 6.2, the biodiversity assessment found that edge effects around the FSL would be an indirect impact due to the Proposal. This may also impact Aboriginal heritage items which have been assessed in the area between the FSL and PMF.

The hydrology assessment of Doon Doon Creek and the Tweed River provided in section 6.1 indicates that physical, or geomorphological, changes are unlikely and/or negligible. There would be some changes to the downstream flow regime, likely reducing extreme droughts or floods, but to an observer this would visually be differences of no more than 0.1 m during high flows. For the purposes of this report, it is not considered that the Proposal would adversely affect any cultural materials downstream of the existing dam.

Intergenerational loss

Ecologically sustainable development, or intergeneration equity, is the principle whereby the current generation should maintain the health, diversity and longevity of the environment for the benefit of future society. For Aboriginal heritage management, intergenerational equity can be considered primarily in terms of the cumulative impacts to Aboriginal objects, sites and/or places in a region. If few Aboriginal objects and places remain in a region (e.g. due to development impacts), there are fewer opportunities for future generations of Aboriginal people and the broader community to enjoy the cultural benefits. Information about the integrity, rarity and representativeness of the Aboriginal objects, sites and places that may be impacted, and how they inform the past visitation and occupation of land by Aboriginal people, are relevant to the consideration of intergenerational equity and the understanding of the cumulative impacts of a project. While not directly related to the ACHAR process, such (future) impacts are also a critical issue for consideration under the *Native Title Act 1993* (see Appendix A of Appendix J for a brief discussion).

Overall, the Proposal would potentially result in adverse impacts to 11 identified Aboriginal sites, objects and/or places, as well as various amounts of buried stone or artefactual material (sections 6 and 8.4 in Appendix J). These consist of one rockshelter, one culturally modified tree and 7 discrete stone artefact scatters and/or deposits. A low-density broader background scatter of stone artefacts extending across the project area would also be adversely affected.

Through ongoing Proposal refinement and liaison with the RAPs, 2 significant sites have been avoided by the Proposal, including CHD-ST1 (#04-1-0285) and one of the overhangs within CHD-RS1 (#04-1-0286). A further 4 sites would be avoided by the Proposal or would be fully inundated, which here is interpreted as a form of conservation albeit one that removes ongoing access by the local Aboriginal community.

Most of the potential impacts are to surface and/or subsurface cultural materials and can be suitably mitigated through careful excavation and recovery. Indeed, improving understanding of the past activity by Aboriginal people in this area has been frequently mentioned through the 6 years of consultation, and excavation of such deposits would assist in this. The recovery of cultural materials from locations that are largely inaccessible would also enable them to be applied to potential educative and interpretive opportunities to be explored elsewhere within the LGA. Given this, the cumulative impact of the Proposal is considered relatively minor, since mitigation of 7 of the adversely affected sites could be offset through mitigation and would enable offsite cultural heritage outcomes.

The inundation of CHD-RS1 and CHD-ST2 would result in some cumulative impact to the regional cultural assemblage. Based on the AHIMS database, only 6 culturally modified trees are documented within the region, of which 2 (~33%) would be lost through the Proposal (this includes the potential culturally modified tree near CHD-RS1). There are few rockshelters documented in the region - NOHC (2018) noted 5 - with one previously inundated by the current dam (DD 6), and

a further 4 through this Proposal. While more significant rockshelters are documented in nearby Jerusalem National Park (as advised by RAPs), the loss of these sites remains of concern to the RAPs. This issue is found as shown in Appendix J (section 2 and Appendix C.

Given this, the Proposal would result in some cumulative impacts to the regional cultural assemblage, including important sites and places. Unfortunately, as an existing dam would be raised, the nature of the Proposal limits alternative options to improve avoidance or limit impacts to the cultural assemblage. As such, management and mitigation measures are proposed to avoid and/or mitigate cultural materials to offset these impacts wherever feasible.

Summary

A summary of potential construction and operation impacts to Aboriginal objects and/or sites by the Proposal is included in Table 6-54 and Figure 6-48, with details provided in section 8 in Appendix J.

Table 6-54 Summary of potential impacts to Aboriginal objects and/or sites by the Proposal

AHMS #	Site type	Significance	Type of harm	Location and/or activity causing harm	Degree of harm	Consequence
04-1-0090	Rockshelter	Moderate	Indirect	Within inundation extent	N/A	N/A
04-1-0238	Artefact scatter and cultural deposit	Moderate	Indirect	Within inundation extent	N/A	N/A
04-1-0249	Artefact scatter and cultural deposit	High	Direct	Within inundation extent, within 20 m of the FSL	Partial	Partial loss of value
04-1-0254	Artefact scatter and cultural deposit	High	-	-	N/A	N/A
04-1-0261	Grinding groove	Moderate	-	-	N/A	N/A
04-1-0264	Artefact scatter and cultural deposit	High	-	-	N/A	M/A
04-1-0280	Artefact scatter and cultural deposit	Moderate	Direct	Within inundation extent, within 20 m of the FSL	Whole	Complete loss of value
04-1-0281	Artefact scatter and cultural deposit	High	Direct	Within inundation extent, within 20 m of the FSL	Whole	Complete loss of value
04-1-0284	Quarry/raw material resource	Low	Direct	Within inundation extent, within 20 m of the FSL	Whole	Complete loss of value
04-1-0285	Culturally modified tree	High	-	-	N/A	N/A

AHMS #	Site type	Significance	Type of harm	Location and/or activity causing harm	Degree of harm	Consequence
04-01-0286	Rockshelter	High	Direct	Within inundation extent, within 20 m of the FSL	Partial	
04-1-0288	Cultural deposit	High	Direct	Within inundation extent, within 20 m of the FSL	Partial	
04-1-0291	Cultural deposit	Moderate	Direct	Within inundation extent, within 20 m of the FSL	Whole	Complete loss of value
04-1-0295	Cultural deposit	High	Direct	Within inundation extent, within 20 m of the FSL	Partial	
04-1-0296	Cultural deposit	High	Direct	Within inundation extent, within 20 m of the FSL	Whole	Complete loss of value
04-1-0303	Culturally modified tree	High	Direct	Within inundation extent, within 20 m of the FSL	Whole	Complete loss of value
Background scatter	Low density artefact scatter	Low	Direct	Within inundation extent, within 20 m of the FSL	Partial	Partial loss

6.5.4 Mitigation measures

Table 6-55 identifies the mitigation measures that would be implemented during construction and operation of the Proposal to manage impacts to Aboriginal heritage.

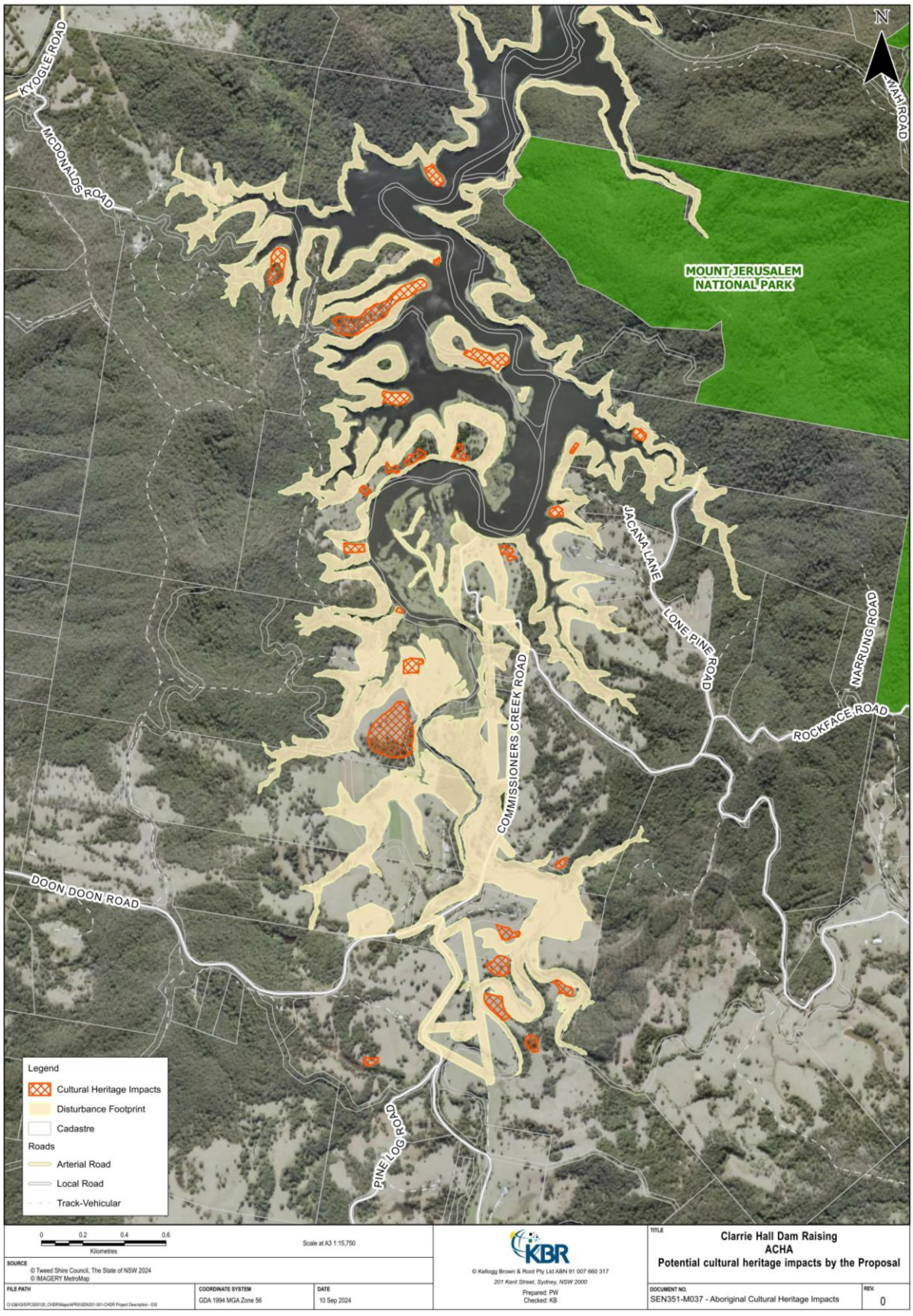
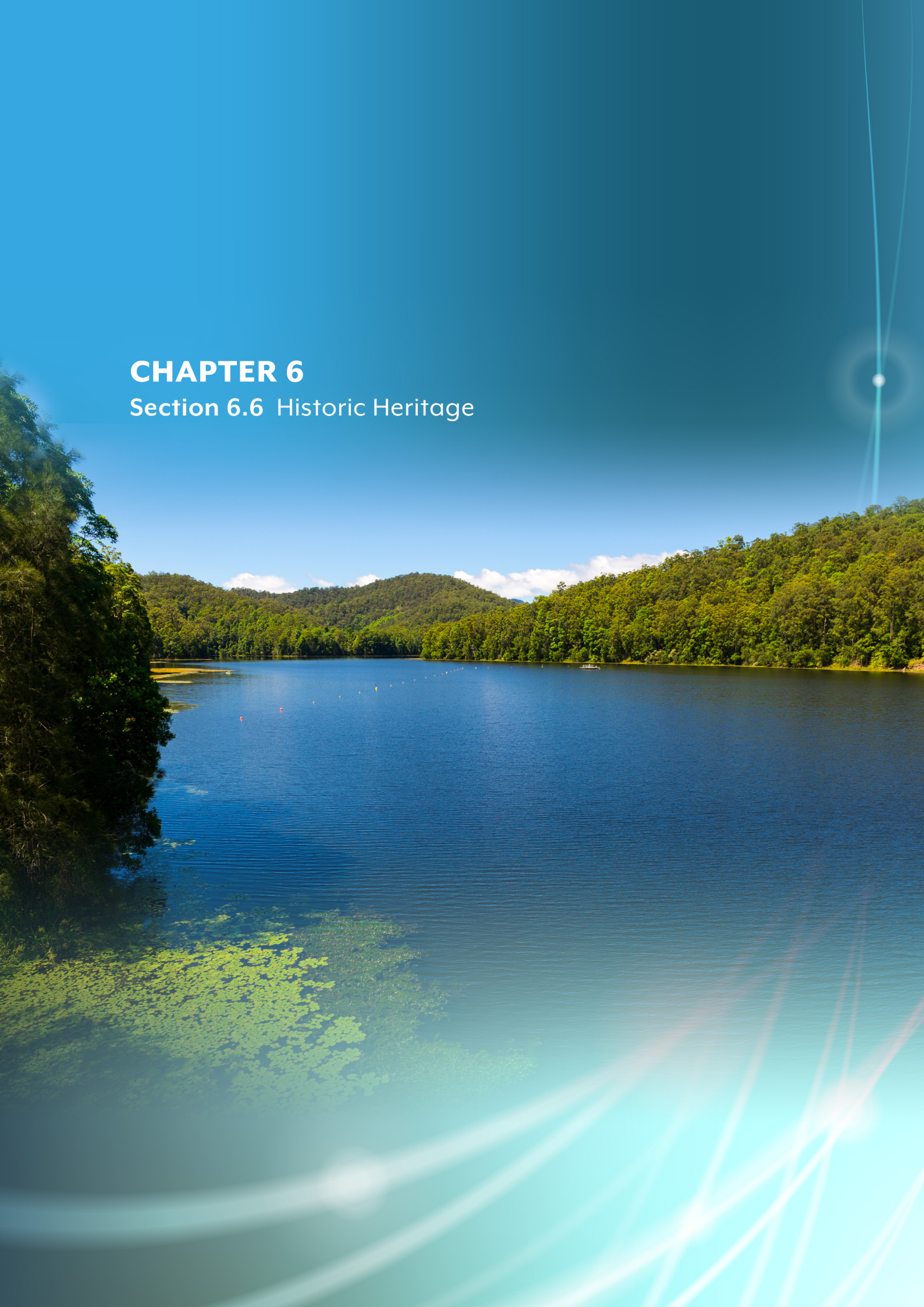


Figure 6-48 Potential cultural heritage impacts by the Proposal

Table 6-55 Aboriginal heritage mitigation measures

Reference	Impact	Mitigation measures	Responsibility	Timeframe
AH1	General	An Aboriginal Cultural Heritage Management Plan (ACHMP) must be developed by a heritage specialist in consultation with the Registered Aboriginal Parties (RAPs) to provide the post-approval framework for managing archaeological mitigation and Aboriginal heritage within the Proposal area. The plan should include the following issues and consider guiding principles: • processes, timing, communication methods and project involvement (e.g. onsite activities) for maintaining Aboriginal community consultation and participation through the remainder of the Proposal. This should include a grievance mechanism that is readily available and designed for use by the local Aboriginal community • if not previously completed, discuss and identify any areas of design optimisation with the RAPs to avoid or further minimise harm to identified Aboriginal sites, objects and places • detail descriptions and methods to avoid any inadvertent impacts to identified Aboriginal objects and/or sites and areas of archaeological sensitivity outside of the construction activities. This should include, but not be limited to, cultural inductions for all personnel and subcontractors outlining their location and significance, fencing and clear marking of heritage sites and zones of interest nearby proposed works, appropriate screening for sensitive and gender-specific areas where needed, and any additional requirements identified by the Aboriginal community. A suitable regime of monitoring these activities should also be outlined, including locations, methods, personnel and timing • detail descriptions and methods of any additional investigative and/or mitigative archaeological actions that may be required before construction works start, or during the Proposal. These should include, but not be limited to, archival recording of all identified Aboriginal objects, sites and places, suitable recovery or relocation, documentation and analysis of any archaeological sites proposed for direct impacts • description and methods for undertaking further Aboriginal cultural heritage assessment, investigation and mitigation of any areas of the Proposal that have changed following completion of the ACHAR and/or during the final design and construction phases of the Proposal • description and methods of post-excavation analysis and reporting of the archaeological investigations and activities implemented as part of the ACHMP • procedures for managing the unexpected discovery of Aboriginal objects, sites and/or human remains during the Proposal • procedures for the curation and long-term management of cultural materials recovered or relocated as part of the works outlined in the ACHMP and any preceding stages associated with the Proposal • processes for reviewing, monitoring, and updating the ACHMP as the Proposal progresses.	Construction contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
AH2	Heritage interpretation	A heritage interpretation strategy must be developed by a heritage specialist to identify the interpretive values of the Proposal, and specifically Aboriginal heritage values across the project area, and to provide direction for potential interpretive opportunities for the Proposal on-or offsite (e.g. at Uki and/or Murwillumbah). This strategy should be made available for consultation and feedback with the RAPs. Following consultation and feedback on the strategy, a heritage interpretation plan would refine the strategy with content (visual and textual) and design details in order to allow the implementation stage. Further detail is included in Appendix J (Appendix A).	Design contractor, construction contractor	Detailed design, pre-construction, construction
AH3	Cultural landscape	The Construction Environment Management Plan (CEMP), or equivalent, should reinforce how the cultural landscape is considered throughout the Proposal and detail the rehabilitation of the disturbance footprint. Rehabilitation of areas where infrastructure is not remaining after construction of the Proposal should be undertaken to determine suitable ecological communities and other factors in returning the cultural landscape as close to its current state as feasible.	Design contractor, construction contractor	Detailed Design, pre-construction, construction
AH4	Communication and consultation	Consultation should be maintained with the RAPs during the finalisation of the assessment process and throughout the Proposal.	Design contractor, construction contractor	Detailed design, Pre-Construction, Construction
AH5	General	A copy of the ACHAR should be lodged with AHIMS and provided to each of the RAPs after finalisation.	Council	Lodgement of EIS
AH6	Communication and consultation	Where the heritage consultant changes through the Proposal, suitable handover should be undertaken to minimise loss or mistranslation of the intent of the information, findings and future steps in heritage management occur.	Council	Ongoing



CHAPTER 6

Section 6.6 Historic Heritage

6.6 HISTORIC HERITAGE

This section summarises the historic heritage impact assessment conducted for construction and operation of the Proposal. A detailed Historical Archaeological Assessment (HAA) has been completed for the Proposal and is provided in Appendix K.

A summary of the relevant SEARs and where they are addressed is provided in Table 6-56.

Table 6-56 Relevant SEARs – historic heritage

Relevant key issue requirement/s	Where addressed
1. The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: (c) environmental heritage, as defined under the Heritage Act 1977 (d) items listed on the National and World Heritage lists.	Section 6.6.3 Appendix K sections 6 and 7
2. Where impacts to State or locally significant heritage items are identified, the assessment must:	
(a) include a statement of heritage impact for all heritage items (including significance assessment)	Section 6.6.3 Appendix K sections 6 and 7
(b) consider impacts to the item of significance caused by the proposal, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant)	Section 6.6.3 Appendix K sections 6 and 7 Appendix P
(c) outline measures to avoid and minimise those impacts in accordance with the current guidelines	Section 6.6.4 Appendix K section 8
(d) be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria).	Appendix K section 1.5
3. A historical archaeological assessment should be prepared by a suitably qualified historical archaeologist in accordance with the relevant guidelines. This assessment should identify what relics, if any, are likely to be present, assess their significance and consider the impacts from the proposal on this potential resource. Where harm is likely to occur, it is recommended that the significance of the relics be considered in determining an appropriate mitigation strategy. If harm cannot be avoided in whole or part, an appropriate Research Design and Excavation Methodology should also be prepared to guide any proposed excavations.	Appendix K

6.6.1 Methodology

The HAA (Appendix K) builds on the findings of previous heritage assessments undertaken for the Proposal as outlined in section 1.7 of Appendix K. The HAA includes the findings of a desktop study and field work.

The desktop study included a review of historical documents, maps and historical and contemporary aerial imagery.

The field work included physical analysis of sites with potential heritage significance and discussions with landholders, and local research to identify potential impacts on historical archaeological relics and sites in the Proposal area.

The field work was undertaken by Heritage Consultant Jim McGuinness on 15 September 2023. The inspection targeted the following:

- areas to be directly impacted by construction activities
- areas within and adjacent to the proposed FSL zone identified as holding potential archaeological sensitivity or historical structures.

The HAA assessed any potential impacts of the Proposal on heritage values defined in the *Environmental Protection and Biodiversity Conservation Act 1999, Heritage Act 1977 and Environmental Planning and Assessment Act 1979*.

The HAA has been completed in accordance with NSW historical heritage principles and guidelines. These include:

- *The Burra Charter,* Australia ICOMOS, 2013
- *Assessing Significance for Archaeological Sites and 'Relics',* Heritage Branch, NSW Department of Planning, 2009
- *Historical Archaeological Investigations: A Code of Practice,* NSW Department of Planning, 2006
- *Archaeological Assessment Guidelines,* NSW Heritage Office, Department of Urban Affairs & Planning, 1996
- *Assessing Heritage Significance,* NSW Department of Planning and Environment, 2023
- *NSW Heritage Manual,* NSW Heritage Office, Department of Urban Affairs & Planning, 1996
- Tweed Local Environment Plan 2014 and Tweed Development Control Plan 2016.

6.6.2 Existing Environment

The Proposal is located within the Doon Doon Creek catchment, within the tribal boundaries of the Bundjalung people. Historically, the area has been central to Bundjalung culture, agriculture and forestry, supporting long-standing interaction between the community and its natural resources. A summary of the Aboriginal Cultural Heritage Assessment is provided in section 6.5.

Historic and natural heritage

Clarrie Hall Dam is not a listed heritage item on any heritage register or database and there are no listed historical archaeological sites or heritage items in the Proposal area (Table 6-57 and Figure 6-49). However, heritage buildings and sites are located in the vicinity of the Proposal area and these are discussed below.

The following natural heritage sites are within 3 km of the Proposal:

- Wollumbin National Park, which is part of the World Heritage List (WHL) and National Heritage List (NHL)

- Gondwana Rainforests of Australia (Place ID 105135 and 105704 respectively) (GRA)
- Mount Jerusalem National Park, adjacent to the Proposal FSL (refer to section 6.4), is listed on the State Heritage Register and the Tweed Shire LEP.

These areas are discussed below, and impacts are addressed in section 6.6.3 and section 7.4 of Appendix K.

Table 6-57 Historical and natural heritage listed items

Jurisdiction	Heritage register	Items in Proposal area	Items within 3km of Proposal area
Federal	World Heritage List	Nil	Wollumbin National Park portion of the Gondwana Rainforests of Australia (ID#105135)
	Commonwealth Heritage List	Nil	Nil
	National Heritage List	Nil	Wollumbin National Park portion of the Gondwana Rainforests of Australia (ID#105704)
State	State Heritage Register	Nil	Nil
	Section 170 of the Heritage and Conservation Registers	Nil	Nil
Local	Tweed LEP 2000	Nil	Nil
	Tweed LEP 2014	Nil	'High Conservation Value Old Growth Forest', being Mount Jerusalem National Park, is located 500 m east of the proposed dam (#I101)
Non-statutory	Register of the National Estate	Nil	Nil

Historical buildings and sites

Three historical buildings/sites were identified in the Proposal area, as shown in Table 6-58. Two sites, Crams Farm Site Complex and Doon Doon Hall, were determined to hold local heritage significance. The third site, the Francis Garner property building platform, was assessed as not meeting the NSW heritage significance thresholds.

Table 6-58 Summary of historical buildings

Building	Description
Cram Farm Site Complex	Crams Farm Reserve is located on Commissioners Creek Road, Doon Doon and occupies a low rise in a natural oxbow of Doon Doon Creek at the south end of the meandering Clarrie Hall Dam reservoir. Four existing historical buildings are present, the most prominent of which are the dairy yard and Doon Doon Hall.
Doon Doon Hall	Doon Doon Hall (1930), originally Terragon Hall (1900), is an archetypal late-Victorian era community hall in its simplest form – a rectangular, weatherboard building raised on piers with a steeply pitched corrugated iron roof and gable ends, with a gabled entry.
Doon Doon Sawmill	Doon Doon Sawmill was described as being on Crams Farm near the old road. Discussion with the current landholder of adjoining lands to the east of Crams Farm Reserve (former Cram property), and long-term neighbour of the Cram family, led to the sharing of information on the former location of the sawmill and a photograph of the site, which was exposed within the FSL zone of the reservoir during a drought in the early 2000s.

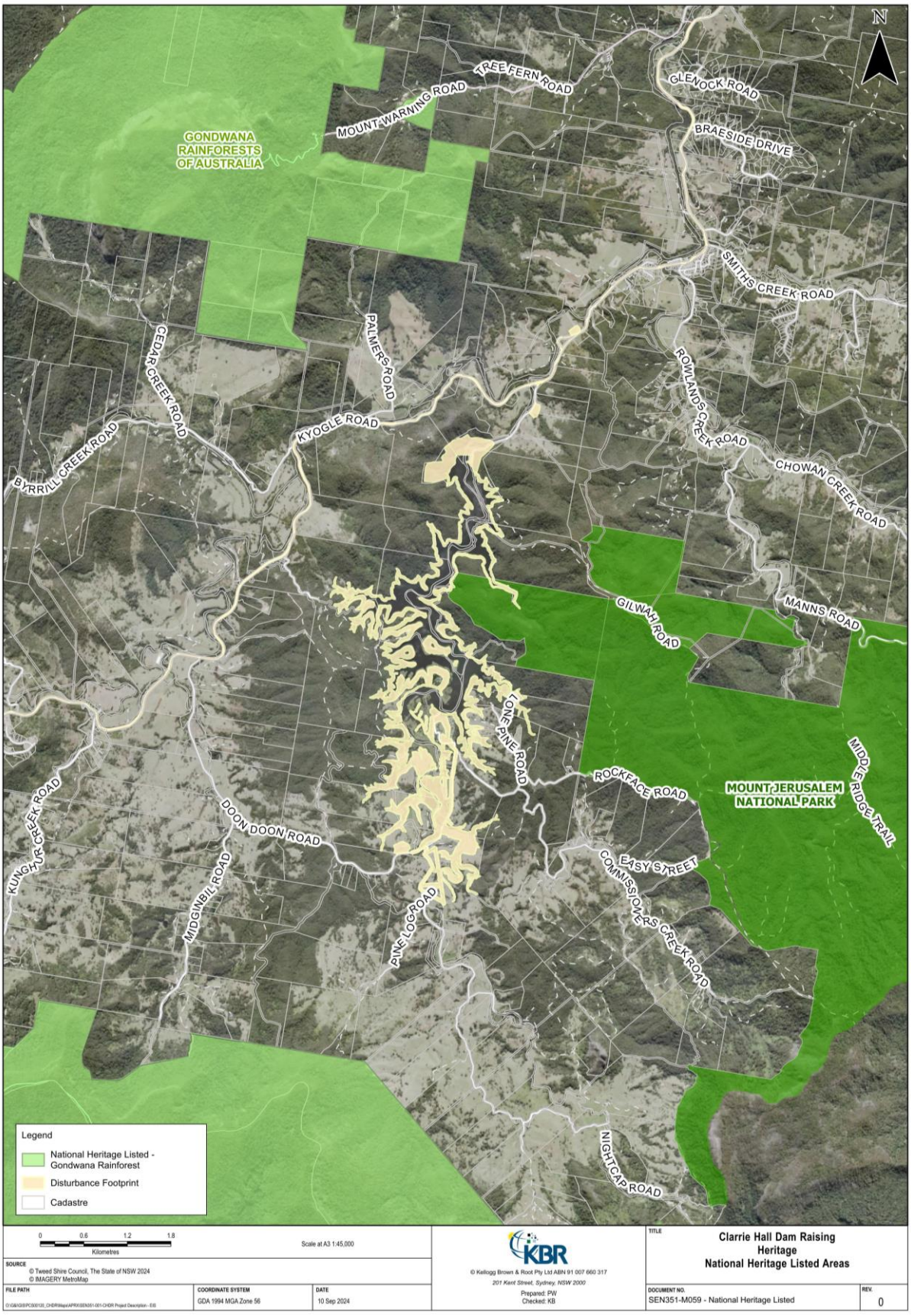


Figure 6-49 Locations of natural heritage sites

Natural heritage

The Proposal area is located adjacent to the southern boundary of the Gondwana Rainforests of Australia, a world heritage listed region. The Gondwana Rainforests of Australia include areas of exceptional biological diversity as well as examples of the major stages of the earth's evolutionary history and ongoing geological and biological processes. The Proposal is located approximately 3 km south of Wollumbin National Park and borders the eastern extent of Mount Jerusalem National Park, both of which fall under the Tweed Caldera group.

European settlement

European exploration of the region commenced in 1823 and mostly comprised voyages up the Tweed River. Initial interest related to the abundance of naturally available resources including timber (red cedar) and fertile grazing land, and European settlers began to infiltrate the Tweed Valley from the 1840s.

Early efforts of logging in the region were hampered by the existing dense rainforest and resultant low yields. The establishment of timber settlements in the 1860s led to increases in the volume of logging and resulted in the clearing of mature trees. This newly cleared land presented other opportunities for the agricultural industry leading to farming and livestock grazing.

Land was gradually cleared to an extent where stock could be moved into the hinterland, which coincided with improvements in land selection terms and conditions under the Robertson Land Act of 1860. Livestock grazing, particularly dairy farming, became established, with the first grazing runs in the vicinity of the project area being established by Joshua Bray and Samuel Gray after 1860.

By the late 19th century, most of the red cedar in the region had been harvested. However, other excellent hardwood and softwood species were still abundant and as such, the region's timber resource was still considered the most valuable in the State.

Small mills sprang up to meet demand for timber for local growth after WWI. Larger mills also shipped to major NSW centres.

Mills were present in Murwillumbah by 1891, Stokers Siding by 1900, and Uki by 1908 (Boileau 2004). Road access was limited, and upland of the Tweed River transportation of logs and milled timber was carried out by trained bullock teams hauling timber on four-wheeled 'jinker' wagons (Figure 6-50). Over the next 50 years, mills established in the Tweed region included at Terragon, Crams mill at Doon Doon, 2 in Mount Nullum, Mount Warning, Mount Burrell, Kunghur, Kunghur Creek, Kunghur Loo, Commissioners Creek, Perch Creek, Smiths Creek, Rowlands Creek and Cedar Creek; all within a 30 km radius of the Proposal area (Hargreaves 1995). The widespread clearing of forests, which accelerated at the turn of the century, began to rapidly reduce the extent of rainforest across accessible parts of the region.

It was not until a Forestry Commission was established and the *Forestry Act 1916* was introduced that indiscriminate clearing of leasehold lands in eastern and central NSW was brought under some degree of control.



Figure 6-50 Bullock team hauling logs over the creek crossing at Uki in the early 20th century

Source: Tweed Regional Museum image, Image Id.: MUS2015.79.21 (Appendix K)

Doon Doon

The majority of useable land at Lower Doon Doon, on either side of Doon Doon Creek, had been selected within 10 years of the land's resumption for sale in 1906. Early settlers of Upper Doon Doon to the south of the Proposal area were the Patch, Clark, Levy, Lillicrap, Sweetman, Roberts, Hawkey and Evans families, who all purchased land in 1907. These first settlers followed the old steep and winding cedar getters track from Terragon, bringing their belongings on jinkers pulled by bullocks and on pack horses if they had them (Johansen 2015). This road was soon improved under contract by Charles Hicks with a team of men, horses and drays. The settlers would then select their homestead site and they, or their contracted workers, would erect tents or bark huts as temporary shelters (Jack Evans in Johansen 2015) and commence clearing the land. Red cedar was harvested for sale. The rest of the timber was initially cleared and burnt, and paspalum grass was planted out for pasture with great success (Jack Evans in Johansen 2015).

The original selector of the roughly 320-acre portions 35 and 99 to the east and south of Doon Doon Creek was Thomas Wood, who purchased these portions in 1909. The property was sold to David Gilmour, and then 649 acres were purchased in 1918 by James and Mary Ann Cram (Figure 6-51).



Figure 6-51 Parish map of Nullum, County of Rous in 1921

Source: NSW Land Registry Services: HRLV (Appendix K)

Note: the map shows the two portions bought by James (Ned) Cram as well as the southern portion purchased by Charles Cram at lower right

Cram family farm

Mary Ann (Polly) and James (Ned) Cram relocated to the Tweed with their 6 children from Bulli on the NSW south coast, where Ned had worked as a commercial diver. They arrived at Ballina on the steamship Orara in February 1908 and lived for a time with relatives in Lismore, where two more children were born (Johansen 2015).

The family then leased land near Nimbin and tried dairying until Ned decided to buy property at Doon Doon to run his own dairy. Ned reached an agreement with David Gilmour to purchase his 649 acres – approximately 1 square mile, in 1918. Amendments to the 1921 parish map of Nullum show that son Charles Cram later added a third portion of land to the south to the family property (Plate 3.4). The family came out to Lower Doon Doon in 1919 on a German wagon carting their pigs and driving their cattle on the dirt road. The farm was already partly cleared and had a house and dairy bails erected in a separate location to the later farm (Ron Duckworth, personal communication, September 15, 2023). Dolly, one of the Cram children, recalled in personal reminiscences recorded in 1991 that the children would happily assist with fetching tubs of water with the horse and slide, milking the 100 head of dairy cows, or performing other farm chores prior to preparing for school and travelling the 3½ miles to Terragon Public School on foot or horseback (Johansen 2015).

The early decades on the farm coincided with the height of polio infections in Australia. At just 16 years of age, Roy Cram contracted the disease and was for a time completely paralysed. His restless energy and resilience, as well as the urgency of economic survival on the farm are apparent in recollections of him. As soon as he was able, he would have himself taken to the bails in a wheelbarrow where he would milk the more cooperative cows. Eventually he received major corrective surgery after which he regained partial use of his limbs and could walk with the assistance of crutches and then a cane. Roy was an able horseman, continued to manage the bullock team and, not to be slowed on foot, would also travel about the farm on a specially constructed skid slide behind a trusted horse (Ron Duckworth, personal communication, September 15, 2023). He was renowned throughout the region for his physical ability and was able to perform all manner of farm labour. The mettle of the family is evident in the fact that Ned raised the heavy timber roof of the dairy holding yard with the help of a block and tackle and his 11-year-old daughter Ivy and 9-year-old son Joe. Tragically, Ron's elder brother Charles also contracted polio as an adult 20 years after Roy and suffered severe spinal and respiratory paralysis, spending several years in an iron lung. He was afterwards confined to a wheelchair.

In 1929, the original farmhouse, thought to have been nearer the old road, burnt down and a new house was built on the current site beside the former dairy and milking yards (Ron Duckworth, personal communication, September 15, 2023). Around 1950, a photograph was taken of members of the Cram family and friends gathered at the rear of this second house (Figure 6-52). The house was soon remodelled, as seen from a photograph taken several years later that shows the current residence, sided in mass-produced vinyl cladding.



Figure 6-52 Members of the Cram family and friends c. 1950 at the rear of the Cram house. Charlie Cram is seated in the wheelchair and Grace Cram wears the white apron

Source: Tweed Regional Museum, Image Id.: US000027 (Appendix K)

Over time, the farm grew to include the dairy/creamery, a timber mill, Clydesdale stud, piggery, corn plantation, bullock herd and even the local telephone exchange. The farm became something of a social centre, where regular cricket matches and gatherings were held. The small and isolated community valued their social engagements and in 1930 arranged and paid for Terragon Hall (built c.1900) (Figure 6-53) to be relocated to Cliff Devine's property in central Doon Doon. The new Doon Doon Hall became a focal point of the community for celebrations as well as a refuge in times of flood. Over time, use of the hall declined and it came under the management of a local committee.

Following the death of Ned Cram in 1955, Roy, who had been living in Lismore for several years, returned to the farm, sold the lands east of the main Terragon Road to Ron Duckworth and managed the remaining land surrounding the farm. The dairy supplied cream to the Norco Butter Factory and then later produced whole milk after the Norco factory's closure. In 1979, when the family sold to Tweed Council, there were 19 family members living on the property (Tweed Council, Crams Farm signage).

Following construction of the dam, inundation of the Creek channel and floodplain surrounding Crams Farm created a scenic lake around the elevated cluster of farm buildings. Council recognised the aesthetic value of the setting and dedicated resources to the management of the site as a public reserve for community use. Council relocated Doon Doon Hall to the reserve in 1990 to ensure its survival and, in doing so, created an historical 'complex' at the site of Crams Farm that reflects the nature of farm and community life at Doon Doon in the 20th century.

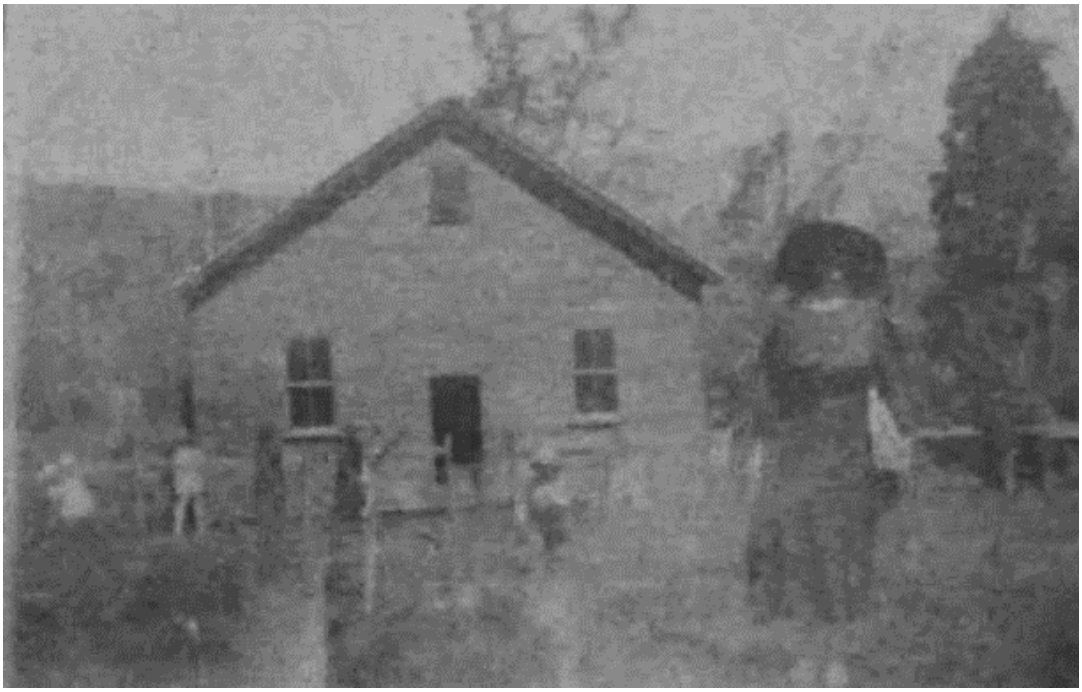


Figure 6-53 Terragon Hall prior to its transferral to Doon Doon in 1927

Source: Tweed Regional Museum, Image id.: US000027 (Appendix K)

Doon Doon Sawmill Company

Soon after purchasing the property in 1919, Ned Cram, together with his brother Bob and Bob's son Tim, established a sawmill on the property that they named the Doon Doon Sawmill Company. Thousands of banana cases were cut and made for the many plantations in the region. They also cut timber for flooring and bridge decking in Murwillumbah.

In February 1927, the sawmill was destroyed by fire, the 'almost inevitable cause of major loss to sawmillers' due to the combination of heat, fuel and sawdust (Kerr 1998). The fire could not be contained and resulted in total loss of all structures, machinery and a portion of timber to the value of 300 pounds. The business was insured but was not re-established by the Crams. However, in 1930, local residents Bill Charleton and George Richardson were contracted to rebuild the mill by Byron Bay Sawmillers, who had purchased the rights to the timber, and to re-erect the mill. (*Tweed Daily*, 23 October 1930, p. 2; Johansen 2015). They operated it for a few years until Ned and Charlie Cram once again reworked the mill during the 1930s, with Charlie soon regaining ownership, likely in 1935 under special lease as indicated by the 1933 parish map of Nullum (NSW LRS: HLRV 2020). Younger brother Joe now worked in the mill and operated the bullock team, sourcing timber from the Nullum and Goonenbar State Forests.

After Charlie became ill in 1938, operation of the mill became too much for the family and it was sold to Sly Brothers Sawmills in 1940. Sly Brothers had begun a steam powered mill at Greenhills in South Murwillumbah in the early 1930s and rapidly converted it into the first fully electrified sawmill on the north coast (Johansen 2015). It is unclear whether the Crams maintained any involvement in the mill after 1940, and by 1965 most of the mill infrastructure including the workers cottages had been removed (Ron Duckworth, personal communication, September 15, 2023).

Clarrie Hall Dam

Clarence Henry Hall, or 'Clarrie' as he was known, was a dairy farmer and former schoolteacher from Kunghur. He entered Tweed Shire Council as a newly elected councillor in 1953 and went on to serve continuously on Council until his death 26 years later. He served during Council's 1970s development of the water supply scheme for the Tweed Shire and the development of Clarrie Hall Dam.

Clarrie Hall Dam was designed and constructed between 1974 and 1983 (construction began in 1979) by the Department of Public Works for the Tweed Shire Council (see Figure 6-54).

In addition to the dam, the program included augmentation of the Bray Park treatment works, and construction of additional reservoirs, pumping and trunk mains to meet the increasing demand of water in the shire (Johansen 2015). The scheme was one of the biggest carried out by a NSW regional council area at that time.

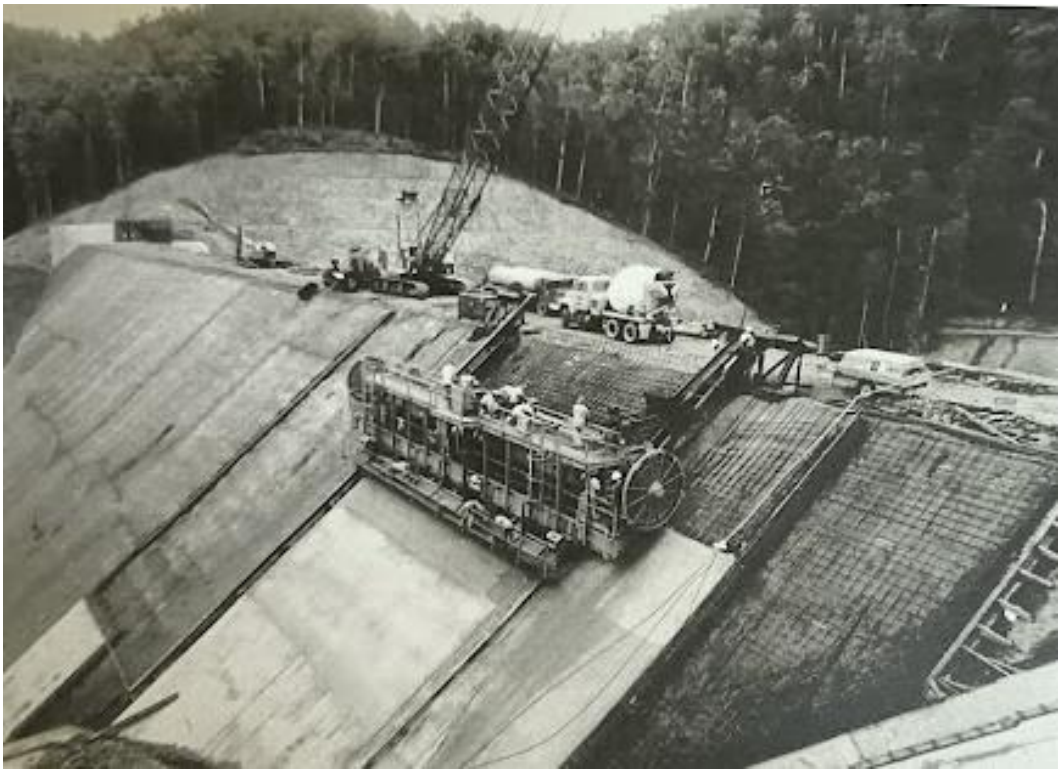


Figure 6-54 The giant screed machine applying a 300 mm concrete face to the inner compacted rock fill dam wall

Source: Johansen 2015:81 (Appendix K)

Field study

The findings of the field study are provided in the following sections to provide context for the discussion of archaeological potential (section 5 of Appendix K) and heritage significance (section 6 of Appendix K).

Crams Farm

Crams Farm Reserve is located on Commissioners Creek Road, Doon Doon and occupies a low rise in a natural oxbow of Doon Doon Creek at the south end of the meandering Clarrie Hall Dam reservoir. The reserve encompasses 14 ha of the former property of the Cram family that was purchased by Tweed Council and dedicated as a reserve in 1991 to provide public access to the reservoir for recreational purposes.

Over generations the Cram family have planted out the farm with a variety of native and introduced trees that are now mature and create a park-like setting ideally suited to public recreation (Figure 6-55). These include several large native figs, stands of melaleucas and other Eucalypts, conifers, fruit trees and a large Pecan planted out by Grace Cram in 1954. The remaining buildings within the farm complex provide a historical landscape setting that is complementary to the scenic backdrop of the reservoir and surrounding ranges with views to Mount Warning. Four extant historical buildings present, the most prominent of which are the dairy yard and Doon Doon Hall. These buildings include:

- Doon Doon Hall (1930), originally Terragon Hall (1900) – is an archetypal late-Victorian era community hall in its simplest form
- the bails and dairy
- the piggery yard
- Cram residence.



Figure 6-55 Crams Farm west view

Note: the view west over the park-like setting of trees planted by successive generations of the Cram family
Source: EMM Appendix K

McCabes Bridge

McCabes Bridge, named after the local pioneering McCabe family, forms a crossing of Doon Doon Creek south of Crams Farm on Doon Doon Road that is to be replaced as part of the Proposal. Concrete beam bridges of the first half of the 20th century have been recognised as structures of potential heritage value (RTA 2005). However, McCabes Bridge (Figure 6-56) is a modern, precast, concrete slab deck and girder bridge of no historical heritage significance and as a result, is not assessed further. McCabes Bridge was constructed after 1954 to replace an earlier roundwood timber beam bridge destroyed by flooding in 1954.



Figure 6-56 McCabes Bridge

Source: EMM Appendix K

Doon Doon Sawmill

The location of the Doon Doon Sawmill was described as being on Crams Farm near the old road (Tweed Daily, 21 March 1942:3). Discussion with Ron Duckworth, the current landholder of adjoining lands to the east of Crams Farm Reserve (former Cram property) and long-term neighbour of the Cram family, led to the sharing of information on the former location of the sawmill and a photograph of the site, which was exposed within the FSL zone of the reservoir during a drought in the early 2000s. (Ron Duckworth personal communication, September 15 2023). The site was submerged at the time of the site inspection and could not be visited.

Historical archaeological potential

The HAA identified what archaeological resources and/or relics are likely to exist in the Proposal area that may be impacted by the Proposal, as discussed above. The HAA assessed whether these resources are of significance (section 6.3.3 of Appendix K). The assessment of archaeological potential considered the site history as summarised above and detailed in section 5 of Appendix K. A revised summary of archaeological sites potentially located in and around the Proposal area is detailed in Table 6-59.

Table 6-59 Summary of archaeological potential in the Proposal area

Historical phase	Archaeological potential	Possible resources	Potential significance
Phase 1. 1840 – 1900: squatters and cedar getters	Low – nil	Postholes, excavated ditches, sawpits, marked trees, isolated iron, glass and ceramic historical artefacts and refuse pits, isolated unmarked graves	Local

Historical phase	Archaeological potential	Possible resources	Potential significance
Phase 2. 1900-1920: early European settlement	Low	Postholes, foundations, traces of timber floors, masonry chimneys, cobbled or Portland concrete surfaces, agricultural hoe marks, ridge and furrow cropping lines marked trees/stumps, sawpits, pit latrine, masonry wells and cisterns, sheet metal, barbed-wire, hand-wrought metal tools and fixings, mechanical and domestic refuse, isolated grave markers	Unlikely to meet thresholds for significance (relics)
Phase 3. 1920-1940: industry and agriculture	Low	Postholes, foundations, traces of timber floors, masonry chimneys, cobbled or Portland concrete surfaces, pit latrine, masonry wells and cisterns, exotic tree plantings, ridge and furrow crop lines, sheet metal, mass-produced tools and fixings, industrial refuse, increased mechanical and domestic refuse	Unlikely to meet thresholds for significance (relics)
Phase 4. 1940 – 1973: centralisation of commerce	Low	Postholes, masonry chimneys, Portland concrete surfaces, pit latrine, septic tanks, exotic tree plantings, ridge and furrow cropping lines, sheet metal, mass-produced tools and fixings, industrial refuse, increased mechanical and domestic refuse including plastics	Unlikely to meet thresholds for significance (relics)
Phase 5. 1973 – 1983: Clarrie Hall Dam and land resumption	Nil	Non-archaeological historical phase	Unlikely to meet thresholds for significance (relics)
Phase 6. 1983 – 2023: the modern era	Nil	Non-archaeological historical phase	Unlikely to meet thresholds for significance (relics)

6.6.3 Impact assessment

The Proposal would result in the inundation of an additional 209 ha of land throughout Lower Doon Doon. This would inundate parts of previously accessible roads, including Doon Doon Road at McCabes Bridge and a section of Long Pine Road that provides access to Council-owned land.

The assessment of heritage significance in NSW is based on the Burra Charter (Australia ICOMOS 2013) and is further expanded upon in the DPE's guidelines, *Assessing Heritage Significance* (Department of Planning and Environment (NSW), 2023), including significance assessment criteria, outlined in Table 6.5 of Appendix K. The Heritage Manual (Heritage Office 2001) also provides a framework to identify heritage gradings that apply to heritage elements (features or components) within a given context. These gradings are provided in *Assessing Heritage Significance* (NSW DPE 2023). They are set out in Table 6.6 of Appendix K and provide context for assessment of elements within Crams Farm (section 6.1.3 of Appendix K).

Potential sources of impact during construction include disturbance from earthworks, access as a result of altered road alignments, and vibration. Vibration impacts are discussed in section 6.12.

Impacts during operation would include alterations to landscape and vistas as a result of the raising of the dam reservoir and alterations to historic curtilages.

Clarrie Hall Dam

Due to the proposed modifications to Clarrie Hall Dam, the original structure would be impacted by the proposed construction works. As a result, potential impacts to significant heritage fabric were considered.

While Clarrie Hall Dam demonstrates the same historical theme as the Mount Warning Dam and may hold a degree of social significance to members of the community involved in its construction, the dam is not unique and does not share comparable levels of historical and technical significance.

Crams Farm

Crams Farm is not expected to be impacted during construction. However, it may be closed to the public for periods of time.

During operation of the Proposal, the HAA determined that two locally significant historical structures, the Crams Farm Bails and Dairy, and Doon Doon Hall occur in proximity to the Proposal area. However, as these historic structures are not currently listed in Schedule 5 of the Tweed LEP, potential impacts were considered through relevant assessment questions outlined by Heritage NSW Guidelines for Statements of Heritage Impact (NSW DPE 2023), provided below.

The Proposal will potentially involve utilisation of elevated areas of the entrance road into Crams Farm Reserve as an option for stockpiling and establishment of construction offices. These works would be temporary and would occur at a distance from the identified significant historical structures. As a result, the Bails and Dairy, Doon Doon Hall and their setting would not be permanently affected by these proposed works.

The increased FSL would significantly alter the current physical and hydrological setting of the area of Crams Farm Reserve that surrounds the Bails and Dairy and Doon Doon Hall. The terrestrial area of the Crams Farm Reserve would be reduced by approximately 35% by raising the FSL up to 70 m AHD. The area between the FSL and PMF of 77 m AHD would temporarily isolate the Crams Farm buildings in a 1,700 m² island of land, inaccessible by road. In the rare case of a PMF event, the water level would, for a short duration, encroach upon the buildings and potentially inundate the root systems of the mature native figs, Melaleucas and other trees that form contributory elements of the setting.

Despite these changes, the proposed works are unlikely to adversely affect the significance of the Bails and Dairy or Doon Doon Hall. The historical setting of the public reserve is currently enhanced, not reduced, by the waterway formed by the dam. This would remain the case if the buildings were brought closer to the waterline. It is also unlikely that the mature trees present would be adversely impacted by the PMF, as native Ficus and Melaleuca, and even the introduced Pecan tree, are all tolerant of intermittent flooding or increase in the water table (DECC 2007; Wazir et al. 1988). The structures themselves are unlikely to be directly inundated. Doon Doon Hall sits close to the 77 m AHD level; however, the building is raised on steel supports that would elevate it above the predicted PMF.

The assessment of significance (section 6 of Appendix K) has therefore determined that although the green space of Crams Farm Reserve will be reduced raising Clarrie Hall Dam, no direct impacts are posed to the Bails and Dairy building by the proposed works.

Indirect impacts would also be limited to a reduction in the surrounding green space and former area of Crams Farm. The immediate, contributory setting provided by mature trees and additional structures within Crams Farm Reserve would not be altered or impacted as a result of operation of the Proposal.

Archaeological potential

The potential of the proposed works to impact any significant archaeological resources was also assessed when relevant questions from NSW Environment and Heritage's Guidelines for Preparing a Statement of Heritage Impact (2023) were considered.

The assessment of past historical activities and past land disturbance in the Proposal area has determined that the Proposal area holds a nil to low level of potential to include significant archaeological deposits associated with historical phases 1 and 2.

Historical phases 3–6 have been found to hold nil potential for significant archaeological deposits or 'relics' as defined by the relics provision of the *Heritage Act 1977*.

If significant archaeological resources associated with phases 1 and 2 are located in the study area, they may be impacted by the proposed increase in the inundation area. However, it is unlikely that they would be present and that there would be any impact.

Natural heritage

Wollumbin National Park

The Proposal is located within 3 km of Wollumbin National Park, which is listed internationally, nationally and in NSW.

During construction, there will be no direct impacts arising from the Proposal on vegetation within the World Heritage property or National Heritage place given the distance between the Proposal and the Wollumbin National Park.

During operation, the raising of the dam wall will result in an increase in the surface area of Clarrie Hall Dam. However, given the distance between Clarrie Hall Dam and the Wollumbin National Park, together with intervening topography and vegetation, it is considered that the visual alteration is likely to be negligible. Wollumbin Mountain is closed at the behest of the Aboriginal custodians; it has therefore not been possible to provide images of the views from the mountain towards Clarrie Hall Dam and determine the full extent of the possible change.

Wollumbin National Park sits at a higher elevation to Clarrie Hall Dam. Modelling of the Proposal on ground and surface water indicates that there will be no impact to the water regimes in WNP.

Mount Jerusalem National Park

No impacts are expected to Mount Jerusalem National Park due to construction.

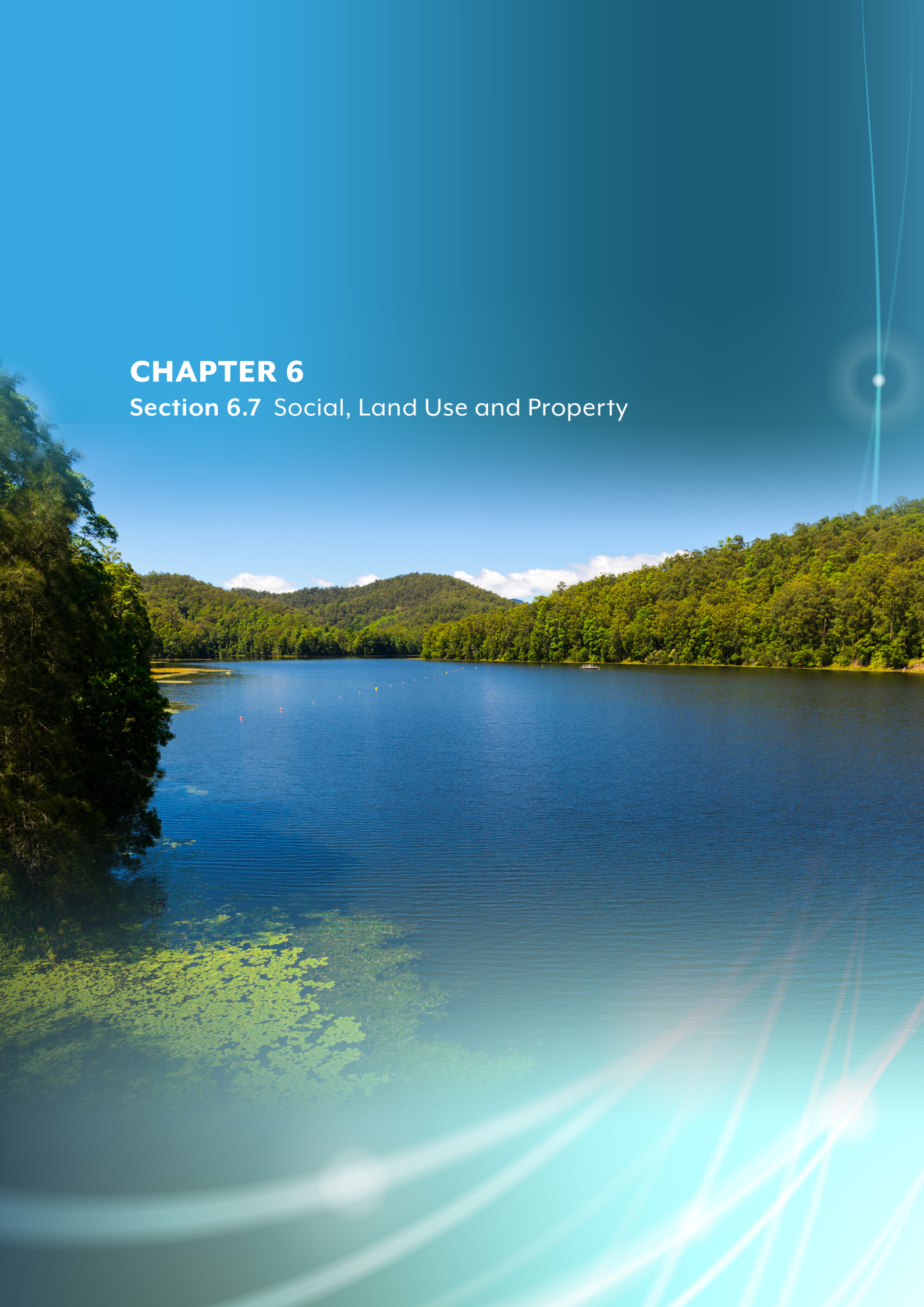
During operation, the raised FSL would directly abut the State-listed and locally listed Mount Jerusalem National Park at 2 locations. While there would be no direct impact on Mount Jerusalem National Park, and therefore its natural heritage values, there would be indirect impacts, which are discussed in section 6.2 and Appendix H.

6.6.4 Mitigation measures

Measures to manage potential impacts to historic heritage are provided in Table 6-60.

Table 6-60 Historic heritage mitigation measures

Identifier	Impact	Mitigation	Responsibility	Timeframe
HHA1	General	An Historic Heritage Management Plan (HHMP) would be prepared and implemented as part of the CEMP that provides procedures for implementing the mitigation measures provided in this EIS. The HHMP would include: • locations of identified heritage sites, i.e. Crams Farm bails and dairy, Doon Doon Hall • management measures, including responsibilities and actions • an unexpected finds protocol • inclusion of heritage awareness and management training within the site induction process for relevant personnel involved in site works • a process and methodology for assessing areas not covered in the HAA.	Construction contractor	Pre-construction, construction
HHA2	Training	All personnel must attend a site induction that includes identification of Aboriginal and historic heritage issues and requirements prior to the commencement of works (and/or the commencement of individual contracts).	Construction contractor	Pre-construction, construction
HHA3	Unexpected finds	In the event that any unexpected heritage items, archaeological remains or potential relics of non-Aboriginal origin are encountered, works would cease immediately, Council would be informed, and the Unexpected Finds Procedure would be implemented. Work would only recommence once the requirements of that procedure have been satisfied.	Construction contractor	Pre-construction, construction
HAA4	Crams Farm	A no-go area to protect Doon Doon Hall and the Bails and Dairy would be implemented.	Construction contractor	Pre- construction, construction
HAA 5	Local heritage	Council should consider the local heritage listing of built items Doon Doon Hall and the Bails and Dairy under future amendments to the Tweed Local Environment Plan. This would ensure the ongoing management of built items with consideration that public engagement and interaction with the site may increase during operation of the Proposal.	Council	Operation



CHAPTER 6

Section 6.7 Social, Land Use and Property

6.7 SOCIAL, LAND USE AND PROPERTY

This section provides a summary of potential socio-economic, land use and property impacts resulting from the Proposal. A Social Impact Assessment (SIA) has been prepared for the Proposal in accordance with the *Social Impact Assessment Guideline* (New South Wales Department of Planning and Environment, 2023b) and is provided in Appendix L. Land use and property impacts have been identified in Chapters 2 and 3 of this EIS.

The relevant SEARs and where they are addressed are listed in Table 6-61.

Table 6-61 Relevant SEARs – social, land use and property

Relevant key issue requirement/s	Where addressed
Provide a Social Impact Assessment prepared in accordance with the Social Impact Assessment Guideline for State Significant Projects	Section 6.7 Appendix L
The Proponent must undertake a comprehensive social impact assessment, supported and informed by a comprehensive, inclusive, and participatory program of community engagement, actively seeking input from the affected community and other stakeholders	Section 6.7.1 and 6.7.2 Appendix L (Chapters 2 and 3)
The Proponent must assess impacts from construction and operation on potentially affected properties, businesses, recreational users and land and water users (for example, agricultural land uses), including property acquisitions/adjustments, access, amenity and relevant statutory rights.	Table 6-67 and Table 6-68 Appendix L (Chapter 6)

6.7.1 Methodology

The SIA was prepared in accordance with the principles in the SIA Guideline (DPE 2023b), as summarised in Table 6-62, and builds upon the findings of previous social impact assessments undertaken by Council, facilitated by Coffey Services (2021).

Table 6-62 SIA guideline principles

Principles	Description	SIA response
Action-orientated	The SIA delivers outcomes that are practical and effective.	Mitigation / enhancement measures – section 6 of Appendix L
Adaptive	The SIA establishes systems to respond to new information and support continuous improvement.	Stakeholder engagement – section 3 of Appendix L – to inform the SIA and EIS
Culturally responsive	The SIA considers how different social groups would experience social impacts differently.	Analysis of social baseline and identification of different stakeholder group impacts – section 3 of Appendix L
Distributive equity	The SIA considers how social impacts are felt across vulnerable groups and between current and future generations.	Consideration of local and regional impact, over time in identified impacts – sections 5 and 6 of Appendix L
Impartial	The SIA is undertaken in a fair, unbiased manner and follows relevant ethical standards.	Commitment to objective and ethical assessment – section 1.4 of Appendix L

Principles	Description	SIA response
Inclusive	The SIA seeks to hear, understand, respect and document the perspective of all likely affected people. Uses respectful, meaningful and effective engagement activities.	Stakeholder engagement to inform and shape the SIA and EIS – section 3 of Appendix L
Integrated	The SIA uses and references relevant information and analysis from other assessments to avoid duplication. It supports the effective integration of social, economic, and environmental considerations in decision- making.	Reference to other technical documents in the delivery of the SIA – sections 5, 6, and 7 of Appendix L
Life-cycle focus	The SIA seeks to understand likely impacts at all project stages from pre-construction to operation.	Assessment includes a focus on construction and operations – sections 5 and 6 of Appendix L
Material	The SIA identifies which likely social impacts matter the most for people and pose the greatest risk / opportunity to those expected to be affected.	SIA scoping and stakeholder engagement – sections 3 and 4 of Appendix L
Precautionary	The SIA avoids using any limits on full scientific certainty as a reason for postponing measures to prevent environmental degradation.	Impact assessment to consider any residual risks – section 6 of Appendix L
Proportionate	The SIA ensures the scope and scale corresponds to the scope and scale of the likely social impacts.	SIA scoping to define potential material impacts – phase 1
Rigorous	The SIA uses appropriate, accepted social science methods and robust evidence from authoritative and trustworthy sources.	Methods and evidence sources are described and justified – section 2 of Appendix L
Transparent	The SIA explains, justifies, and makes available information, methods, and assumptions so that people can see how their input is considered.	Stakeholder inputs are documented and references to relevant assessment sections are drawn – sections 3–7 of Appendix L

The steps in the methodology used to conduct the SIA are shown in Table 6-63.

Table 6-63 Methodology for social impact assessment

Step 1: Identify impacts	Step 2: Evaluate impacts	Step 3: Post-approval
• Document project components • Identify stakeholders • Understand the social baseline and context • Identify and describe impacts • Evaluate, draw attention to and prioritise the social impacts that are important to people	• Assess the likelihood and consequence of impacts on the social baseline • Consider and document mitigations • Document opportunities to provide positive impact • Describe impacts after mitigation • Assess the likelihood and consequence of impacts after mitigation	• Assess how social impacts are managed • Monitor and manage social impacts after approval

Details of the steps shown in Table 6-63 are provided in section 2 of Appendix L and summarised below.

The SIA aims to predict and evaluate likely social impacts arising from the proposed raising of Clarrie Hall Dam and provide responses to the predicted impacts through:

- a social baseline prepared by reviewing socioeconomic data for the Tweed Shire
- consultation with impacted community groups and individuals
- identification of potential impacts and opportunities and pre-mitigation risk assessment
- an assessment of how potential impacts could be avoided and/or mitigated
- a risk assessment following the application of proposed mitigation
- management measures for residual impacts.

Social baseline

The initial demographic profile and the SIA study area were identified during the scoping phase as proposed in the Scoping Report submitted in support of the State Significant Infrastructure application to obtain the SEARs.

A social baseline for the SIA study area was defined from desktop analysis of the latest Australian Bureau of Statistics census data, previous consultation and community engagement activities. This focused on the social context of the Tweed Shire with specific focus on townships located near the Proposal (Doon Doon, Uki and Murwillumbah).

Stakeholder engagement

The study area relevant to the Proposal is the Tweed Shire. An outline of the social environment of the region is detailed in section 6.7.3.

Community engagement was conducted in accordance with Appendix A of the *Social Impact Assessment Guidelines* (DPE 2023b) and included people from all parts of the community. This was completed in addition to previous consultation activities. Community and stakeholder consultation undertaken is summarised in Chapter 5, and detailed in Appendix L.

A stakeholder engagement plan that identified different stakeholders within the community was developed specifically for the SIA, with input from Council. The stakeholder engagement plan included potentially impacted (negatively or positively) stakeholders in the Tweed Shire as shown in Table 6-64.

Each stakeholder identified in the stakeholder engagement plan was emailed a request to be part of the SIA engagement. Where responses were not received from stakeholders, at least one phone call was made to follow up the request.

A summary of stakeholder engagement and responses is provided in section 6.7.2.

Table 6-64 Stakeholder engagement

Consultation forum	Stakeholders
Residents and businesses, particularly those close to the project location and in nearby localities, or any other potential users of the project	• Crams Farm recreation site managers • Doon Doon Hall Committee • Local businesses in Uki
	Community information sessions: • Attendees of sessions held in Murwillumbah and Uki
	• Landowners adjacent to the dam and surrounding areas that will be impacted during construction and/or operation.

Consultation forum	Stakeholders
Aboriginal people and groups, especially those with a cultural connection to the project location, and including traditional owners or custodians who can speak for Country, native title holders or registered native title claimants and relevant Local Aboriginal Land Council/s	• Consultation with Aboriginal people and groups has been conducted since 2010 with recent site visits, meetings and cultural values mapping conducted in 2023 and 2024 • Ongoing consultation is being conducted and is documented in the Aboriginal Cultural Heritage Assessment Report (Appendix J) prepared for the EIS (see section 6.5).
Industry, business, cultural and environmental organisations, advocacy groups and peak bodies	• Uki Historical Society • Tweed Residents and Ratepayers Association • Kunghar Regional Fire Brigade • Uki Fire Brigade • Murwillumbah Business Chamber • Environment groups (Friends of the Koala and Tweed Valley Wildlife Carers) • Uki Residents Association • Casuarina and Seaside Salt Residential Association.
Public and private service and infrastructure providers and regulatory agencies (especially local, State and Commonwealth government-funded education, health, community, emergency and social services)	• Power and telecommunications utility service providers – have been consulted regarding the relocation of powerlines and to determine the capacity during construction • State and Commonwealth Government agencies – have been consulted extensively and a summary is provided in Chapter 5 of the EIS, with specific comments addressed in Chapter 6 of the EIS • Education services (Uki Public School, Aetomah School, Murwillumbah TAFE and Murwillumbah High School) • Health, emergency and social services (Police, SES, Murwillumbah Hospital and Services Murwillumbah) • Tweed Shire Council.
Elected representatives and other community leaders	• Council has consulted with elected representatives from local and State governments.

Online survey

Information on stakeholder views regarding the Proposal was collected through an online community survey conducted by Council. The survey was available on the Tweed Council 'Your Say Tweed' website (www.yoursayweed.com.au) for anyone to complete between 17 February and 18 March 2021. The survey was advertised through the local newspaper (Tweed Link), media releases, and via social media posts on Facebook.

The survey covered a range of topics, including four questions designed to provide information for the SIA study:

- What do you value about living in the community (Uki, Murwillumbah, the Tweed Shire)? (a list of previously identified social values was provided and an option for 'other').
- Do you think the proposed project will impact the values you have identified or present any opportunities to enhance those values? Please explain your responses.
- Do you have any concerns about the proposed project? Please explain what these are and, if you like, why you hold these concerns.

- Can you see any opportunities during construction or operation of the project that could benefit the community such as local employment opportunities. Please provide examples of these opportunities.

Sixty-four people responded to the survey.

Identification and assessment of impacts

The assessment of social impacts was conducted based on the social baseline and consultation, using the categories of likely social impacts provided in the *Social Impact Assessment Guidelines* (DPE 2023b) as follows:

- **way of life**: how people live, work, play and interact
- **community**: the community's composition, cohesion, character, how the community functions, resilience, and people's sense of place
- **accessibility**: how infrastructure provided by public, private or not-for-profit organisations, including services and facilities, is accessed and used
- **culture**: shared beliefs, customs, values and stories, and connection to Country, land, places, waterways and buildings, both Aboriginal and non-Aboriginal
- **health and wellbeing**: physical and mental health
- **surroundings**: access to and use of ecosystem, public safety and security, access to and use of natural and built environment, aesthetic value and/or amenity
- **livelihoods**: how people sustain themselves through employment or business, their capacity to do so, and whether disadvantage is experienced
- **decision-making systems**: the extent to which the community can have a say in decisions that affect their lives, and have access to complaint, remedy and grievance mechanisms.

Risk assessment

An evaluation of the significance of each potential social impact was conducted without mitigation or enhancement for both negative and positive impacts. The risk assessment was conducted using the likelihood, magnitude and impact significance matrix provided in section 5.8 of Appendix L.

Mitigation measures

Mitigation measures and responses to social impact have been developed to be both effective and easy to implement to increase the likelihood of beneficial community outcomes.

An outline of a Social Impact Management Plan for adaptively managing and monitoring social impacts has been developed, as discussed in sections 6.7.4 and 7 of Appendix L. If the Proposal is approved, conditions of consent will be required to be included in the plan.

6.7.2 Stakeholder engagement

Engagement activities

Council has conducted extensive community engagement since 2009 regarding water supply augmentation options and the proposed raising of Clarrie Hall Dam.

As discussed in the previous section, consultation conducted for the SIA includes:

- stakeholder interviews
- an online survey
- workshops with council.

Engagement activities undertaken as part of the SIA have been coordinated with the following community consultation activities:

- Raising Clarrie Hall Dam – Environmental Impact Statement web page on the Your Say Tweed website
- newsletter distributed by post and available on the web page
- frequently asked questions available on the web page
- meetings and correspondence with impacted landowners
- community information sessions.

Feedback received from the above activities is provided in this SIA where relevant, with further details in Chapter 5.

Stakeholder interviews

Key engagement activities undertaken as part of the SIA have been conducted to build upon previous consultation completed by Coffey Services (2021) in 2020 and 2021.

Additional interviews were conducted by KBR with local community groups and key stakeholders in 2023 and 2024. This involved discussions about the values, vulnerabilities and strengths of the local community as well as the perceived impacts and benefits that would stem from the Proposal. A workshop was run with Council that identified the vulnerable and at-risk groups within the local communities.

Table 6-65 outlines the stakeholders interviewed for the SIA between 2020 to 2024. Other stakeholders were contacted but did not respond.

Table 6-65 Stakeholders interviewed to date

Stakeholder	Timing	Details	Comments
Tweed District Residents and Ratepayers Association	17 September 2020 21 February 2024	Approximately 10 to 15 members covering locations across the Shire	The Association strongly supports the Clarrie Hall Dam raising. The Proposal is viewed as critical to future water supply in the Tweed Shire. The Association recognises that there will be some environmental and vegetation impacts and that recreation facilities must be provided and improved.
Local residents, Uki	Ongoing	Located in proximity to the Proposal	Various comments ranging from support for the Proposal to preference for other options. Refer to Chapter 5 of the EIS.
Tweed Shire Council	24 September 2020	Representatives from the Sports and Recreation Department	Reponses for potential options for recreational uses provided in section 6 of Appendix L.
	Workshop held 30 January 2024	Council supports vulnerable and at-risk groups within the local community and staff responsible for the following were consulted to discuss resilience: • community disaster resilience • community development inclusion • community wellbeing • Aboriginal Land Council and Traditional Owner liaison	Council wants to see opportunities for vulnerable and local people provided. This includes improved accessibility at recreation facilities and employment opportunities for First Nations people. Environmental impacts top every Council survey of concerns.
Tweed Tourism Company	24 September 2020	Official tourism development and destination marketing agency for the Tweed Shire	Summarised in section 3.1.2
Tweed Landcare	25 September 2020	Tweed-focused community-run environmental organisation that provides information, training, project coordination, advocacy and representation for members, local groups, landholders and the community	Summarised in section 3.1.2
Real estate agent, Murwillumbah	30 September 2020	Rural real estate agent based in Murwillumbah and sponsor of local events and organisations	Summarised in section 3.1.2
Tweed Holiday Parks		Tweed Holiday Parks manages 7 holiday parks on the Tweed coast that offer various forms of accommodation	Summarised in section 3.1.2

Stakeholder	Timing	Details	Comments
Uki Village and District Residents Association	1 October 2020	The Association has 12 members and engages with the community on social issues in various forms, including through the Uki News Publication (6 issues per year), holding a market stall, and other initiatives	Summarised in the section following this table.
NSW Public Works Advisory, Engineer		PWA provides expert advice, planning, delivery and support services to local and state government agencies on critical infrastructure developments	Summarised in the section following this table.
Tweed Shire Parks and Active Communities	13 October 2020	This unit of the Council manages several sporting grounds and recreation facilities in the Shire	Summarised in the section following this table.
Tweed Shire Community Services	12 November 2020	This Council team manages programs to support residents in the disability and aged care sphere, including administering bookings of local facilities such as Doon Doon Hall	Summarised in the section following this table.
• Crams Farm Recreation Site Manager • Doon Doon Hall Committee • Kunghur Regional Fire Brigade • Uki Historical Society • Local Uki Businesses	7 December 2023	Upstream and downstream groups who would be potentially impacted by the Proposal	Existing access to Commissioner Creek Road will be required during bridge works. Crams Farm is an important recreational area. Local business knowledge of the project was limited, with the community meeting key to raising the profile of the project.
Murwillumbah and Uki communities	6 and 7 February 2024	Community information sessions were held for the public in Uki and Murwillumbah to answer questions regarding the proposal and EIS process	Various comments ranging from support for the Proposal to preference for other options. Refer to Chapter 5 of the EIS.
Tweed Valley Wildlife Carers	8 July 2024	The Tweed Wildlife Carers respond to and receive approximately 5,000–6,000 calls a year regarding injured or distressed fauna	The Proposal is a better option than building a new dam. Environmental impacts are expected during construction.

Stakeholder	Timing	Details	Comments
Murwillumbah Business Chamber	11 July 2024	The Murwillumbah Business Chamber provides support and guidance for small business in the Tweed Shire, resulting in a stronger business community.	Business in the Tweed Shire is generally hard to establish. Local procurement and expenditure could benefit the local community. Businesses in the Tweed Shire can benefit from the Proposal.

Stakeholder interview responses summary

The stakeholder interviews conducted by Coffey Services (2021) demonstrated that stakeholders had a good understanding of the Proposal and its elements. Feedback from one respondent highlighted uncertainty about the source of quarry material and lack of support for the restricted access to Crams Farm during construction. Overall, general feedback demonstrated that communication from Council to the community and stakeholders was considered adequate.

The interview responses demonstrated a close-knit community whose identity is strongly linked to the natural environment. Crams Farm was identified as an important location for people to meet and socialise with local families holding close ties to the farm. There is a strong involvement in local volunteering including for cultural and arts events, environmental restoration groups and the State Emergency Service. It was considered important to control environmental and recreational impacts from the Proposal, as the community values environmental and recreational aspects highly.

The respondents highlighted that many younger people beyond high-school age leave the local area to pursue education or employment opportunities. A potential benefit of the Proposal was identified as creating employment options for the local labour force during the construction phase.

Other findings from the consultation (Coffey Services 2021) are summarised below:

- There were concerns around the potential risk of road accidents associated with the higher volume of vehicle movements (particularly trucks) along Kyogle Road from Murwillumbah to Uki and onto the construction site, and onto the McCabes Bridge construction site. Some stakeholders indicated restricting access to Crams Farm was also a potential issue.
- Increases in housing prices and the lack of affordable rental properties are the result of local population growth. This has been driven by people relocating from larger cities.
- There is some capacity for the construction workforce to be sourced from Uki and Murwillumbah, which has a number of earthworks, construction and excavation businesses.
- Tourism visitation to the Tweed hinterland area peaks in the winter months; however, visitation to the Clarrie Hall Dam is popular with locals in summer.
- Respondents asked about options to increase nature-based recreation around the dam through improving and expanding on the available walking paths, as well as the employment opportunities the Proposal presents for local people in the construction industry.

More recent engagement conducted in 2023 and 2024 by KBR through face-to-face meetings, online meetings and phone calls found that there continues to be a high level of community awareness regarding the Proposal and that the Proposal is generally supported within the community.

The strong connection identified between the community and nature supports the potential to establish and enhance recreational facilities impacted at Crams Farm and the dam wall. Feedback continues to focus on the opportunity to improve recreational sites at and around the dam. Opportunities identified included improved accessibility at Crams Farm and the dam wall for people with disabilities and making information on public display as part of the EIS process easy to access.

Stakeholder meetings highlighted external pressures in the region from flooding and population growth with vulnerable groups impacted the most. The overall consensus was that the Proposal is required to support an increase in the local population and provide water security to the region. Ongoing efforts to encourage efficient water use were suggested.

Consultation undertaken with the Tweed Residents and Ratepayers Association demonstrated that long-term support of the Proposal has been maintained in the region, and a future focus of

updating existing recreational facilities is supported. The meeting highlighted that if alternative dam locations were pursued, the impacts on the environment would likely be worse. This rationale supports the outcomes of the options assessment and previous consultation.

Online survey

Consultation during 2021 was undertaken by Coffey Services and Council and conducted online, as Covid-19 limited in-person access. The online survey had a low uptake – only 64 people (0.06%) across the entire Tweed Shire responded to online questions.

The online community survey revealed that 20 people specifically stated they wanted to see the Proposal progress. Most of them indicated they wanted to see it happen without further delay. Nine people opposed the Proposal progressing, citing that alternative options, such as Byrrill Creek Dam, should be pursued to secure the long-term water supply for the Shire.

Survey participants raised concerns regarding the potential for environmental impacts from the proposed dam wall raising.

Community consultation

Tweed Shire Council established a page on its Your Say Tweed website (Tweed Shire Council, *Raising Clarrie Hall Dam – Environmental Impact Assessment*), where it is possible for stakeholders to find information and for Council to respond to questions. Responses again highlighted a strong connection between respondents and nature. The strongest concerns related to environmental impacts, increased traffic, noise from construction and access to recreation sites. Overall, the community supported the Proposal, although the community considered that ongoing water saving measures from new housing developments were not in keeping with Council's need to secure a long-term water supply.

The common theme running through stakeholder consultation was that stakeholders generally wanted to see the Proposal progress with some urgency. A program of ongoing consultation with key stakeholders and the community would be essential as the Proposal progresses.

Proposal updates are currently communicated through the Tweed Shire Council website Your Say Tweed, media releases, articles in the Tweed Link newspaper and water notices, which provides a means for questions and comments about the Proposal to be addressed. Further information about the comments and responses received through Your Say Tweed is provided in Chapter 5.

Community information sessions were held on 6 and 7 February 2024 in Uki and Murwillumbah to provide an update about the Proposal and EIS process and answer questions. The outcomes and responses to these information sessions and other consultation methods are documented in Chapter 5. Feedback was similar to that provided through Your Say Tweed, including the view that the Proposal should proceed, in addition to questions about why the raising of Clarrie Hall Dam was chosen over a new dam at Byrill Creek.

Aboriginal consultation

Engagement with the local Aboriginal community was initiated by Council during the options study multi-criteria analysis in 2010 to liaise with the Aboriginal community on a preferred option. Consultation with the Aboriginal community was also undertaken as part of earlier detailed investigations and assessments of the Proposal in 2018. This included the Tweed-Byron Local Aboriginal Land Council and various Bundjalung Traditional Owners (notably the McDonald-Buxton family). While liaison was largely maintained since that time, as part of the latest Aboriginal cultural heritage assessment documented in the Aboriginal Cultural Heritage Assessment Report (ACHAR), consultation as outlined in the Aboriginal *cultural heritage consultation requirements for proponents* (DECCW 2010) was re-initiated in May 2023.

This consultation included a re-notification process, which identified 10 Aboriginal individuals and/or organisations that are now 'registered' for the Proposal. These parties include both those that have been involved previously and additional local and regional Traditional Owners.

Since notification, over 70 interactions have occurred with the registered Aboriginal parties. This includes meeting with representatives onsite to discuss important tangible sites and their future conservation and management, a study of intangible values (e.g. Dreaming places and stories) by an anthropologist with Elders and key knowledge-holders, and additional archaeological field survey. Additional meetings to discuss the ACHAR when in draft form were also undertaken to further discuss the Proposal findings, potential impacts and their management, as outlined in section 6.5.

6.7.3 Existing environment

The social baseline provides an understanding of the characteristics of the communities within the social locality of the Proposal. The social baseline describes the social context without the Proposal by documenting the existing social environment, conditions and trends relevant to the impacts identified.

Locality

The social baseline has considered social impacts in the social locality of the Tweed Shire LGA, including the townships in proximity (Uki, Murwillumbah and Doon Doon), as shown in Figure 6-58.

Tweed Shire covers an area of 1,309 km^2 and is built around coastal communities, rural areas, agricultural land, national parks and urban areas. The largest towns are Tweed Heads, Kingscliff, Pottsville and Murwillumbah. The 2 main townships closest to the Proposal are Uki (4 km south-west) and Murwillumbah (15 km south-west). The population in the region has grown faster recently than before.

The communities are linked by a network of state roads and local government roads managed by Council. Kyogle Road forms the most direct route from Murwillumbah to Uki and would be the main transport route for material and people to Clarrie Hall Dam.

The original inhabitants of the Tweed Shire are the Bundjalung nation, which comprised 3 groups: the Tul-Gi-Gin people of the northern area, the Goodjinburra people of the Tweed coast area and the Moorang-Moobar people of the southern and central areas around Wollumbin (Mount Warning). The Bundjalung nation has a strong cultural connection to the land and environment.

European settlement of the region dates from the 1840s. Early settlers worked as cedar getters, followed by timber merchants and boat builders (Tweed Regional Museum 2023). Population growth was slow until the 1980s, when rapid growth was driven by tourism across the region (Tweed Regional Museum 2023). The proximity to the Gold Coast and Brisbane has led to continued high levels of tourism in the region. Recently there has been a change in demography and land use, as people from urban centres have been relocating to the region for lifestyle reasons, bringing money and investment into the area.

Local industry in the region is built around health care and social assistance, retail, construction and hospitality. There has been a trend for younger workers to move from the region to pursue work or education opportunities.

Baseline data used identify the existing social conditions including access to housing, social services and economic livelihoods has been derived from the Australian Bureau of Statistics census dataset and other stated sources. A detailed summary of the local government area is included as the social baseline in Appendix L. The key elements of this baseline with direct relevance to the Proposal are summarised below.

Population demographics

The population of the Tweed Shire was 97,969 in 2022 (ABS 2022) and has steadily been increasing. As per population forecasts, the local population is expected to rise to 132,221 by 2041 (TSC 2023b).

Population density is mostly higher around coastal communities except for Murwillumbah (9,812 people) which has the second largest population after Tweed Heads (20,563 people). The two largest townships located near the Proposal are Murwillumbah (9,812 people) and Uki (685 people), as shown in Figure 6-60.

The latest census data highlights that the region supports an older population, which is higher than the average for Australia.

The Tweed Shire has seen constant population growth of approximately 680 people per year, with a slight slowdown in 2021, which was likely the result of the Covid-19 pandemic. Growth is forecast to continue within the region, with the population estimated to reach 132,221 by 2041, as shown in Figure 6-57 (TSC 2023b).

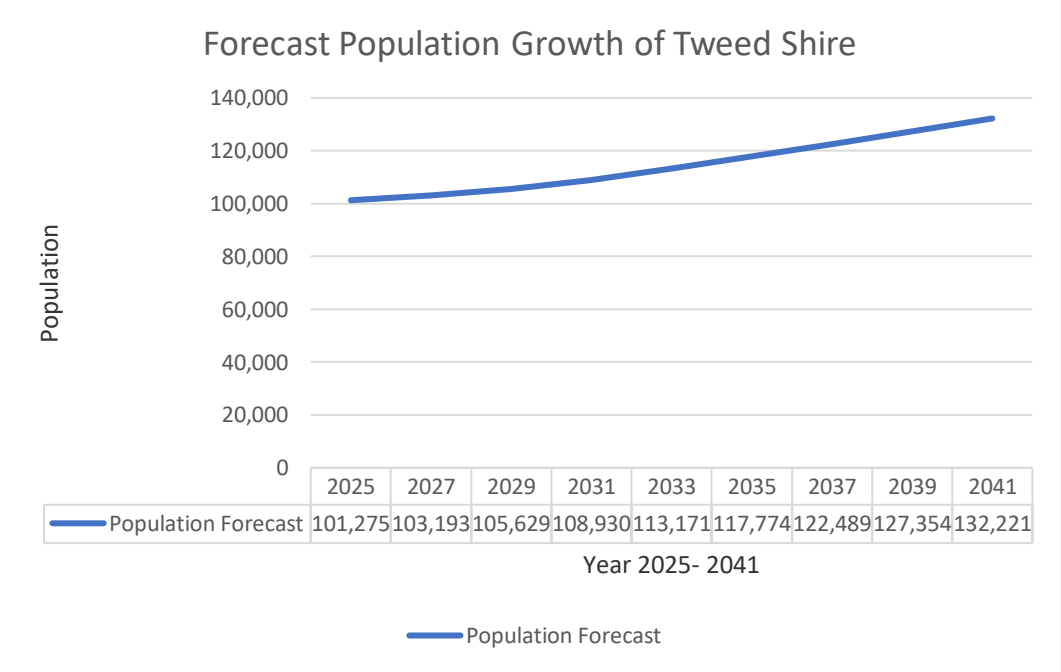


Figure 6-57 Year-to-year population forecast within the Tweed Shire

Source: Tweed Shire Council 2023b



Figure 6-58 Social locality – Tweed Shire

Population demographics

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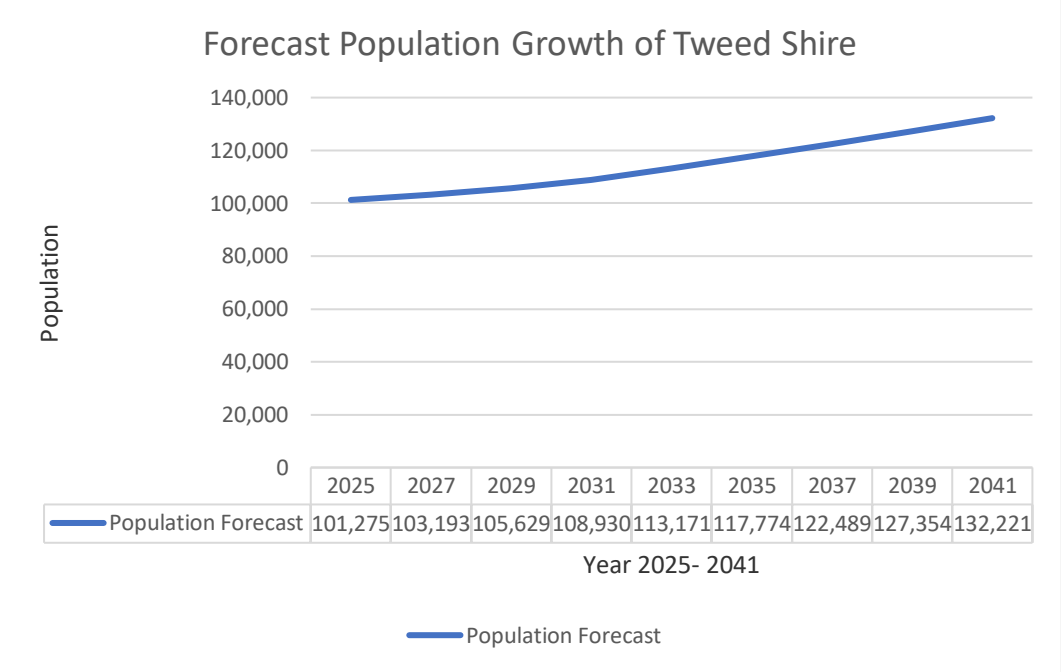


Figure 6-59 Year-to-year population forecast within the Tweed Shire

Source: Tweed Shire Council 2023b

Vulnerable groups

Within the Tweed Shire, vulnerable groups include the elderly, persons with disability (need for assistance), socio-economically disadvantaged groups, homeless persons, flood impacted persons and Aboriginal and/or Torres Strait Island persons.

In the latest census, 4.4% of the Tweed Shire population identified as Indigenous. The townships of Murwillumbah (3.6%) and Uki (2.3%) had fewer people identify as Indigenous. Some 529 people in the Tweed Shire identified as experiencing homelessness with no data available for Uki and Murwillumbah (ABS 2021). Further data on persons impacted by floods was not available but raised as an issue during community information sessions.

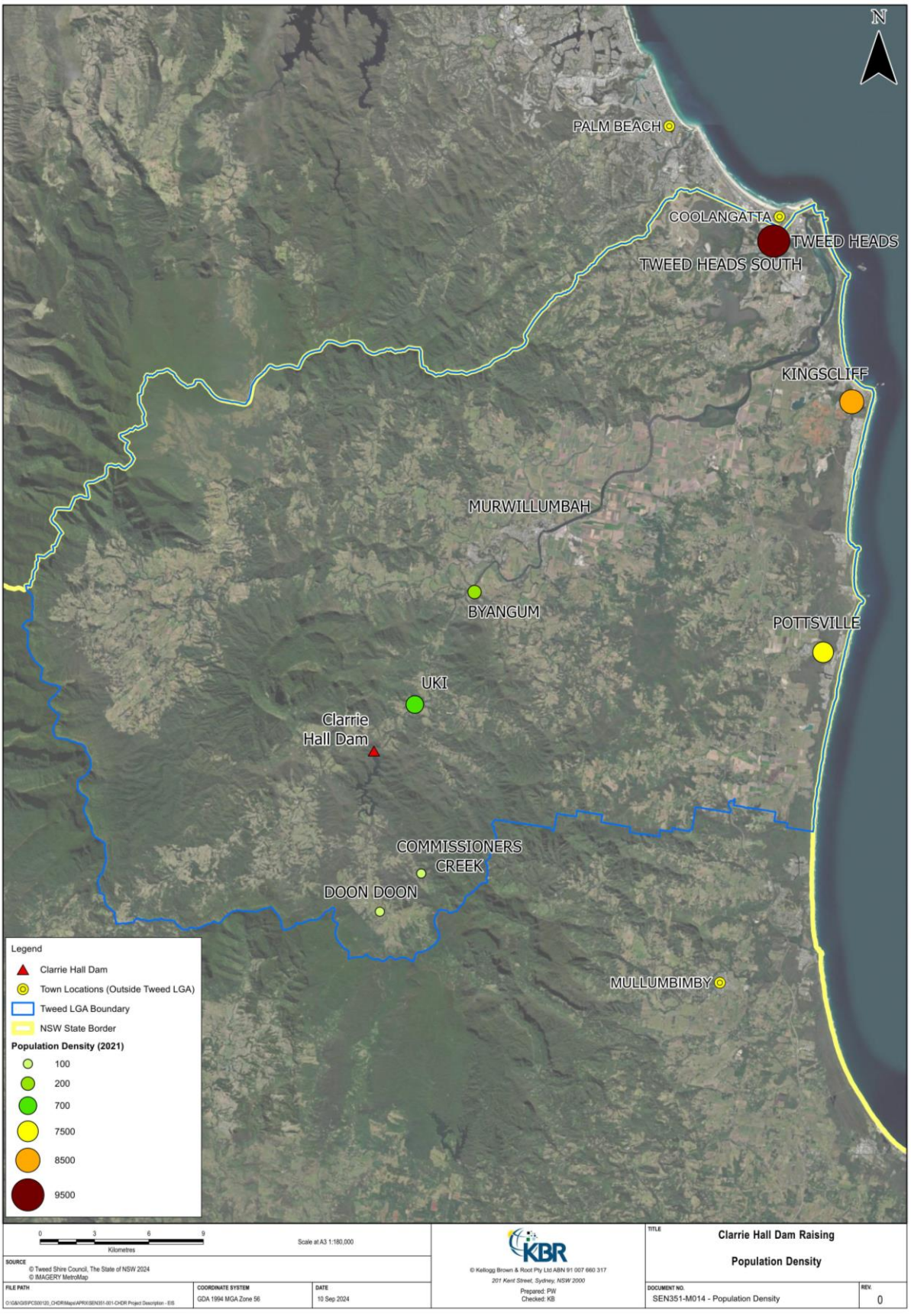


Figure 6-60 Population heat map of Tweed Shire showing key communities around Clarrie Hall Dam

Income

On average, people in the Tweed Shire had a lower median weekly income when compared to the rest of NSW. This was repeated for individuals, households and families. In the Tweed, the weekly median personal income is $658, family incomes are $1,663 and household incomes are $1,296.

Housing and accommodation

A review of housing availability demonstrated that there was a similar percentage of separate houses within the Tweed Shire (66%) as in NSW (65.6%). The main differences were found in the percentage of semi-detached houses and flats within the Tweed Shire. The Tweed Shire had more semi-detached housing and fewer flats compared to the rest of NSW. A breakdown of residential types in the Tweed Shire and NSW as a whole is provided in Table 6-66.

Table 6-66 Tweed Shire and New South Wales housing types 2021

Housing style	Number	Uki (%)	Murwillumbah (%)	Tweed Shire (%)	New South Wales (%)
Separate house	24,836	99.6	79.3	66.0	65.6
Semi-detached	7,107	1.8	6.1	18.9	11.7
Flat or apartment	4,828	0	13.6	12.8	21.7
Other dwelling	716	0	0.8	1.9	0.7
Total occupied private dwellings	37,602	88.0	93.2	90.6	90.6
Total unoccupied private dwellings	3,892	9.6	6.8	9.4	9.4

Source: Australian Bureau of Statistics 2022

Tweed Shire has a higher number of properties owned outright (41.5%), compared to NSW (31.5%), as shown in Figure 6-61. This is reflected in the number of rental accommodations being lower in Tweed Head (24.2%), compared to NSW (32.5%).

Median monthly mortgage repayments in the region have risen from $1,733 in 2011 to $1,872 in 2021 and median weekly rent has risen from $300 to $400 over this time. This reflects the trend across NSW, where mortgage repayments and rent have both risen since 2011. Median weekly rental prices have risen significantly between 2011 and 2021 – a 62.5% rise in Uki and a 67% rise in Murwillumbah. This is reflected by house prices, which have risen by 59% in the last 5 years.

There was no data on short-term accommodation occupancy within the social locality. Local accommodation in Uki and Murwillumbah appears to be mostly bed and breakfasts and small retreat-style accommodation facilities, with some hotels and motels. There is also a number of short-term rentals listed on online platforms such as Airbnb.

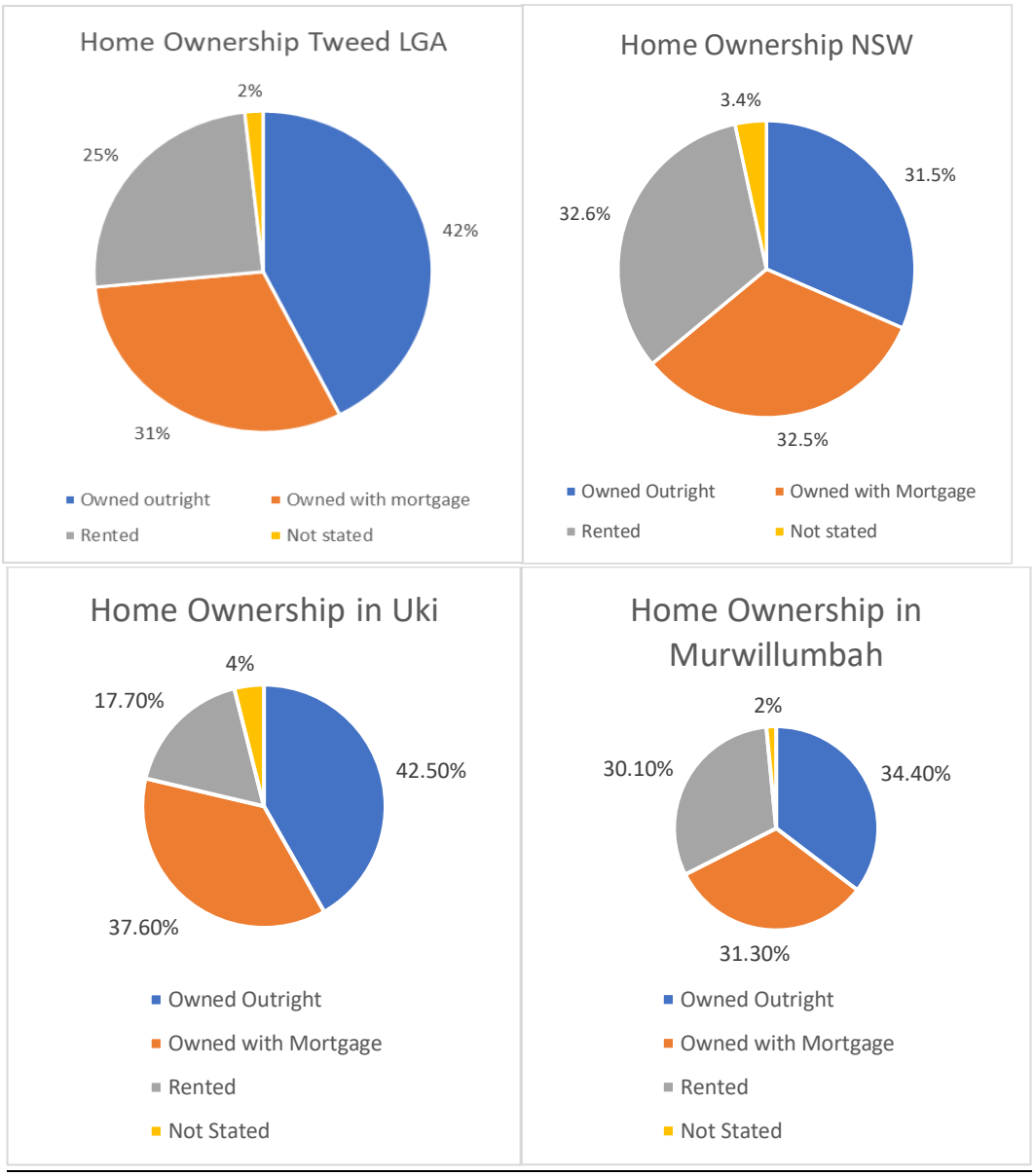


Figure 6-61 Percentage of tenancy type within the Tweed Shire, Uki, Murwillumbah and New South Wales, 2021

Source: Australian Bureau of Statistics, 2022

Surrounding properties

Seventeen properties were identified as impacted by the implementation of the Proposal. To date, Council has either acquired, and/or has under contract all, or a sub-divided portion, of 15 of the 17 identified affected properties. One property owner is not negotiating further until the EIS has been determined and Council has resolved to implement the Proposal. An area of about 1.91 hectares (ha) has been revoked from Mount Jerusalem National Park (further discussion on land tenure is provided in Chapter 4 and section 6.4).

Local employment and education

The main employment industries within the study area are retail, accommodation and food, health care and social assistance and construction. Locally in Uki the most frequent employment industries are professionals and technicians and trade workers (26.6 and 16.7%). This further

reflected in Murwillumbah with professionals, technicians and trade workers and community and personal service workers the most frequent employment industries (16.5, 16.1 and 15.4%).

The 5.0% unemployment rate within the Tweed Shire (ABS 2022) has risen since 2016 and is higher than the NSW rate of unemployment of 4.9%.

The latest (2022) ABS data showed unemployment at 5.5% in Murwillumbah and 7.3% in Uki, which is higher than the Tweed Shire at 5.0%.

The Tweed Shire has a lower level of education than the rest of NSW. This is demonstrated by 58% of the Tweed Shire population having no qualifications, compared to 39.6% in NSW.

Social infrastructure and services

Access to education, community services and health services in the study area is varied, with greater access found close to larger population centres including Murwillumbah.

Murwillumbah District Hospital is the closest health-care facility to the Proposal, with the larger Tweed Hospital located approximately 20 km north-east of Murwillumbah District Hospital, being the major regional referral hospital. Nearby to the Proposal are 2 regional fire services found in Uki and Kunghur. Other emergency services must be sourced from Murwillumbah.

The study area contains many local schools and childcare facilities, with most schools located near Murwillumbah. Access to community services is shown to be limited in smaller townships (Uki) but service organisations and service providers are available in Murwillumbah.

Flood history

The Tweed Shire has historically been affected by severe flooding events. The impacts of these floods have been felt most recently in 2017 and 2022. The impacts from the 2022 flood event are currently still affecting communities.

Recent flood damage has resulted in significant damage to regional infrastructure and property. In the study area, 2,100 properties were impacted by the 2022 flood (Housing, roads, flood resilience and mitigation top wish list, 2022). This has created housing impacts and resulted in large clean-ups and much construction work for the local labour force.

Key locations

In the study area, there are locations that hold significant value for local communities. This includes Crams Farm. Traffic counts included in the traffic impact assessment (see section 6.14) demonstrated regular visits by recreational visitors for walks, picnics, kayaking and events. Further, Clarrie Hall Dam wall and spillway area is a popular location for walkers and fishers. These built and natural environments were identified through stakeholder engagement as being important to local community identity.

Crime

Crime tends to be less prevalent in the local area when compared to the rest of NSW and is mostly comprised of theft. The closest police station to the Proposal, in Murwillumbah, is responsible for the surrounding region.

Community structure

The Tweed Shire Council is the only local government within the social locality of the Proposal. In the local townships of Murwillumbah and Uki the community demonstrates a strong connection to nature and high participation in volunteer and artistic activities.

6.7.4 Impact assessment

Potential social impacts and benefits of the Proposal have been assessed using a risk-based framework shown in section 5.8.1 in Appendix L. The unmitigated social impacts have been assessed initially and then the residual impacts assessed after mitigation measures have been applied for all direct and indirect impacts on the Proposal.

The risk assessment of unmitigated potential social impacts is provided in Table 6-67 (positive impacts) and Table 6-68 (negative impacts) of Appendix L.

Social impacts after mitigation

Mitigation measures have been applied to the potential positive and negative impacts of the Proposal, and the subsequent residual risk have been identified, as shown in Table 6-67 and Table 6-68 respectively.

Table 6-67 Summary of positive social impacts and their residual risk ratings after applying mitigation measures

Summary of social benefits	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Way of life						
Secure water supply maintains quality of life	• Operation	Positive	Residents	High	Education about sustainable water use and project need will continue.	Very high
Livelihoods						
During operation regional communities would be the beneficiaries of additional water supply which may increase agricultural opportunities	• Operation	Positive	Local community	Medium	Council will continue to monitor water consumption and water security.	High
Increased local employment during the construction phase	• Construction	Positive	Labour market, local community	Medium	Procurement contracts for detailed design and construction must include requirements to support Indigenous procurement and employ locally as much as possible.	High
Community						
Additional trade for existing business in local communities	• Construction	Positive	Local business	Medium	Engagement with local businesses to identify capacity and perspectives on risks and opportunities associated with population increases is recommended. This information should be provided to new workers about local businesses.	Medium
Surroundings						
Increased volume and reliability of water supply to residents in the Tweed Shire	• Operation	Positive	Local community, residents	High	Council will continue to monitor water consumption and water security.	High

Summary of social benefits	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Opportunity to improve existing facilities and public spaces at Crams Farm recreational area and the dam wall	• Operation	Positive	Local community, residents	Medium	Council will investigate the potential to enhance recreational uses of the areas surrounding the dam including walking trails and other facilities in line with a catchment management plan to be developed in consultation with the community. The potential to reuse facilities will be investigated during detailed design.	High

Table 6-68 Summary of negative social impacts, mitigation measures and their residual risk ratings after applying mitigation measures

Summary of social impacts	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Way of life						
Land loss of properties within the dam footprint	• Construction • Operation	Negative	Landowners	High	Council has purchased, or is in the process of purchasing, impacted parcels of land from landowners and maintains regular communication. Refer to Chapter 6.07 (Social, land use and property) for further information.	Low
Increase in road traffic during construction raising the risk of motor vehicle accidents	• Construction	Negative	Residents, local community	High	A traffic impact assessment has been prepared for the EIS and a traffic management plan will be developed for construction that provides traffic impact mitigation measures. Refer to section 6.14 for further information on the traffic impact assessment, including traffic routes outside of the Tweed Shire.	High

Summary of social impacts	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Increased housing demand impacting lower income residents already vulnerable to relocation and resettlement	• Construction	Negative	Local community, residents	High	It is proposed to employ local workers; however, workers from outside the area will need to be employed. Temporary accommodation is proposed. The detailed design and construction contractor will undertake a housing supply analysis and develop an accommodation plan.	Medium
Secure water supply leads to unnecessary water usage	• Operation	Negative	Residents	High	Education about sustainable water use and project need will continue.	Low
Increased costs of rent and property values due to increased demand during construction	• Construction • Operation	Negative	Residents	Medium	Undertake a housing supply analysis and develop an accommodation plan for the construction workforce.	Medium
Increased demand and pressure placed on community and support services	• Construction	Negative	Local Community	Medium	Support services are expected to have capacity to cater for the small increase in workers.	Low
Increases in the price of water rates	• Construction • Operation	Negative	Ratepayers	Low	Council included the cost of the project in its long-term financial plans for a number of years. The planning has been done to ensure the project will not cause a significant increase to residents over CPI.	Low
Increased demand for local resources raising the price of construction materials	• Construction	Negative	Local community	Low	Most materials will be sourced from the adjacent quarry to be reopened specifically for the Proposal. Ethical, sustainable, local and Indigenous procurement processes will be prioritised. A resource plan will be developed that includes the waste hierarchy so that materials are sourced from reuse and recycling unless engineering requirements preclude this.	Low

Summary of social impacts	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Community						
Decreased access to Clarrie Hall Dam	• Construction	Negative	Local community	High	Maintain access and communicate any changes to road conditions to residents.	Medium
Decreased visual amenity at Crams Farm and Clarrie Hall Dam because of the induction of vegetation and land	• Operation	Negative	Local community	High	Implement a catchment management plan including future recreation opportunities to be developed with the local community.	Medium
Decreased access to Crams Farm.	• Construction	Negative	Local community	High	Maintain access and communicate any changes to road conditions to residents.	Medium
Anxiety regarding perception of increased flooding risk	• Construction • Operation	Negative	Residents, local community	High	Communicate clearly around the outcomes of assessments regarding changes to flood risk. Continue to educate the community that the Proposal is not for flood mitigation.	Low
Presence of the construction workforce may impact community cohesion	• Construction	Negative	Local community	Medium	Onsite accommodation will mean that the workforce is located separate to local communities. Programs and policies to encourage workforce diversity will focus on reducing gender imbalance and support First Nations participation to support community cohesion. Education and inclusivity activities are provided to workers with guidance from local emergency, health and education services.	Low

Summary of social impacts	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Reduced amenity due to noise and air pollution	• Construction	Negative	Landowners	Medium	Noise and vibration and air quality impact assessments have been prepared for the EIS, and management plans will be developed for construction that provides impact mitigation measures. Curfews will be in place on the works that produce high levels of noise and vibration.	Low
Accessibility						
Decreased access to Crams Farm and surrounding properties	• Construction	Negative	Local community, residents	High	Maintain access to recreational areas for as long as possible. Keep recreational users informed of progress and when the recreational facilities will be updated for use. A catchment management plan will be developed with community involvement. Maintain access and communicate any changes to road conditions to residents.	High
Decreased access to Clarrie Hall Dam and surrounding properties	• Construction	Negative	Local community, residents	High	Maintain access to recreational areas for as long as possible. Keep recreational users informed of progress and when the recreational facilities will be updated for use. Develop a catchment management plan with community involvement. Maintain access and communicate any changes to road conditions to residents.	Medium

Summary of social impacts	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Increased traffic associated with construction may impact accessibility to properties, essential services and businesses	• Construction	Negative	Local community, residents	Medium	A traffic impact assessment has been prepared for the EIS, and a traffic management plan will be developed for construction that provides traffic impact mitigation measures. Changes to road conditions will be communicated to impacted residents.	Medium
Limited capacity in the immediate area to respond to the demands of construction workers with limited health and education services	• Construction	Negative	Local community, residents	Medium	A health and safety management plan will be prepared for construction that includes an assessment of access to health services. It is not anticipated that the construction workforce would bring families due to the lack of accommodation options for families.	Medium
Increased demand raising the price of consumables	• Construction	Negative	Local community, residents	Low	No mitigation is proposed.	Low
Culture						
Cultural and heritage impacts of the Proposal during construction and operation through loss of cultural sites	• Construction • Operation	Negative	Traditional Owners	High	An Aboriginal cultural heritage assessment has been prepared for the EIS, and extensive consultation has been conducted with the local Aboriginal community. Mitigation measures have been discussed with the local Aboriginal community and incorporated into a management plan for construction and operation.	Medium

Summary of social impacts	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Inundation of vegetation impacting peoples' values and beliefs associated with the natural environment	• Construction	Negative	Local community, residents	Medium	A biodiversity impact assessment has been prepared for the EIS that includes potential offset areas. A biodiversity management plan will be prepared for construction. Council is proposing to develop areas of vegetation to offset the impacts. Partnering with local Indigenous communities to support Country restoration and ongoing cultural management will be conducted.	Medium
Impacts and threats to fauna including iconic species such as the koala	• Construction	Negative	Local community	Medium	A biodiversity impact assessment has been prepared for the EIS that includes potential offset areas. A biodiversity management plan will be prepared for construction. Construction specific mitigation measures will include use of registered ecologists / fauna spotters and fauna management plans.	Low
Health and wellbeing						
Increased risk of workplace accidents from use of heavy machinery and undertaking high-risk activities.	• Construction	Negative	Workforce	Medium	All workers must hold relevant and up to date qualifications and licenses to undertake designated activities. Safe work plans will be developed for all construction activities and communicated to workers.	Low
Noise impacts, visual amenity changes, traffic and air quality impacts may cause physical or psychological stress	• Construction • Operation	Negative	Local community	Low	Noise and vibration, air quality and traffic impact assessments have been prepared for the EIS, and management plans will be developed for construction that provide impact mitigation measures.	Low

Summary of social impacts	Project phase	Nature of the impact	Stakeholders	Unmitigated risk rating	Mitigation measures	Significance rating after mitigation
Decision-making systems						
The approval process may be delayed, causing additional cost and anxiety	• Planning and Approval	Negative	Local community	Medium	Council will continue to liaise with the NSW Government to support the progress of the EIS submission and response to submissions.	Low
Conflicting community feedback and opinions	• Planning and Approval	Negative	Local community	Medium	Detailed community and engagement processes will be followed including active involvement in developing the design of recreational spaces and Indigenous involvement in Country restoration and management.	Low

6.7.5 Management measures

In managing social impacts, it is recommended that an adaptive approach is taken where ongoing monitoring and periodic review of mitigation measures, shown in Table 6-67 and Table 6-68, is undertaken. This aims to ensure that any negative social impacts are minimised to best benefit the community.

A Social Impact Management Plan (SIMP) is to be prepared for construction and operation of the Proposal to:

- enhance and refine mitigation, monitoring and management of social impacts over the life of the Proposal, and explain how unanticipated impacts would be addressed
- set out how the community can provide feedback as part of adaptive management
- describe requirements of performance-based and prescriptive conditions
- set out elements, indicators, baseline values, frequencies, triggers, stakeholders and responses.

The SIMP will contain a program to monitor predicted social impacts against actual impacts which describes, for each impact area:

- the desired outcomes in social terms
- the indicator(s) that will be used to monitor change
- the targets against which performance will be assessed
- the methods that will be used to monitor the social impact
- the frequency of monitoring
- the people responsible for monitoring
- the methods that will be used to respond to monitoring results.



CHAPTER 6

Section 6.8 Soils and Contamination

6.8 SOILS AND CONTAMINATION

This section provides a summary of potential impacts due to soil disturbance and contamination during construction and operation of the Proposal, as detailed in the Land, Soils and Erosion Assessment (LSEA) provided in Appendix M and the contamination Preliminary Site Investigation provided in Appendix N.

The soils and contamination assessment has been undertaken in accordance with the SEARs as shown in Table 6-69.

Table 6-69 Relevant SEARs – soils and contamination

Relevant key issue requirement/s	Where addressed
The Proponent must assess the impacts of sourcing, importation, and emplacement of fill / quarried material for the proposal.	Section 6.8.3 – Appendix M - sections 7.2 and 8.4.1
The Proponent must assess potential impacts on landforms (topography), paying particular attention to the long term geotechnical stability of any new landforms (such as embankments etc).	Section 6.8.3 –Appendix M - sections 7.3 and 8.4
The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Section 6.8.3 and Table 6-71; Appendix N - sections 4, 5 and 6
The Proponent must assess whether salinity is likely to be an issue and if so, assess the impacts of the proposal on soil salinity.	Section 6.8.2 –and section 6.8.3 – Appendix M - sections 3.6.2 and 8.1
The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Section 6.8.3 Appendix M - sections 5 and 8.2
Consideration should also be given to areas inundated by the probable maximum flood and how soil and other impacts due to changed hydrological regimes as a result of the proposal would be managed and/or remediated.	Sections 6.8.3 –and 6.8.4 Appendix M - section 8.2.2
The Proponent must detail the capacity of the site to support the increased size of the structure.	Section 6.8.3 –Appendix M - section 8.4.3

6.8.1 Assessment methodology

The methodology for the soils and contamination assessment that has been undertaken is provided below.

Soils

The soils assessment included a desktop review and field soil sampling, erosion and geomorphology inspection within the extent of the Full Supply Level (FSL) and construction impact areas to assess baseline soil conditions and characteristics relating to salinity and erosion potential. The soil sampling is described in section 4.1.1 of Appendix M where samples were submitted for laboratory analysis at a National Association of Testing Authorities and Australasian Soil and Plant Analysis Council accredited laboratory. The assessment was conducted in accordance with relevant guidelines as discussed below and in section 6.8.2 to section 6.8.4.

The desktop review criteria and characterisation of existing information on soils and soil environments for the study area were sourced from:

- NSW Soil and Land Information System (DPIE 2021e), accessed through eSPADE (DPIE 2020d)
- Soil Landscapes of Central and Eastern NSW (DPIE 2020e)
- Hydrogeological Landscapes of New South Wales and the Australian Capital Territory (DPE 2022g)
- Australian Soil Classification system soil type mapping of NSW (DPIE 2021f)
- Great Soil Group Soil Type map of NSW (DPIE 2021g)
- Inherent soil fertility (DPIE 2020f)
- Land and Soil Capability Mapping for NSW (DPIE 2020g).

The assessment of soils and contamination included a desktop review and field survey as follows:

- desktop overview of site land and soil capability, agricultural productivity, any present biophysical strategic agricultural land (BSAL), soil landscapes and soil types likely to be present onsite and commentary on their constraints relevant to salinity and erosion risk
- detailed erosion hazard analysis as per Landcom (2004)
- soils sampling and testing and analysis of physical and chemical characteristics of the encountered soil types, their potential erosion risk and salinity limitations
- assessment of salinity constraints and potential with consideration for surface water and groundwater environment
- review of the geology utilising the NSW Seamless Geology database, version 2.1 (Colquhoun, GP et al. 2021) accessed through the MinView web portal (GSNSW 2023)
- geomorphology assessment (desktop review and site visit)
- geotechnical review (desktop review)
- assessment of the potential impacts on downstream creek and river geomorphology due to changes in catchment sediment yield and the runoff hydrograph
- impact assessment on soil and land resources, agriculture and erosion.

Contamination

The preliminary site investigation (PSI) for contamination included a desktop review and field survey, for the area within the proposed FSL, the area between the proposed FSL and PMF level, and the construction disturbance footprint, as follows:

- review of available drawings / plans / reports relating to project footprint, and associated properties
- incorporation of contamination data obtained as part of previous contamination investigations conducted within proximity to the project including an assessment of the FSL and PMF level and mitigation measures
- identification of any known contaminated sites in the Proposal footprint as detailed on the NSW Environment Protection Authority (EPA) List of contaminated sites
- identification of properties along the proposed footprint which are listed on the NSW EPA contaminated land record of notices

- identification of current or historical land uses located along or nearby the project footprint that are likely to have caused contamination
- review of historic aerial photographs to identify the presence of any visually identifiable potentially contaminating activities either within the vicinity of the Proposal footprint
- review of published maps of the area to gain an understanding of surface and subsurface conditions within a 500 m radius of the Proposal (e.g. Geology, hydrogeology, soil, acid sulfate soils and topography)
- search and review of information readily available through the internet (e.g. Historic parish maps, NSW Office of Water [NOW] registered groundwater bore database within identified areas of potential environmental concern (AEC) within the Proposal footprint)
- interviewing relevant personnel (where identified), such as local landowners, to assess any pertinent information relating to properties
- inspections of the Proposal footprint, focussing on proposed construction staging and laydown areas and other areas of disturbance where the potential for encountering contaminated material during construction is highest based on the findings of the desktop review.

The findings of the above were included in plans identifying:

- low, medium or high-risk areas of contamination
- areas where no evidence of contamination has been identified based on the results of the desktop study.

Potential contaminants of concern likely to be present in the areas identified as confirmed through a site inspection or historical reports or potentially contaminated areas were assessed as follows:

- Assessment of source-pathway-receptor linkages was undertaken, and presentation of a conceptual site model provided to inform the understanding of the likelihood of contamination being present at a particular location and the consequence of contamination impacts on the construction and operation of the Proposal.
- Based on the above, further assessment of the linkages between the risk posed by the contamination, and the mitigation measures applied was undertaken at each specific area of concern (AEC).
- Based on the assessment of source-pathway-receptor linkages, conclusions have been provided on whether the land is likely to be contaminated and whether further assessment, remediation or management of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. A summary of areas of low, medium and high contamination risk and their relationship to potential or actual human health and environmental impacts has been provided.
- Measures and recommendations are consistent with the site assessment and remediation processes in the National Environment Protection (Assessment of Site Contamination) Measure (NEPC 2013).

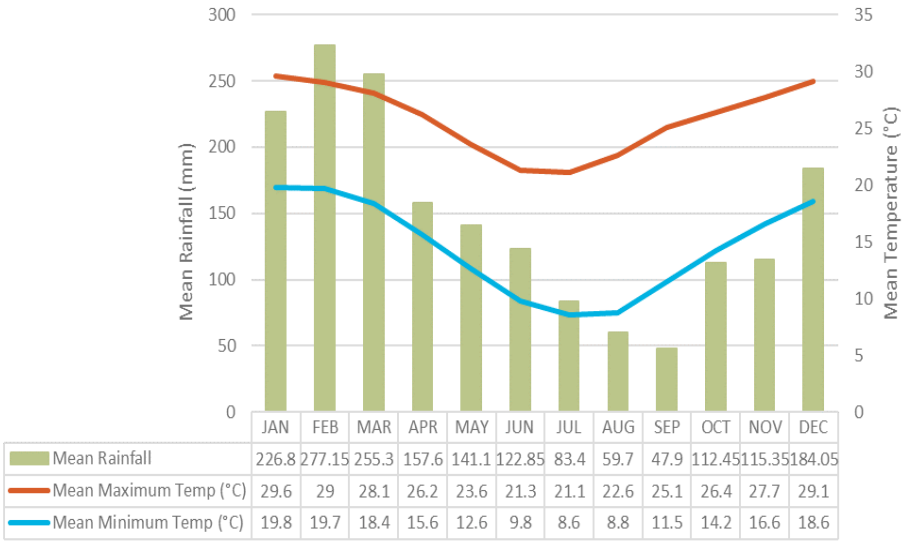
6.8.2 Existing environment

The existing environment relevant to the assessment of soils and contamination within, and in proximity to, the Proposal area is discussed below.

Climate

The Proposal site is described by the Bureau of Meteorology (BoM) modified Köppen classification system as subtropical with a distinct dry season, wet summer and low winter rainfall, and with warm summers and cold winters (BoM 2023a). These descriptions are based on 30-year

climatology between 1961 and 1990. Figure 6-62 illustrates the latest rainfall and temperature data retrieved from BoM weather stations 58019 (Doon Doon) and 58005 (Brays Creek). This data is consistent with the Köppen classification where mean rainfall trends below 50 mm per month for late winter and early spring, rising up to 280 mm per month during summer. The mean annual rainfall over the catchment is 1,595 mm. On average, 111 days per year have rainfall greater than 1 mm.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean Rainfall	226.8	277.15	255.3	157.6	141.1	122.85	83.4	59.7	47.9	112.45	115.35	184.05
Mean Maximum Temp (°C)	29.6	29	28.1	26.2	23.6	21.3	21.1	22.6	25.1	26.4	27.7	29.1
Mean Minimum Temp (°C)	19.8	19.7	18.4	15.6	12.6	9.8	8.6	8.8	11.5	14.2	16.6	18.6

Figure 6-62 Mean monthly temperature and rainfall for Clarrie Hall Dam

Source: BoM 2023a (Appendix M)

The BoM wind roses for Murwillumbah (Bray Park) (station number 058158) show the daily prevailing wind directions for 9 am and 3 pm as south-westerly to easterly, respectively (see Figure 3.2 in Appendix M).

Hydrology

A short summary of the waterways and hydrology is provided below with a detailed description of the hydrology of the Proposal area provided in section 6.1 and Appendix G1).

Waterways

Doon Doon Creek is a 5th order stream with upstream linkage to lower order streams and downstream linkage to the Tweed River. At and around the junction with Doon Doon Creek, the NSW HydroLines dataset defines the Tweed River as a 6th order waterway. The Tweed River flows in a generally easterly direction towards the coast. In the upper reaches, the river has a stoney bed with sequences of pools and riffles.

River styles

The catchment linkages are summarised from the NSW River Styles spatial dataset (DPE Water 2023), accessed via the NSW Sharing and Enabling Environmental Data (SEED) portal (DPIE 2020h), in Table 3.1 of Appendix M. Figure 3.3 of Appendix M shows the watercourses present within the catchment of the dam and downstream from the dam wall.

Streamflow regimes

The surface water assessment provided in section 6.1 indicates a strong seasonality to flow conditions within the Tweed River. Both of the flow monitoring gauges (located in the Tweed River downstream of Palmers Road Crossing – 201015 and the Tweed River at Uki – 201900)

demonstrate perennial flow conditions, with summer and autumn typically having higher flow rates than winter or spring.

Doon Doon Creek is not gauged; however, estimates of streamflow have been developed as described in section 6.1. The summary flow characteristics predicted for Doon Doon Creek are:

- perennial flow conditions, supported through releases from the dam
- flow range (20th to 80th percentile) of 4 ML/day to 100 ML/day.

Further detail on the estimates of streamflow, streamflow regimes and flow conditions within Doon Doon Creek and the Tweed River is provided in section 6.1.

Topography and geology

Clarrie Hall Dam is situated on the Doon Doon Creek with a total catchment area of approximately 60 square kilometres. The volume of the existing dam reservoir is contained within the extended valley margins confined by bedrock and cohesive terraces.

The dam is bound to the east by a ridge which rises to 250 m AHD with a 30% gradient across the easterly aspect. Slopes across the westerly aspect are defined by multiple spur and re-entrance features with a 25% gradient. Steeper slopes are located near the dam spillway averaging between 20% and 40% gradients. The western boundary ridge ends 500 m downstream of the spillway, and the topography opens to undulating land and floodplains.

The study area's parent materials are described as Triassic igneous rock, silicic to intermediate type. Holocene sediment deposition has occurred in the existing dam area. Downstream of the spillway, valley boundaries are composed of sedimentary units, including feldspar-rich sandstones, siltstones, mudstones and conglomerates.

The northern extent of the Proposal site is underlain by the Triassic-aged Chillingham Volcanics with the southern extent of the Proposal site, near Crams Farm, underlain by the Triassic-aged Ripley Road Sandstone, belonging to the Woogaroo subgroup. The upper reaches of the Proposal are underlain by Jurassic-aged claystone and sandstone.

Floodplain deposits of the Tweed River and in the upgradient reaches of Doon Doon Creek are alluvial mud, silt, sand and gravel. The alluvial deposits are typically narrow, ranging between 50 and 400 m in width, and are thin – that is, typically less than 10 m in depth. Gravel deposits on the inside bends of Doon Doon Creek bends are mapped in Hawke (1979), and further minor pockets of alluvium were expected based on inspection of aerial imagery.

A summary of the geological units relevant to the Proposal is presented in Figure 3.4 and Table 3.3 of Appendix M.

The geology that underlies the Proposal area is shown in Figure 6-63.

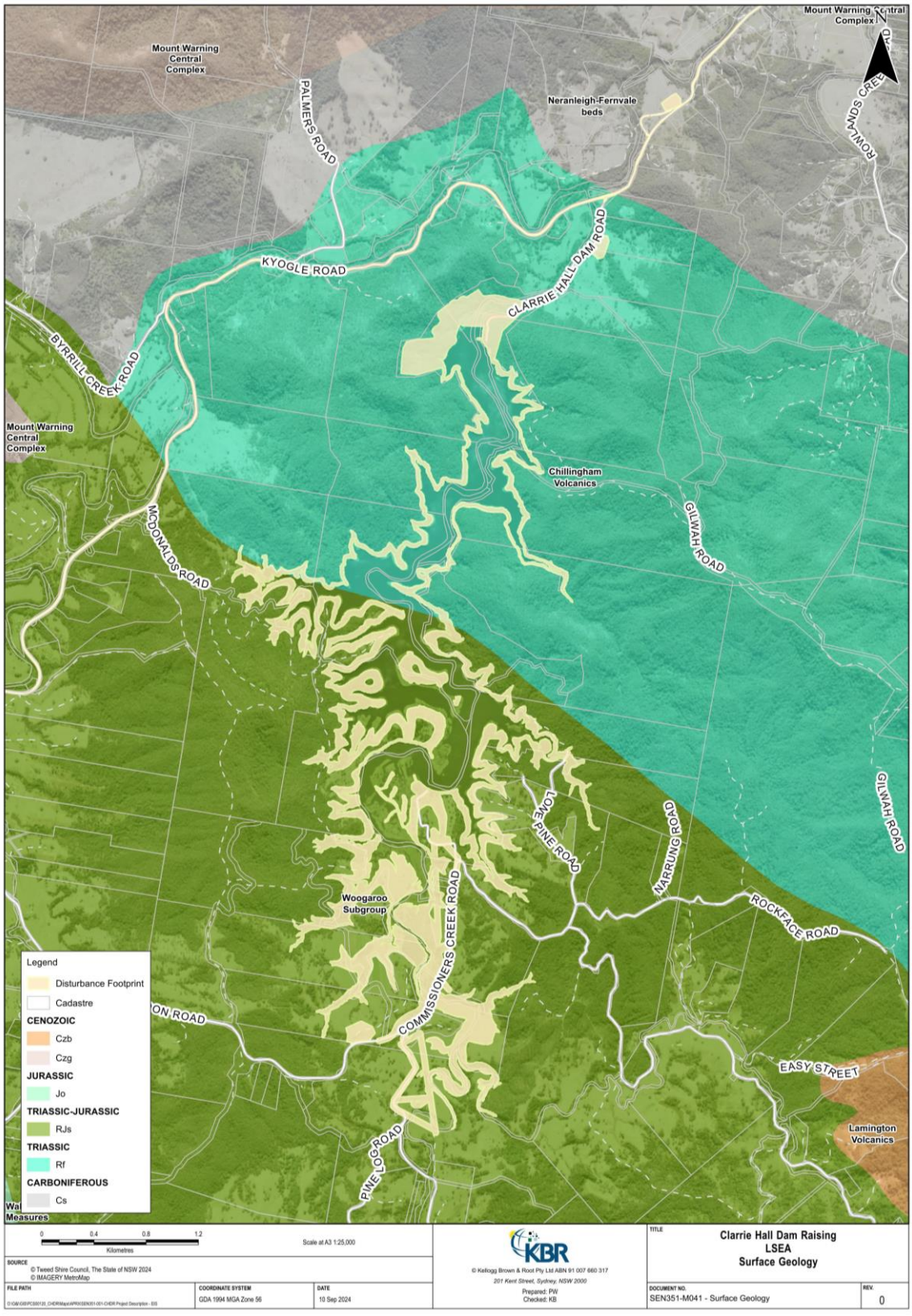


Figure 6-63 Map depicting surface geology of the study region

Soils

Soil landscapes

The Proposal is located within the mapped area of the *Soil Landscapes of the Murwillumbah-Tweed Heads 1:100,000 Sheets* (Morand DT 1996). Based on the desktop review, the Proposal is primarily located on the soil landscapes of Frogs Hollow and Kunghur (and its variants). The main soil landscapes within the Proposal site are summarised in Table 6-70 and shown in Figure 6-64.

Table 6-70 Soil landscapes relevant to the Proposal

Soil landscape	Location	Characteristics
Kunghur (with variants)	Southern half of the Proposal area	• Shallow to deep (between 0.5 and 1.5 m) well-drained yellow podzolic soils on ridges and upper slopes. • Deep (more than 1 m) moderately well drained yellow and red podzolic soils and red earths on slopes. • Moderately deep (1–1.5 m) poorly drained gleyed podzolic soils and yellow podzolic soils on lower slopes and poorly drained areas. • Limitations include strong acidity, high erodibility and permeability, hard setting and low water holding capacity.
Terania	Doon Doon Creek	• Deep (more than 1 m) well drained soils of no suitable group and dark alluvial clays. • Near sandstone areas, the soils are deep (more than 3 m), well-drained soils of no suitable group and brown alluvial clays. • On more recent floodplains, soils are deep (more than 2 m), poorly drained weisenboden and black earths. • Deep, rapidly drained earthy sands line the channels. • Limitations include stony soil, low soil fertility, moderate-high erodibility, low to high permeability and low available water holding capacity.
Frogs hollow	Northern half of the Proposal area	• Moderately deep (1–2 m), moderately well-drained brown podzolic soils and brown earths on ridges and upper slopes • Deep (more than 2 m) moderately well-drained red podzolic soils and red clays elsewhere. • Limitations include stony soil, strong acidity, high aluminium toxicity potential, low soil fertility and permeability, high erodibility and hard setting.
Oxley	Soil surrounding the Tweed River near the intersection with Kyogle Road	• Shallow to moderately deep (up to 1 m), imperfectly drained alluvial soils and/or minimal prairie soils on floodplain. • Deep (more than 2 m) moderately well drained minimal prairie soils and dark alluvial clays on alluvial plains. • Limitations include stony soil, low soil fertility, high erodibility and moderate plasticity.
Burringbar	Soil near Kyogle Road and proposed ancillary facilities	• Shallow to moderately deep (less than 1 m) moderately well drained stony grey earths on crests and some slopes. • Deep (more than 1 m) moderately well-drained red podzolic soils on slopes of deeply weathered siltstone/mudstone/ shale. • Shallow (0.5–1 m) poorly drained yellow podzolic soils on slopes of quartzite/phyllite. • Deep (more than 1.5 m) imperfectly drained stony yellow podzolic soils on old coastline. • Limitations include stony soil, strong acidity, moderately dispersive and hard setting.

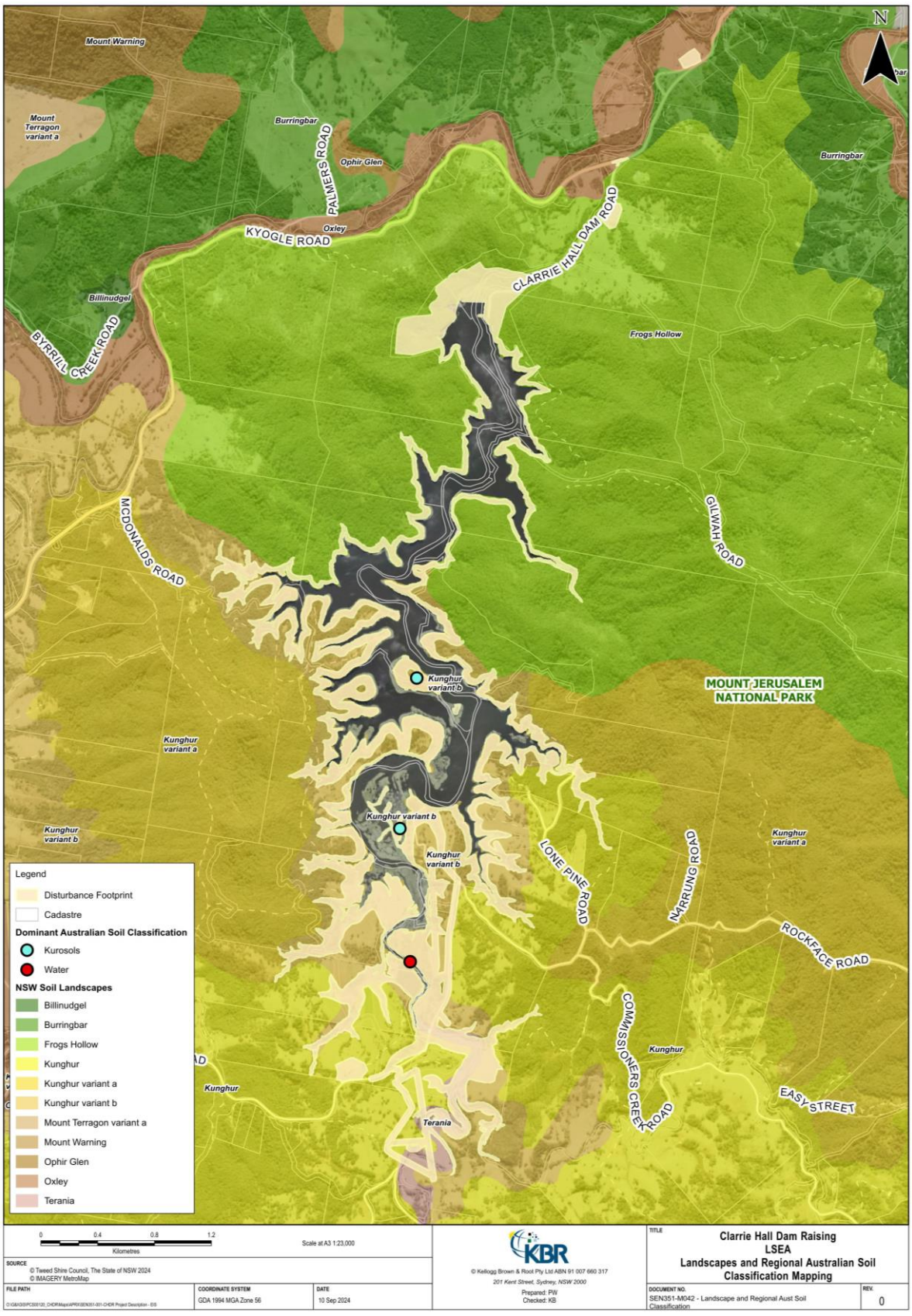


Figure 6-64 Map depicting soil landscapes in the study region

Salinity

Hydrogeological landscape boundaries and descriptions have been derived for a number of areas across NSW based on how salinity manifests itself in the landscape and how differences in salinity are expressed across the landscape. A hydrogeological landscape spatially defines areas of similar salt stores and pathways for salt mobilisation and relies on the integration of a number of factors: geology, soils, slope, regolith depth, and climate; an understanding of the differences in salinity development; and the impacts (land salinity/salt load/water electrical conductivity [EC]) in landscapes.

The Proposal is located outside of detailed mapped areas, but at the statewide level the area is mapped as low to moderate overall salinity hazard respectively to a north-south divide. This roughly correlates with the occurrence of the Frogs Hollow soil landscape. Land salinity is similarly mapped as low in the north and high in the south.

Australian soil classification

The Australian Soil Classification (ASC) scheme is a multi-category scheme used to define soil orders based on their profile. NSW mapping (DPIE 2021e) identifies Dermosols and Kurosols within the Proposal site:

- Kurosols are often dispersive and have the highest erosion risk and the highest risk of generating turbid runoff.
- Dermosols typically have higher agricultural potential and fewer limitations. However, Dermosols could exhibit similar constraints to Kurosols under certain conditions and subject to their specific soil chemistry.

A summary of regional ASC soil mapping is provided in Table 3.6 of Appendix M.

The soil chemistry of the site-specific soils is discussed in section 4.2 of Appendix M.

Soil fertility

Inherent soil fertility is used as a general indication of a soil's capacity to retain and release nutrients and soil water for use by vegetation and is a function of the interrelationship between physical, chemical and biological components in the soil.

As per the eSPADE database (DPIE 2020d), the NSW scale mapping shows that the soils of the Proposal area have variable inherent soil fertility ranging from ‘moderate’ to ‘moderately low’ (see Table 3.8 of Appendix M).

Land and soil capability

The NSW ‘Land and soil capability assessment scheme, 2nd approximation’ (OEH 2012) (‘LSC Scheme’) assesses the inherent physical capacity of the land to sustain a range of land uses (and management practices) in the long term without leading to degradation of soil, land, air and water resources. Each hazard is given a rating between 1 (best, highest capability land) and 8 (worst, lowest capability land). The overall LSC class of the land is based on the most limiting feature/hazard.

With reference to the eSPADE database (DPIE 2020d) and DPIE (2020g) the state scale mapping completed for NSW shows the study area includes Classes 3, 4, 6, 7 and 8, representing land with high to extremely low capability (Table 3.9, Table 3.10 and Figure 3.6 of Appendix M).

Acid sulfate soils

Acid sulfate soils (ASS) and potential ASS are naturally occurring soils containing iron sulfides. On exposure to air, iron sulfides oxidise and create sulfuric acid. This increases soil acidity and can result in the mobilisation of aluminium, iron and manganese from the soils.

The desktop assessment identified that there are no ASS or potential ASS within close proximity to the Proposal, in accordance with the *Guidelines for the Use of Acid Sulfate Soil Risk Maps* (Naylor et al. 1998). Risk mapping identifies the nearest site with a high probability of ASS is approximately 10.5 km north-east of the Proposal.

Acid sulfate soils are typically found in coastal areas, which is not applicable for the Proposal. However, inland ASS theoretically has the potential to occur within and around any waterway where suitable conditions prevail (such as sulfate salinised areas in inland regions with anoxic conditions and abundant organic matter). Such conditions could occur within the Proposal area; therefore, managing salinity and carbon sources (such as algae, riparian litter, and municipal wastewater) is key to prevent the potential for ASS.

Hydrogeology

The groundwater systems within the study area comprise:

- minor local, shallow groundwater associated with alluvial deposits
- local, groundwater systems associated with the tertiary volcanic rocks
- local to regional groundwater systems associated with the porous and fractured rock units within the Clarence-Moreton Basin
- local to regional groundwater systems associated with the fractured rock units of the New England Fold Belt.

These groundwater systems have different hydrogeological properties due to their depositional environment. Generally, this is a low-yielding region with no highly productive aquifer systems. The groundwater systems are discussed in detail in section 6.1.

Land use

Land use within the study area was assessed utilising the catchment scale land use maps of Australia (ABARES 2021a), a national compilation of catchment scale land use data for Australia compiled at a resolution of 50 m by 50 m.

The 2021 mapping utilises the standards of the Australian Collaborative Land Use and Management Program and the Australian Land Use and Management (ALUM) Classification version 8. Six primary land use classes are described in Table 3.12 of Appendix M.

Under the ALUM classification and mapping, the study area is predominantly mapped as ALUM 6.1.0, Lake and secondarily as ALUM 1.3.3, Residual native cover. ALUM 2.1.0, grazing native vegetation and 3.2.0, grazing modified pastures are the other more significant land uses. A detailed breakdown of the ALUM classification of the study area is contained in Table 3.13 of Appendix M.

Land zoning is discussed in Chapter 4.

Agriculture

The Proposal is located within the North Coast Natural Resource Management Region of NSW.

The assessment of Proposal impacts to agricultural land has been based on desktop assessment of available agricultural land use and productivity at a regional level.

Strategic agricultural land

Strategic agricultural land in NSW is safeguarded through 2 primary measures – classification as Biophysical Strategic Agricultural Land (BSAL) or the implementation of Critical Industry Clusters (CICs). The Stage Significant Agricultural Land (SSAL) map is currently in draft format on public

exhibition for comment and feedback and is not yet approved or implemented for any purpose but has been considered in addition to BSAL and CICs.

The presence of BSAL, SSAL and CICs within the study area is described as follows:

- There is a small area of mapped BSAL present that overlaps the southern portion of the Proposal footprint, associated with the Terania soil landscape, and Class 3 LSC mapping (Figure 3.6 of Appendix M).
- There is a small area of mapped BSAL present to the south of the study area, associated with the Terania soil landscape, as well as to the north, associated with the Tweed River.
- No CICs are present within the study area.

Agricultural water resources

The existing use of surface water resources in agricultural activities is discussed in section 6.1. The assessment summarised that agricultural land use within the Tweed Shire LGA consists of around 75% of RU1, RU2, R5, 7(d), 7(f), and 7(l) zoned land, comprising grazing lands, broadacre sugarcane cropping, horticulture, forestry and rural living activities. Water use through irrigation is typically highest with cattle production and dairying. Within the surface water source associated with Clarrie Hall Dam, 5 irrigation and one stock and domestic water access licences exist, totalling 56 shares (equivalent to 56 ML/year when water availability is 100%).

Groundwater

There are 32 registered groundwater bore installations within a 5 km radius of Clarrie Hall Dam. Of these registered groundwater bores, approximately 2 have an irrigation purpose and 3 have a stock and domestic purpose, indicating some level of water access for agriculture. Further information about groundwater access and interactions with the Proposal can be found in section 6.1.

Land use

The LGA has agricultural land use dominated by livestock production, with 33.98% of the LGA land use being grazing of native or modified pasture, making up 74.4% of the agricultural land use. Much of the LGA outside of agriculture is utilised for nature conservation (34.82%) (ABARES 2021b).

Given the utilisation of the dam for local drinking water supply, the Council has endeavoured to remove all agricultural practices, such as excluding stock grazing, from proximity of the dam full supply level to protect the dam catchment from degradation and minimise water quality impacts associated with sedimentation and agricultural runoff.

Production

Agricultural production is discussed in sections 3.9.5 and 3.9.5 of Appendix M. It is noted that due to the function of Clarrie Hall Dam as a domestic water supply, much of the agricultural land adjacent to the dam, subject to potential impact by the Proposal, has been purchased by Council. With these purchases, much of the agricultural activities have ceased in order to prevent future impacts to drinking water. As such, the estimated agricultural impacts are likely to be much reduced compared to those values calculated in Table 3.17 of Appendix M.

Catchment geomorphology

Of the watercourses present within the dam catchment, further review of the River Styles dataset was undertaken to understand the existing condition of each system, with the results summarised in Table 3.18 of Appendix M.

Soil field investigation

Site investigations were undertaken in March 2023 to inform the assessment and complement the desktop review findings. The surveyed area encompassed approximately 232 ha of the 252.3 ha study area. A total of 5 soil profile sites were investigated to a depth of 1.2 m, achieving an approximate site intensity of 1 site per 50 hectares. An additional 4 sites were sampled to collect discrete soil samples for laboratory analysis where profile assessment was not possible.The soil survey methodology is provided in section 4.1 of Appendix M.

The soil investigation site locations are shown in Figure 6-65 and described in Table 4.1, of Appendix M.

Soil profile classes

Soil profiles were described at 5 locations, with single soil samples taken at a further 4 locations. The soil profile at each detailed site was classified using the Australian Soil Classification system (Isbell & NCST 2021). Soils with comparable profiles determined by similar morphological properties, physico-chemical properties, parent material, representative landforms and geomorphological position in the landscape were grouped into SPCs (McKenzie et al. 2008).

Soil profiles across the study area, provided in detail in section 4.2 of Appendix M, were grouped into 3 SPCs (Table 4.4 of Appendix M), based primarily on classification under the ASC. The site consists predominantly of non-cracking clay Dermosols and acidic, texture contrast Kurosols, with minor areas of poorly developed alluvial Rudosols, which is generally consistent with regional soil mapping described previously.

Soil hazards

The assessment of soil chemistry found the soils of the Proposal area are relatively stable, with no sodicity and typically balanced Ca:Mg ratios, indicating the potential for soil dispersion is low. This is inconsistent with the potential for erosion and dispersion identified in the soil landscape soil materials, which should be considered. Erosion risk is increased in the sandier, less developed profiles (SPC03) as their reduced cohesion means they are likely to be susceptible to erosion.

There are no apparent soil salinity limitations in any of the soil samples submitted for laboratory analysis.

The primary chemical limitation identified, consistent with some of the soil landscape soil materials, is the acidic soil pH and potential for aluminium toxicity, which could be a constraint to revegetation and should be considered in selection of species utilised in rehabilitation.

Erosion hazard analysis

The assessment of erosion hazard was completed as per Landcom (2004), which considers the overall erosion hazard based on slope and rainfall erosivity (R-factor) and subsequent determination of SLC. The assessment is described in detail in section 5 of Appendix M.

The erosion potential of soils of the study area, expressed as K-factor, is moderate. Assessment of rainfall erosivity indicates erosion hazard will be high for areas of the Proposal where slopes exceed 5%, which aligns with the assessment of SLCs, indicating a change from low to moderate erosion risk (SLC 4) at 6–7% and to high erosion (SLC 5) at slopes between 8 and 9.5% (Table 5.7 of Appendix M). Beyond approximately 17% slopes and lengths of 18 m, erosion hazard during construction disturbance activities should be considered extreme and appropriate strategies and mitigations be adopted. The average gradients within the quarry, dam wall proposed construction compound area, recreation area footprint and the raised dam wall and spillway embankments were identified as the highest in the Proposal area and therefore are likely to be the areas with the greatest susceptibility to erosion and sediment loss.

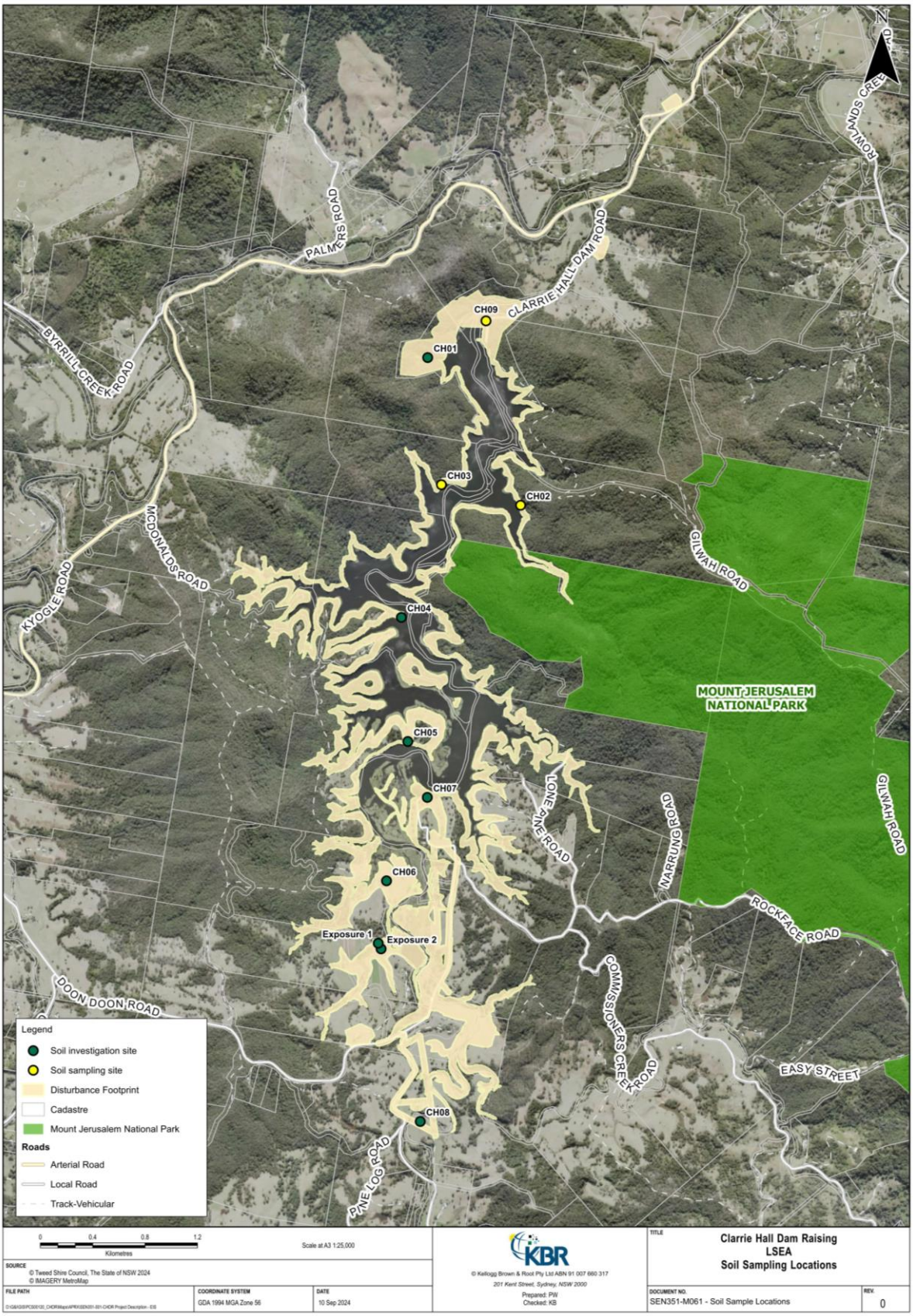


Figure 6-65 Soil investigation locations

Geomorphology

To support an understanding of the potential for change due to the Proposal on downstream geomorphology, a desktop review, informed by site inspections was undertaken. Outcomes from the hydrology modelling completed (see section 6.1) were also considered.

The key mechanisms for geomorphic change as a result of the Proposal are:

- changes in sediment mobilisation downstream of the dam
- increased scour due to changes in the frequency, duration and volume of the raised dam spillway releases.

To understand the potential for the above impact mechanisms to occur or be significant, the geomorphology assessment comprised of a condition analysis and review of hydraulic modelling outcomes described in section 6.1, with the results summarised in Table 6.9 of Appendix M.

Contamination

The construction disturbance footprint consists of the quarry, old haul road, dam wall, spillway, intake tower, control room, toilet block and picnic area. During the time of the site inspection, there was newly eroded material near the quarry, which appeared consistent with the geology of the area. No visible algal bloom was observed on or in the dam water. Minor household general solid waste was found dumped near the picnic area.

Listed contamination sites

A search of the NSW EPA register of contaminated sites and list of notified sites identified no records within 500 m of the Proposal.

There are also no known contaminated legacy areas, Defence sites, military sites, unexploded explosive ordnance areas, former gasworks sites or Per- and Polyfluorinated Substances sites within a 2 km radius of the Proposal.

A search of the NSW Department of Primary Industries Cattle dip site locator identified 4 dip sites (refer to Figure 6-66).

Areas of contamination concern

Following a desktop review and site investigation, the assessment identified a number of areas of contamination concern shown in Figure 6-66. Table 6-71 provides an overview of potential contamination sources and contaminants of concern. The potential to encounter significant or widespread contamination is considered to be low.

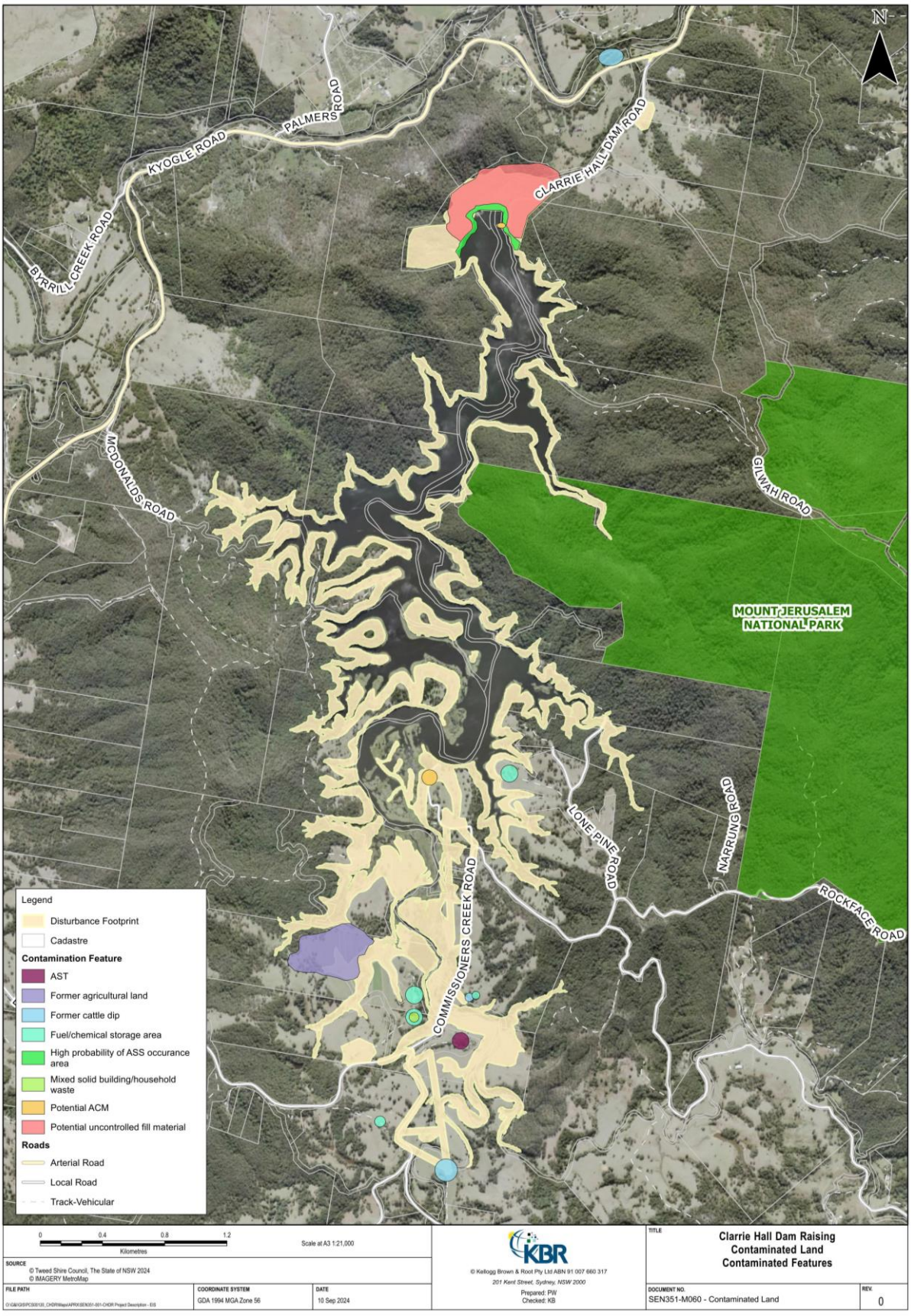


Figure 6-66 Potential contamination sources in the study region

Table 6-71 Overview of potential contamination sources

Potential source of contamination	Discussion	Contaminants of potential concern
Fuel and/or chemical storage	During the site investigation, a number of fuel and/or chemical storage sites were identified. These areas are not located within the proposed construction disturbance footprint or within the FSL. The types of potential contamination include above-ground storage tanks and intermediate bulk containers with unknown liquids, spray containers and chemical containers.	• Total recoverable hydrocarbons (TRH) • Benzene, Toluene, Ethylene, Xylene and Naphthalene (BTEXN) • Polyaromatic hydrocarbons (PAH) • Petroleum hydrocarbons (PHCs) • Metals
Household / building waste	Two areas of mixed solid building and household waste were observed at Doon Doon Road near McCabes Bridge, containing materials such as wood, concrete, metal, brick, plastic, tin, electrical and white goods. There was also a small quantity of dumped general household waste near the picnic area at the dam wall.	• Polychlorinated Biphenyls (PCBs) • Organochlorine Pesticides (OCPs) • Metals • TRH • BTEXN • Asbestos containing material (ACM)
Asbestos-containing material (ACM) is present in some building structures	Asbestos must be managed in accordance with prevailing legislative requirements. **Crams Farm** The bails and dairy building at Crams Farm was visually inspected for asbestos in 2020, and it was found that there is presumed ACM that has not been confirmed within interior walls, ceilings and ceiling space. The public toilet block at Crams Farm was visually inspected for asbestos in 2021, and it was found that there is presumed ACM that has not been confirmed within the Soffit sheeting around the entire building, ceiling sheeting, tile adhesive and ACM fibres in the ceiling space. The Doon Doon Hall at Crams Farm was visually inspected for asbestos in 2021, and it was found that there is presumed ACM that has not been confirmed within the interior walls, ceilings and ACM fibres within the ceiling space. There is therefore potential ACM in the toilet block, shelter, and Doon Doon Hall at Crams Farm Reserve, and asbestos warning signs have been placed on these buildings. **Dam wall area** The intake tower roof and cladding, intake tower switchboard in the carpark, public toilet storeroom and valve control house roof sheets were visually inspected for asbestos in 2015, and it was found that there was a very high likelihood of friable asbestos within interior walls, ceilings and meter box. The likely presence of ACM in the intake tower and the toilet blocks in the dam wall picnic area, has resulted in asbestos warning signs being placed on these buildings.	Asbestos containing material (ACM)

Potential source of contamination	Discussion	Contaminants of potential concern
Gilmore's cattle dip	Located within the existing FSL, the site was demolished, removed and inundated as part of the original Clarrie Hall Dam construction in 1979. Chemicals historically used were noted to include arsenic, DDT (an organochlorine pesticide (OCP)), dioxathion, chlorpyrifos and ethion chlordimeform (organophosphorus pesticides (OPP)) and armitraz (a non-systemic acaricide and insecticide).	• Organochlorine Pesticides (OCPs) • Organophosphorus Pesticides (OPPs) • Acaricides and insecticides • Arsenic
Fogarty's cattle dip site	Located in proximity to the PMF, the site remains in place and observed to be not completely decommissioned, with leftover fencing still in place and in proximity to the PMF. Currently listed as active with a lapsed lease/licence. Chemicals noted to be used were consistent with Gilmore's dip.	
Lower Commissioner's Creek cattle dip site	Located in proximity to the PMF, the site is listed as decommissioned with lapsed licence and has been dismantled and capped. The bath was demolished and either removed or buried. Chemicals noted to be used were consistent with Gilmore's dip.	
Doon Doon cattle dip site	Located in proximity to the Clarrie Hall Dam Road and Kyogle Road Intersection, the site is listed as active with lapsed licence. It is understood to be still standing, capable of dipping operations either immediately or with some minor upgrades. Chemicals noted to be used were consistent with Gilmore's dip. Assessment and remediation (or management) of the Doon Doon dip site would be required in the event that it is confirmed that the proposed road upgrade works would disturb the dip site.	

6.8.3 Impact assessment

A summary of construction and operational impacts is outlined below, with a detailed assessment provided in Appendix M and Appendix N.

Construction impacts

Construction phase impacts relate to the excavation and surface disturbance areas associated with the Proposal.

Soil

i Soil disturbance

The proposed construction activities will disturb soils through:

- clearing, topsoil stripping and earthworks across the construction footprint, including the establishment of the proposed sites for workers accommodation and concrete batching plant
- decommissioning of any existing Clarrie Hall Dam infrastructure
- management of construction materials (import/export and movement)
- excavation from existing borrow (quarry) areas.

The soil disturbance during construction has the potential to result in the following impacts:

- reduction in soil stability and increased susceptibility to erosion due to vegetation removal, flow concentration or soil exposure, especially where subsoils are sodic and dispersive
- reduction in soil quality, quantity and associated productivity
- loss of structure and water holding capacity due to mechanical compaction
- reduced topsoil nutrients and biological activity
- loss or degradation of topsoil material viable for use in rehabilitation
- introduction of constraints into the topsoil material if soil is inadequately managed or from imported material.

Topsoil stripped from any areas for new infrastructure for construction should be retained for rehabilitation (general disturbance areas and the rockfill quarry).

ii Soil mixing

Inappropriate separation of topsoil and subsoils during stripping and stockpiling can result in less fertile topsoils due to introduced constraints (such as sodicity or salinity) or potentially constrained subsoils forming the upper part of the soil profile. Mixing of the soil profile can also result in increased stoniness of surface soils impacting the ability to cultivate the soil. Given the acidic and aluminium constrained soils encountered in the study area, inappropriate soil handling practices represents a key risk for land and soil capability.

Imported material will need to be characterised and appropriately handled during rehabilitation works to ensure that it is placed in a suitable portion of the recreated soil profile.

Loss of nutrients and nutrient holding capacity in soil can result in a less fertile environment for crop and pasture production.

iii Compaction

Topsoil degradation can result in organic matter reduction that can lead to soil density increases and subsequent compaction. Construction equipment, such as plant movement, can also compact the soil.

Compaction reduces the infiltration rate of water into the soil profile, available water holding capacity, gaseous exchange and plant root and shoot penetration. Lower organic matter levels are also associated with weaker soil aggregates and therefore greater risk of further erosion and soil crusting.

iv Soil salinity

Construction activities are not anticipated to significantly alter the soil hydrology leading to mobilisation of salt that would affect the water quality in the water storages or resulting in surface expression causing scalding. There was no soil salinity present in laboratory testing, and any salt present in subsoils will be covered by topsoil in any earthworks areas requiring rehabilitation. Overall construction activities are not expected to be impacted by or adversely impact on salinity.

v Acid sulfate soils

ASS risk mapping indicates that the Proposal is not located in or in proximity to areas mapped with ASS risk as per the NSW OEH Acids Sulfate Risk Map (OEH 2018) and are Bn(p4), Low Probability of Occurrence with moderate confidence per the Atlas of Australian ASS mapping (Fitzpatrick et al. 2013).

Due to the high elevation of the Proposal relative to coastal areas where ASS is more prevalent, it is considered that ASS would not be disturbed as part of the works and therefore would not be

impacted. Should ASS be discovered onsite during construction, processing will cease, and the material will be managed according to the relevant guidelines, such as the NSW Acid Sulfate Soil Manual (Stone et al. 1998).

Erosion and sediment control

There is a potential risk of soil erosion and related sedimentation impacts associated with construction activities. These risks arise from vegetation clearing, soil disturbance, and runoff concentration over disturbed areas, leading to potential offsite discharge of sediment and turbid runoff, degradation of water quality, sediment infilling of waterway pools, mud tracking from vehicles, increased rill and gully erosion, and dust emissions.

Specific impacts include sedimentation from quarry activities, requiring management measures such as temporary clean water diversions and sediment control structures. Haul roads and other temporary unsealed access roads also pose sediment risks, necessitating adherence to design parameters for sediment management and subsequent rehabilitation. Temporary watercourse crossings are planned for haul roads across Doon Doon Creek, following guidelines to prevent erosion and sediment loss.

Areas for construction equipment laydown and temporary concrete batching will be established on levelled areas and include appropriate diversion of clean water away from the operational areas. Stabilisation of these established pads would include a form of ground stabilisation such as pavement or gravel which will reduce the potential erosion, material tracking and general maintenance issues of these areas during construction.

Construction of offices and temporary construction accommodation areas will include establishment of levelled areas for which both permanent and temporary buildings can be established. Areas dedicated to traffic movements associated with offices and construction accommodation would be stabilised to mitigate potential erosion and soil loss.

Geotechnical

Geotechnical considerations related to sourcing, importation and management of overburden and quarried materials, landslide risk and landform stability are summarised below:

- Dam wall and spillway: For the construction of the dam wall and spillway, significant volumes of material are needed. Raising the dam wall requires 133,000 cubic metres of various fill materials, while spillway excavation will generate approximately 190,000 cubic metres of material. Most material extracted from these excavations will not be suitable for the dam embankment, thus requiring up to 125,000 cubic metres of rock-fill from the quarry. Quarry expansion is planned to yield the necessary materials, with further geotechnical testing to ensure suitability and safety. Stockpiling areas are proposed near the site, and excess material will be used for rehabilitation or disposed of offsite if not reusable within the Proposal area.
- Realignment of Clarrie Hall Dam Road and intake tower: The realignment of Clarrie Hall Dam Road will generate 21,300 cubic metres of cut rock and overburden, the quality of which will be subject to further testing. Excess material will be processed, stockpiled, or disposed of offsite. The intake tower construction will not significantly impact the overall material balance.
- McCabes Bridge and road alignment: Construction of McCabes Bridge will use suitable excess material from the spillway excavation for abutments and road alignment adjustments, with stockpiling managed onsite.
- Haul road options: Material for haul roads will likely come from spillway excavation rockfill. Option 1 haul road requires more material than Option 2 haul road due to its length and construction requirements. This is discussed further in chapter 3.

- General material stockpiling: Stockpiles will be placed in designated areas away from riparian zones and floodways to minimise erosion and stability risks. Locations will be refined during detailed design and construction planning.
- Landslide risk: The site qualifies for landslide risk assessment due to the presence of landslide hazards. Construction increasing slopes or soil moisture content, particularly in the Frogs Hollow Soil Landscape, may heighten landslide risks. However, the overall risk to upstream persons or property is considered low due to the site's isolation and lack of infrastructure.
- Dam bank stability: The stability of the Clarrie Hall Dam embankment, constructed with free-draining rockfill and featuring upstream and downstream slopes of 1V:1.3H, is supported by the existing geological conditions, including a foundation of hard rhyolite rock. Design analyses are deemed unnecessary due to the use of a concrete face, which keeps the rockfill dry and free from pore pressure. Past successful performance justifies this design approach. Studies have shown no engineering impediments to raising the dam, with very high strength rock supporting the increased embankment. The new spillway may require additional controls like longer anchoring bolts, while proposed access roads and related infrastructure will adhere to design standards. The existing quarry will supply construction materials, with its expansion and detailed design to be confirmed by a qualified geotechnical engineer.

Contamination

Construction activities will cause excavation and surface disturbances that might lead to contamination from both existing and new sources. Potential contamination sources include uncontrolled fill, historical pesticide use, abandoned cattle dips, soil stockpiles, fuel and chemical storage areas, above-ground storage tanks and mixed solid waste, with specific contaminants like asbestos, pesticides, hydrocarbons, and metals. The potential McCabes Bridge stockpile and construction office site (511 Doon Doon Road) poses a contamination risk, necessitating targeted investigation and possible remediation before stockpiling. Excavated material will be reused or disposed of offsite if contaminated. Activities such as road upgrades, infrastructure relocation and bridge replacement will require careful management of spoil, materials and equipment. New contamination risks include spills or leaks of chemicals and waste from utility works, storage of petroleum and chemicals, and establishment of site offices and infrastructure. Proper management measures are essential to mitigate these risks. Unmanaged contamination can expose construction workers and ecological receptors through direct contact, ingestion, inhalation of dust, and plant or animal uptake.

Operational impacts

Soil

Impacts to soils during operation of the Proposal are expected to include:

- permanent inundation of land due to the raised FSL and potential inundation up to and including PMF level (which is unlikely but has been considered)
- localised soil erosion associated with fluctuating water levels within the reservoir area resulting in overland flow over exposed soils
- erosion and subsequent sedimentation potential from disturbed areas such as permanent unsealed tracks and drainage structures
- soil disturbance from maintenance activities such as use of machinery, vehicle traffic and excavation, similar to existing impacts.

Impacts relating to soil erosion are described in section 8.2 of Appendix M.

Inundation of soil resources

Raising the dam wall and FSL will inundate areas of land not previously inundated and result in additional areas subject to potential inundation in large flood events. The raised FSL level will result in the loss of the soil resource for other productive uses. Areas of potential inundation up to and including the PMF event are above the FSL level but are not expected to result in a loss of resource. However, it does increase the potential risk of these lands being subject to flooding.

The existing catchment is largely destocked to minimise impacts to water quality and therefore impacts to agricultural use of the area will be minimal. Changes in the PMF extent due to the Proposal would result in the inundation of similar land use types and proportions.

The impacts to Land Suitability Classes (LSC) of the Proposal suitable for agriculture (LSC Classes 3–6) are not significant, based on the impacted percentage (approximately 0.3%) in the Tweed Shire LGA area (refer Table 8.1 of Appendix M); and the impacted areas will not fragment contiguous areas of potential agricultural land. Any fluctuation of the FSL including consideration of the PMF event is unlikely to materially affect the significance of these impacts.

Any temporary disturbances will be manageable with proper soil management and rehabilitation. The main erosion consequences include the loss of topsoil and subsoil, which degrades water quality and hampers revegetation efforts post-construction.

Erosion and sediment control

Potential operational erosion and sediment control impacts include offsite discharge of sediment and turbid runoff due to ongoing erosion from unsuitable drainage, landform and infrastructure design. This necessitates increased maintenance for stabilisation of landforms, roads, drains and infrastructure, along with the operation and maintenance of sediment control structures. Erosion can lead to decreased dam capacity and water quality due to upstream deposition of sediment, as well as reputational damage and litigation costs from non-compliance and pollution events. Soil structural decline due to fluctuations in water levels, drowning vegetation and wave action can cause erosion scarps from bank weakening and slumping. Although the soils in the study area are relatively resistant to erosion due to their electrochemical stability and rockiness, they are potentially at risk of slumping. Many lateral gullies have eroded to bedrock and are unlikely to experience significant head cut migration.

The Doon Doon Creek system downstream of the dam, characterised by gravel and larger rocks with pool and riffle sequences, presents a low risk of channel shift due to the Proposal. The upstream catchment is confined by valley margin bedrock, suggesting minimal changes in flow regime and sediment storage, with flood peaks likely spread over a wider area. However, land clearing and disturbances could increase erosion, particularly where riparian vegetation is not retained. Vegetation clearing will be coordinated with the Council, retaining stumps, and not all areas will be cleared due to access issues. Sediment in the creek is resistant to erosion but can be suspended if threshold limits are exceeded, potentially harming ecosystems and posing health risks. Sedimentation can reduce aquatic habitats and submerged surface area while stabilising riffle rocks, affecting natural bed material movement. Riparian vegetation and bedrock exposures help reduce erosive flow paths. Modelling indicates reduced flood peak flows, leading to fewer erosive events and greater geomorphological stability, with negligible differences in bed shear stress between current and proposed scenarios, maintaining low stress within downstream pools.

Geomorphology

For upstream watercourses, the results of soil sampling indicate that topsoils show the presence of cohesive sediments and some localised cobbles and gravels that are likely to provide some protection from periodic inundation. However, there is potential for bank failure, during heavy rain making undercutting of the banks possible. The consequence of this potential bank instability is expected to be minor.

The SWA (Appendix G1) found that raising of the dam is expected to lead to a minor decrease in the supply of sediment moving downstream along Doon Doon Creek. This is predicted to occur due to the reservoir capturing and retaining more sediment. The decrease in sediment supply would promote erosion of fine particles downstream while the decrease in high flows as described above will likely promote sedimentation and a reduction in erosion. The combination of these effects mean that any geomorphological change is difficult to predict. However, the magnitude of each geomorphological effect is expected to be relatively small and any geomorphological change that does occur is expected to occur as slow adjustments over an extended period of time.

In locations with a gravel/rocky bed, it is likely that no geomorphological change will occur due to the Proposal. Rocks of the sizes observed in the riverbed are not expected to be affected by erosion due to changes in reservoir sedimentation.

No geomorphological changes are expected downstream from Uki as the Doon Doon Creek catchment represents only a small portion of the catchment upstream from Uki, with the remainder unregulated and unaffected by the Proposal.

The replacement of McCabes Bridge is proposed to include 3 spans and therefore potentially 2 piers within the channel zone. Due to the location of the bridge within the proposed FSL, scour effects from potentially higher catchment-driven velocity flow events is unlikely; however, it is expected that the detailed design of the bridge crossing would include the specification of appropriate scour protection of the piers to the required industry standards, which considers the existing bed material and scour potential. On this basis, the proposed bridge works, and associated road realignment are unlikely to result in adverse impacts to geomorphology.

Contamination

During the operation of the Proposal, potential impacts from existing contamination sources are primarily associated with the reuse or disturbance of contaminated soil. To address these risks, management protocols need to be implemented. Operational impacts primarily relate to the low potential for contamination of soil, surface water, and groundwater due to maintenance incidents, leaks, and spills. Maintenance activities, such as servicing valves and other mechanical infrastructure involve only minor quantities of oils and greases, making the risk of contamination events low. To manage spills and leaks, spill containment facilities will be established at permanent operational sites. Site management activities will be documented in an Operational Environmental Management Plan (OEMP) to guide the operation of the Proposal.

Rehabilitation

Once construction is completed, rehabilitation of the site will be required to achieve final landforms that are safe, stable, non-polluting and in harmony with the surrounding landscape.

Table 6-72 summarises the rehabilitation risks and proposed controls for the Proposal that will be considered as part of future design stages and Rehabilitation Management Plan (RMP) development.

Table 6-72 Rehabilitation risks and controls

Reference	Impact	Mitigation Measures
Geotechnical stability	Due to the steep nature of the terrain, current knowledge of geology and spoils and the nature of the proposed constructed landforms and structures, geotechnical instability is a key risk.	Increased geotechnical design detail will be provided during the detailed design stage, and subsequent stages, informed by further geotechnical investigations and testing.
Erosion	Ongoing erosion can potentially impact on constructed slopes and landforms undergoing rehabilitation,	Landform and drainage design will therefore need to be appropriate for the soils present, as well as management of steep slopes (i.e.

Reference	Impact	Mitigation Measures
	resulting in re-work, loss of material and generating turbid runoff. As described in section 5 of Appendix M, the Proposal has a generally high erosion hazard due to high slopes and rainfall with moderately erodible soils.	greater than 20% gradients). Final landforms will need to be designed and constructed to achieve sustainable rates of soil loss. Active stabilisation will be required for areas of timber harvesting within the FSL. Timber harvesting would involve cutting trees to stump height with the root mass left in situ.
Revegetation	Revegetation opportunities are limited on rocky ground or overburden materials, especially when slopes are steep, limiting soil depth.	Where suitable topsoil does not exist, or slopes are too steep for topsoil placement, the material emplacements will be seeded and protected from erosion using hydraulically applied growth mediums or rolled erosion control products. Riparian revegetation should aim to enhance existing native vegetation through exotic weed clearing. Where dead wood debris has been removed or cleared as part of the construction, consideration should be given to reinstating equivalent features to reinstate flood resistance (channel roughness).
Rehabilitation soil resources	Availability, suitability and quality of soils across the Proposal are highly variable due to a combination of terrain (topography) and soil physical and chemical constraints. In some areas, steep terrain is likely to prohibit the safe access and operation of preferred surface mobile equipment (e.g. bulldozers) to undertake soil stripping and future soil reinstatement works. Soils in steeper areas are also generally variable in depth, which impedes accurate stripping and separation of the topsoil and subsoil horizons and result in the undesirable mixing of soil layers.	The assessment of actual topsoil and subsoil resources available for recovery can only be determined through detailed soil assessments prior to ground clearing works and where soils/cover vegetation to be cleared is assessed as having low or no weed load. Where a deficit of soil exists, alternative growth media – such as commercial hydraulic and pneumatically applied growing media such as straw mulches and compost blankets – will be required to provide a suitable growing medium in addition to erosion protection while the vegetation establishes.
Biosecurity	Weeds have the potential to exclude and out-compete native vegetation and desirable pasture species. The presence of exotic weed species is most likely in lower lying areas (e.g. foothills and floodplain areas) and less likely in upper/elevated areas. Pest species can damage establishing vegetation through grazing pressure and damage to soils/growth media (digging and burrowing), compete with native fauna for resources (food, water and habitat) and prey on native fauna and livestock.	Weed and pest survey and control will be required through the construction, operations and rehabilitation phases of the Proposal in areas of and surrounding disturbance activities.
Public safety	Retained infrastructure may result in harm to members of the public, livestock and native fauna.	Controls will be implemented to minimise the potential for impacts on public and fauna safety, such as fencing and warning signs (for example, at access points to reservoir embankments and open water).
Bushfire	Uncontrolled bushfires can impact rehabilitating systems (both establishing and mature revegetation)	Fire management controls to be implemented in coordination with the NSW Rural Fire Service and other authorities, as relevant.

Reference	Impact	Mitigation Measures
	and destroy, or substantially delay, rehabilitation trajectory.	
Landform design	Unsuitable design of the final landform could prevent or constrain the intended end land use(s).	Landform design should consider the limitations and mitigate the identified risks suitably.

A RMP will be prepared, as shown in Table 6-73, to guide the development of safe, stable, and non-polluting landforms that can support future land uses.

6.8.4 Mitigation measures

Overall, potential land and soil-related impacts and the risk of contamination during the construction and operation of the Proposal are considered minor and can be adequately managed through the implementation of mitigation measures, as shown in Table 6-73.

Table 6-73 Soils and contamination mitigation measures

Reference	Impact	Mitigation measures	Responsibility	Timeframe
Land and soil capability				
LSE1	General	A Soil and Water Management Plan (SWMP) would be prepared and implemented as part of the Construction Environmental Management Plan (CEMP). The SWMP would identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction. The SWMP would: • assess and detail the requirements to comply with relevant policies guidelines, legislation and other approvals • be developed in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and other relevant volumes • contain Erosion and Sediment Control Plans (ESCPs) for all work sites. ESCPs will be implemented in advance of site disturbance and will be updated as required as the work progresses and the sites change • contain management procedures for activities, which may result in water pollution or to minimise the risk of erosion and sedimentation • outline management requirements of excess materials including stockpiling and disposal options and requirements for unsuitable construction materials • detail the review and inspection processes for onsite measures to mitigate erosion and sedimentation and water quality risks • detail the responsibilities for the management and implementation of the SWMP • be complementary to the Landscaping and Revegetation Plan and Rehabilitation Management Plan.	Contractor	Pre-construction, construction, post-construction
LSE2	Soil stripping and management plan	As part of the SWMP for the Proposal, soil management measures are recommended to ensure the preservation of soil resources, including: • assessing topsoil depths to be stripped prior to stripping to minimise the mixing of topsoil and subsoil • preserving as much of the topsoil as possible • attempting to strip and manage different soils orders or mapping units separately • avoiding mixing topsoil with subsoil during soil handling operations • where subsoils exhibit variance of constraints with depth, considering managing subsoils in separate layers to minimise introduction of constraints higher into the soil profile • avoiding stripping soil following heavy rain periods that leaves the soil structure saturated • avoiding compaction of soil during stripping and stockpiling operations	Contractor	Pre-construction, construction, post-construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
		• ameliorating topsoil and, where necessary, subsoil during stripping operations in accordance with a soil scientists' recommendations. Ameliorants should be applied prior to stripping of their respective layers, to maximise mixing of the ameliorants during the stripping process • stockpiling topsoil separately from subsoil (if it is necessary to strip subsoil) • ensuring reinstatement of soil horizons in the correct order and depths, where possible • where practical and possible, locating the subsoils and topsoils so that stockpiled material is placed on the same underlying soil unit • protecting stockpiles from erosion using soil stabilising polymers, cover crops or other forms of stabilisation • revegetating long-term topsoil stockpiles with native plant community types to minimise stockpile water logging, the generation of anaerobic conditions, help maintain topsoil biological viability and to create a seed store • testing stockpiled subsoil and topsoil to determine amelioration requirements prior to reinstatement • importing of VENM/ENM into the quarry to provide materials for rehabilitation purposes. The VENM/ENM potentially has less desirable soil physical and chemical properties than the in situ subsoils and will need to be characterised and appropriately handled during rehabilitation works to ensure that it is placed in a suitable portion of the recreated soil profile.		
LSE3	Soil stripping and management	Stripping and saving of topsoil resources from disturbance areas that would be inundated to use for rehabilitation (if suitable) of other Proposal related disturbed areas.	Contractor	Construction
LSE4	Rehabilitation	A Rehabilitation Management Plan (RMP) would be prepared. This plan would cover post-construction rehabilitation and transition to operation. The RMP would identify final land uses, conceptual landforms, site-specific risks, rehabilitation methodologies, performance monitoring, objectives, criteria and maintenance programs. The RMP should include, but not be limited to, the risks and controls in Table 6-72 of section 6.8 of the EIS. Final rehabilitation of lands would be undertaken in accordance with approved completion criteria.	Contractor	Pre-construction, construction, post-construction
Erosion and sediment control				
LSE5	Administrative controls	It is recommended to implement erosion and sediment control measures and site rehabilitation and revegetation in accordance with industry standard practice comprising Managing Urban Stormwater: Soils	Contractor	Pre-construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
	(for all areas)	and Construction – Volume 1 (Landcom 2004), Volume 2A, Volume 2C, Volume 2E (DECC 2008a, 2008b, 2008c) and Best Practice Erosion and Sediment Control (IECA 2008). Preparing an Overarching ESCP and Progressive Erosion and Sediment Control Plans for all Proposal disturbances and phases, including: • access roads • internal roads and haul roads • powerline tracks and pads • any upstream and downstream coffer dams • laydown and stockpile areas • accommodation camp and associated facilities • quarry areas • dam construction site • spoil disposal areas • any existing dam decommissioning areas • ancillary construction facilities such as the concrete batching plant. The ESCPs would be prepared and certified by a suitably qualified and experienced certified professional in erosion and sediment control. Measures and principles would include: • minimising the extent and duration of land disturbance • controlling water movement through the site • minimising soil erosion • promptly stabilising disturbed areas • maximising sediment retention on site • maintain drainage, erosion and sediment control measures • monitor and adjust drainage, erosion and sediment control practices to achieve the desired performance standard • construction of suitable watercourse crossings.		
Geomorphology				
LSE6	Avoid disturbance to waterways	Avoid disturbance of the riparian area to minimise sedimentation, bank damage and enhance soil and water quality. Instream works would be undertaken in accordance with state guidelines including: • controlled activities – guidelines for riparian corridors on waterfront land	Contractor	Construction, post-construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
		• controlled activities – guidelines for watercourse crossings on waterfront land • controlled activities – guidelines for outlet structures on waterfront land • controlled activities – guidelines for instream works on waterfront land		
LSE7	Avoid disturbance to waterways	Detailed design of the bridge crossing would include the specification of appropriate scour protection of the piers to the required industry standards including: Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures	Contractor	Pre-construction, construction
Geotechnical considerations				
LSE8	Additional geotechnical investigation	Detailed geotechnical investigation suitable for construction in conjunction with detailed design phase of the Proposal would be undertaken, including: • in situ weathering profile • rock strength • the quality and quantity of material needed • stability concerns during cutting operations • excavation and haulage techniques • requirement for stockpiles • proposed end-use objectives • landslide risk.	Contractor	Pre-construction, construction
LSE9	Quarry design	A quarry extraction plan would be developed in accordance with relevant standards and requirements outlined by the NSW Resources Regulator. Quarry stability would be confirmed by appropriately qualified geotechnical engineer.	Contractor	Pre-construction construction
LSE10	Landslide risk management	A geotechnical investigation by a professional with specialist knowledge on landslide risk management to: • identify potential landslide hazards and conduct an assessment and evaluation of associated risks • verify that geotechnical works are incorporated within the engineered design • verify that the sub-surface conditions exposed during construction are consistent with those included in the risk assessment • provide evidence of conformance of geotechnical works within the construction of the proposed works.	Contractor	Pre-construction, construction
LSE11	Design and construction	Design and construction stages would consider: • the requirement to stockpile materials and make suitable allowances for stockpiling of materials as required • suitable design to ensure suitable long term topographical and geotechnical stability	Contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
		• strength and quality of materials to ensure suitable material is available.		
Contamination				
LSE12	General	A Contaminated Land Management Plan (CLMP) would be prepared and implemented as part of the CEMP. The plan would include, but not be limited to consideration of the following: • capture and management of any surface runoff contaminated by exposure to the contaminated land • further investigations required to determine the extent, concentration, and type of contamination, as identified in the site investigations • management of the remediation and subsequent validation of the contaminated land, including any certification required • measures to ensure the safety of site personnel and local communities during construction • complete pre- and post-construction site assessments in areas to be used for project office compounds, depots, laydown areas, concrete batching plants and workers accommodation in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 (the ASC NEPM), and process for tracking excavated material and waste.	Contractor	Pre-construction, construction
LSE13	General	Potentially contaminated areas directly affected by the Proposal would be investigated and managed in accordance with the requirements of guidance endorsed under section 105 of the *Contaminated Land Management Act 1997*. This includes further investigations in areas of potential contamination identified in the proposed footprint. If contamination is posing a risk to human or ecological receptors is identified, a Remediation Action Plan would be prepared and implemented.	Contractor	Pre-construction, construction
LSE14	Contamination	The SWMP would include procedures to manage potentially contaminated material.	Contractor	Pre-construction, construction
LSE15	Unexpected Finds	The discovery of previously unidentified contaminated material would be managed in accordance with an unexpected contaminated lands discovery procedure. The procedure would include: • cease work in the vicinity • initial assessment by an appropriately qualified environmental consultant and further assessment and management of contamination, if confirmed, in accordance with section 105 of the CLM Act.	Contractor	Pre-construction, construction
LSE16	Handling of Hazardous Materials	Asbestos handling and management would be undertaken in accordance with an Asbestos Management Plan (as part of the Work Health and Safety Plan).	Contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
LSE17	Accidental spill	A site-specific emergency spill plan would be developed and would include spill management measures in accordance with relevant EPA guidelines. The plan would address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities.	Contractor	Pre-construction, construction
LSE18	Spill management	Activities with the potential for spillage of hydrocarbon and other chemicals (such as refuelling and washing down of plant and equipment) would be undertaken away from water courses or in any location which drains directly to waters with appropriate temporary bunding. Storage of fuels, oils and chemicals would be stored in suitably bunded areas in accordance with relevant legislation and Australian standards. Refuelling operations would not be left unattended.	Contractor	Pre-construction Construction
LSE19	Use of hazardous materials	The use of hazardous materials would be undertaken following a risk assessment in accordance with the Proposal Construction Hazard and Risk Management Plan. Risk assessments would include an environmental assessment to determine whether it is practical to use a chemical with a lower hazard level and the key controls to be implemented prior to use.	Contractor	Pre-construction Construction



CHAPTER 6
Section 6.9 Waste

6.9 WASTE

This section provides an assessment of the waste streams estimated to be generated from the Proposal during construction and operation, potential impacts on the surrounding environment, and management and mitigation measures to address any potential impacts. The assessment of waste includes classification, quantities, management, minimisation and lawful disposal. The relevant SEARs for this section are shown in Table 6-74.

Table 6-74 Relevant SEARs – waste

Relevant key issue requirement/s	Where addressed
1. The Proponent must assess predicted waste generated from the proposal during construction, including:	This section
a) classification of the waste in accordance with the current guidelines	Section 6.9.3 and Table 6-76
b) estimates / details of the quantity of each classification of waste to be generated during the construction of the proposal	Table 6-76
c) handling of waste including measures to facilitate segregation and prevent cross contamination	Section 6.9.3 and Table 6-77
d) management of waste including estimated location and volume of stockpiles	Sections 6.9.3 and 6.9.4 and Figure 6-68 and Figure 6-69
e) waste minimisation and reuse	Section 6.9
f) lawful disposal or recycling locations for each type of waste	Sections 6.9.3 and 6.9.4 and Table 6-76
g) contingencies for the above, including managing unexpected waste volumes.	Section 6.9.4
2. The Proponent must assess potential environmental impacts from the excavation, handling, storage onsite and transport of the waste particularly in relation to sediment control and dust.	Section 6.9.3

6.9.1 Relevant legislation and guidelines

Waste streams generated by the construction of the Proposal are required to be managed and disposed of in accordance with relevant NSW policies and guidelines including:

- NSW *Waste and Sustainable Materials Strategy 2041, Stage 1: 2021–2027*
- NSW *Protection of the Environment Operations Act 1997* (POEO Act)
- NSW Protection of the Environment Operations (Waste) Regulation 2014 (POEO Regulation)
- NSW EPA *Waste Classification Guidelines* (2014a).

Tweed Shire Council has also adopted the Towards Zero Waste Strategy, which sets out strategies to reduce waste from Council operations, including Council construction activities.

NSW Waste and Sustainable Materials Strategy 2041 Stage 1: 2021-2027

The NSW Waste and Sustainable Materials Strategy 2041, Stage 1: 2021–2027 (NSW EPA 2021) replaces the NSW Waste Avoidance and Resource Recovery Strategy 2014–2021. The strategy highlights the environmental benefits and economic opportunities in how waste is managed in NSW. The strategy outlines actions and targets for management of waste in NSW through to 2027. The key targets of the strategy are to:

- reduce total waste generated by 10% per person by 2030
- achieve an 80% average recovery rate from all waste streams by 2030

- significantly increase the use of recycled content by governments and industry
- phase out problematic and unnecessary plastics by 2025
- halve the amount of organic waste sent to landfill by 2030.

Overall, the strategy aims to support the development of a circular economy in NSW. A circular economy is a system that aims to minimise waste and promote the continual reuse of resources. The circular economy is based on the following three key principles:

- Design out waste and pollution.
- Keep products and materials in use.
- Regenerate natural systems.

The approach to waste management within the Proposal is consistent with the principles of circular economy and incorporate measures to ensure waste is reused, recycled or disposed of as appropriate. The priority of waste management for the Proposal is to prevent and avoid waste, followed by the use of renewable and recycled materials.

NSW Protection of the Environment Operations Acts 1997

The POEO Act is administered by the NSW Environment Protection Authority (EPA).

The POEO Act (Schedule 1, Part 3, clause 49) outlines the different types of waste classifications, including general solid waste (non-putrescible), general solid waste (putrescible), hazardous waste, liquid waste, restricted solid waste and special waste. The Waste Classification Guidelines (NSW EPA 2014a) provide guidance on how the different types of waste to be generated from the project have been classified in accordance with the POEO Act.

Section 48 of the POEO Act requires an environment protection licence (EPL) for scheduled activities to be undertaken at a premise, as listed in Part 1 Schedule 1 of the Act. The scheduled activities potentially relevant to the Proposal with respect to waste are provided in Table 6-75.

Table 6-75 Waste-related premise-based scheduled activities of the POEO Act

Premises-based scheduled activity	Relevance to the Proposal
16 Crushing, grinding or separating *1) This clause applies to **crushing, grinding or separating**, meaning the processing of materials (including sand, gravel, rock or minerals, but not including waste of any description) by crushing, grinding or separating them into different sizes.* *1A) However, this clause does not apply to the processing of materials by crushing, grinding or separating that occurs as part of an activity that is declared to be a scheduled activity by—* *(a) clause 33 (Railway activities—railway infrastructure construction), or* *(b) clause 35 (Road construction).* *2) The activity to which this clause applies is declared to be a scheduled activity if it has a capacity to process more than 150 tonnes of materials per day or 30,000 tonnes of materials per year.*	Excavated materials and site-won materials would be reused during construction of the Proposal, which would require processing, screening and crushing (discussed in Chapter 3). Excavated materials and site-won materials would be generated from the following construction activities: • construction of the raised dam wall and new spillway – materials would be sourced from the existing onsite quarry • cutting for the haul road construction. POEO clauses 16(1) and 16(2) would potentially be triggered, as the material to be processed, crushed and separated would potentially be over 30,000 tonnes per year. The construction of the new access road and McCabes Bridge works would potentially require processing, screening and crushing of excavated materials and site-won materials (e.g. asphalt). However, as per clause 16(1A), clause 16 would not be triggered for the new access road and McCabes Bridge construction works as this is not relevant to the reuse of materials for road construction.

NSW Protection of the Environment Operations (Waste) Regulation 2014

The POEO Regulation provides a regulatory framework to enforce penalties in support of the POEO Act.

Under Part 2 of the POEO Regulation, unlicensed waste (waste that is not controlled by an EPL) can be disposed of at a licenced waste facility; however, a levy liability will be placed on the disposer for all waste received at the licenced waste facility. A levy payment will be triggered if waste is stored for more than 12 months or stockpiled illegally at the licenced waste facility or disposed of to landfill. The levy payment is then required to be paid by the disposer, licenced waste facility and landfill facility. The levy liability is extinguished if the waste is transported offsite from the licenced waste facility to be lawfully recovered, recycled or processed.

This would apply to any construction and demolition waste resulting from the Proposal that is taken to a licensed waste facility.

NSW EPA Waste Classification Guidelines

The NSW EPA Waste Classification Guidelines (NSW EPA 2014a) outline the step-by-step process for classifying waste. The guidelines are in 4 parts, which cover classifying waste, immobilising waste, waste containing radioactive material, and acid sulfate soils.

Waste generated from the construction of the Proposal would be classified in accordance with the Waste Classification Guidelines: Part 1 Classifying Waste (NSW EPA 2014a) and as defined in the POEO Act (Schedule 1, Part 3, clause 49).

The types of construction and demolition waste expected from the project are discussed in section 6.9.3.

The NSW EPA Waste Classification Guidelines also defines the NSW EPA waste hierarchy, which prioritises the efficient use of resources. The NSW EPA waste hierarchy is shown in Figure 6-67.



Figure 6-67 NSW EPA waste hierarchy

Source: NSW EPA 2014a

Tweed Shire Council Towards Zero Waste Strategy

The Towards Zero Waste Strategy sets out Council's ambition to reduce waste in operations and service delivery in pursuit of achieving zero waste to landfill targets. The strategy aims to embed circular economy principles across Council operations and aims to maximise recovery of resources. The management of waste (discussed in section 6.9.3) also aims to implement Council's Towards Zero Waste Strategy.

6.9.2 Existing environment

Waste generation from the current dam operations is limited to occasional valve maintenance and replacement, which can generate some solid and liquid waste. These wastes are not generated regularly and are disposed of to a licensed waste facility.

Other wastes generated from current dam operations come from recreational users. Recreational users are required to remove their waste and dispose of it appropriately. Facilities for functions at Crams Farm include toilets, picnic areas and electric barbeques. These facilities are serviced by Council staff, who remove general solid waste to the nearest licenced waste facility for processing. The nearest licenced waste facility is the Stott's Creek Resource Recovery Centre approximately 25 km to the north-east of the site.

Small volumes of other waste categories are disposed of through contractors. The toilets on the site use an onsite effluent treatment system, and waste from these facilities remains onsite. Currently no onsite waste disposal facilities for general rubbish and recycling are provided at the existing dam wall information area and picnic area. All visitors are required to 'pack in and pack out' – that is, all waste must be taken from the site when they leave.

6.9.3 Assessment of construction and operational waste impacts

Overview

This section provides an assessment of potential waste impacts during construction and operation of the Proposal. The assessment identifies the expected waste streams and provides estimates of the expected quantities (where known) to be generated by the Proposal. Applicable waste mitigation and management strategies are provided in section 6.9.4.

Expected quantities and types of waste that would be generated from the construction of the Proposal are based on the Concept Design Report (Appendix B) for the Clarrie Hall Dam raising and the concept design for McCabes Bridge and Commissioners Creek Road. These quantities and types of waste are discussed in Table 6-76 and Table 6-77. The estimates of the quantities of waste expected to be generated during construction would be further refined during the detailed design phase of the Proposal. It is expected that there would be minimal changes to waste volumes generated during the operational phase of the Proposal compared to waste volumes currently generated.

The following classifications of waste, defined in the POEO Act (Schedule 1, clause 49), were used to classify expected waste streams generated from the construction and operation of the Proposal:

- special waste
- liquid waste
- hazardous waste
- restricted solid waste
- general solid waste (putrescible)
- general solid waste (non-putrescible).

To determine which of the above waste classifications apply to the waste identified on the Proposal, the waste classification steps were followed, as outlined in the NSW EPA *Waste Classification Guidelines, Part 1: Classifying Waste* (2014a).

Construction waste

Wastes generated from the construction of the Proposal would likely include a mixture of liquid waste, general solid waste (non-putrescible) and general solid waste (putrescible), with small amounts of special waste and hazardous waste. The key waste types from waste generating construction activities include:

- **Liquid waste:**
  - liquid wastes such as process water for concrete works, grey water and sewerage at construction compounds
- **General solid waste (putrescible):**
  - putrescible food waste from workers at site offices and accommodation
- **General solid waste (non-putrescible):**
  - excavated wastes (spoil) such as soil and rock including virgin excavated natural material (VENM) from excavations including:
    - the construction of the new spillway
    - embankment foundation and construction
    - construction compounds and access roads
  - demolition wastes such as from the demolition of the existing spillway and McCabes Bridge – mainly concrete and rubble and other smaller volumes of metals and solid wastes
  - other demolition wastes, mainly concrete and smaller volumes of bricks, timber (untreated and treated), other metals, electrical cables and plumbing fittings and furnishings from buildings, powerlines, fences and recreational facilities onsite
  - vegetation (green) wastes from the removal of trees, shrubs, and groundcover from clearing construction footprint areas
  - vegetation waste from potential removal of vegetation within the full supply level (FSL) and removal of plantation timber within the FSL
  - general construction waste such as timber formwork, scrap metal, steel, concrete asphalt, concrete slurry from scarifying, packaging material (crates, pallets, cartons, plastics and wrapping materials), and concrete batching plant wastewater from the main site and road upgrade sites
  - construction wastes from placement of concrete and grouting including surface preparation, curing and treatment wastes
  - general wastes from the site office/construction compound such as paper, cardboard, plastics, glass and printer cartridges.
- **Special waste:**
  - asbestos-containing materials present in the intake tower. Also potentially found in the toilet block, shelter, Doon Doon Hall, and Dairy at Crams Farm Reserve

- **Hazardous waste:**
  - waste from the maintenance of construction vehicles and machinery including adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses and tyres.

A summary of waste classifications, total amounts and storage or disposal sites for this waste is outlined in Table 6-76. The approximate waste volumes and material types are derived from the Clarrie Hall Dam concept design (Appendix B) and the concept design for McCabes Bridge.

Waste classifications, sources, impacts, appropriate handling and storage of each waste type listed in Table 6-76 above are discussed below. Potential locations of waste storage and processing areas are provided in Figure 6-68 and Figure 6-69.

Special waste

Potential asbestos containing materials have been identified within the intake tower cladding. Accordingly, potential asbestos waste may be generated though the works associated with the intake tower. The volume of asbestos waste would be identified during the detailed design phase.

Waste tyres are likely to be generated due to the operation of heavy vehicles and earthmoving equipment onsite. Any waste tyres would be disposed of offsite to a licensed waste facility or removed from site by a certified waste contractor.

Special waste that is managed incorrectly or dumped illegally could pose a significant risk to human and environmental health, including surface water, groundwater and soil.

As potential asbestos-containing materials have been identified (section 6.8 and Appendix N), stockpile management and segregation measures would be implemented to prevent contamination of materials. Asbestos waste would be disposed of as special waste and transported and disposed of offsite in accordance with the POEO Regulation. The handling of asbestos waste for the Proposal will be tracked and recorded in accordance with the relevant legislation.

Liquid waste

Construction of the Proposal will generate general liquid waste from grey water and sewage, surface water runoff and construction wastewater. Grey water and sewage will be generated from the construction workforce. The workers accommodation and site offices will include a wastewater storage system, where wastewater would be collected by a licenced contractor and transported to a licenced facility for treatment and disposal. Portable toilets may also be utilised during the construction stage at construction areas. Potential impacts associated with the generation of grey water and sewage is contamination of construction areas and surrounding areas from uncontrolled liquid waste disposal. Mitigation and management measures for grey water and sewage are provided in Table 6-78.

During rain events, rainwater will run from the roof of buildings in the construction area and onto the compacted foundations as run-off. Surface water run-off will also be generated from cleared and levelled land during the construction period. The run-off to surrounding areas could then carry sediment, grit and other contaminants (such as oils and sludge). Rainwater could cause uncontrolled runoff, which could increase erosion and sedimentation of non-hardstand areas or detention basins and pollute surrounding areas. An assessment of erosion and sedimentation impacts is discussed in detail in the surface water assessment (section 6.1 and Appendix G1), and soils and contamination (section 6.8 and Appendix M).

Wastewater generated from construction activities such as rock drilling, wetting of construction materials, quarrying, operation of the concrete batch plant and general excavations has the potential to impact the soil and water.

Estimated volumes and sources of liquid waste to be generated by construction of the Proposal are listed in Table 6-76.

Table 6-76 Waste classification and proposed waste management

Waste classification	Waste description	Source of waste	Estimate of volume or quantity	Management options
Special waste	Asbestos	Present in the intake tower building – not in the dam wall.	• To be determined in detailed design	• Offsite disposal: – nearest offsite disposal licenced facility is at Stotts Creek Resource Recovery Centre (Monday to Friday 7 am – 2:30 pm) – distance from site is 30 km
	Spoil containing other contaminated material from past land uses	No potentially contaminated sites have been identified within the current construction footprint or FSL		
	Waste tyres	Construction vehicles	• Minimal	
Liquid waste	Cementitious wastewater, process water, greywater	Concrete batching, site offices and accommodation	• 10 kL cementitious wastewater • 34,000 kL process water (for quarry rock, concrete production, dust control and/or drinking) • 6,000 kL greywater	• Offsite disposal: – nearest offsite disposal licenced facility is at Kingscliff Wastewater Treatment Plant – distance from site is 45 km
	Sewage	Site offices and accommodation	• 3,600 kL	• Offsite disposal: – nearest offsite disposal licenced facility is at Kingscliff Wastewater Treatment Plant – distance from site is 45 km
Hazardous waste	Lead paint	May be present in old structures	• To be determined in detailed design	• Offsite disposal: – nearest offsite disposal licenced facility is at Stotts Creek Resource Recovery Centre – distance from site is 30 km
	Chemical containers, grease/oil drums and oil filters	Fuel and maintenance of plant	• 11 kL	
Restricted solid waste	None identified (SCC test must be undertaken – see EPA Waste Classification Guidelines)	N/A	• To be determined in detailed design	• Offsite disposal: – nearest appropriate licensed facility to be determined in detailed design

Waste classification	Waste description	Source of waste	Estimate of volume or quantity	Management options
General solid waste (non-putrescible)	Building and demolition waste: concrete rubble, metal, asphalt, plastics, cardboard, cables	Decommissioned spillway, overhead cables, outlet house, roads Construction material packaging Concrete washout, remaining asphalt	• 4,200 m^3 concrete • 84,000 m^3 rubble • 1,100 tonnes metal • 6,800 m^3 asphalt • 1,100 m^3 plastics (packaging) • 250 m^3 cardboard and paper • 500 m^3 timber • 2 tonnes cables	• Concrete crushed and reused onsite (where suitable) • Timber shuttering reused onsite (where suitable) • Offsite recycling (where suitable): – nearest licenced recycling facility is at North Coast Recycling – distance from site is 80–90 km • Offsite disposal: – nearest offsite disposal at Stotts Creek Resource Recovery Centre – distance from site is 30 km
	Excavated soils (VENM and ENM)	Excavated spoil from construction and establishment of: • access roads • main construction compound • spillway • embankment • quarry • haul road • concrete batching plant • workers' accommodation • McCabes Bridge works. Spoil unsuitable for reuse	• Approximately 97,000 m^3 from excavations and clear and grade activities (breakdown provided in Table 6-4) • 80% of excavated rock from the proposed new spillway	• Reuse onsite where suitable • Offsite disposal: – nearest offsite licenced disposal facility is at Stotts Creek Resource Recovery Centre – prior agreement required – distance from site is 30 km
	General waste and mixed recycling	From site offices and workers accommodation	• 18 tonnes general waste • 7 tonnes mixed recycling	• Offsite recycle (where suitable) or disposal: – recycled or disposed at Stotts Creek Resource Recovery Centre – distance from site is 30 km

Waste classification	Waste description	Source of waste	Estimate of volume or quantity	Management options
	Cleared vegetation (natural fibrous organic and vegetative materials)	Native forest and native plantation and removed to clear for construction activities (does not include vegetation removal within the FSL which will be determined during detailed design)	• 2,400 tonnes reused onsite • 5,300 tonnes for disposal	• Mulched for reuse onsite (where suitable) • Offsite recycle (where suitable) or disposal: – nearest recycling/disposal is at Stotts Creek Resource Recovery Centre – distance from site is 30 km
General solid waste (putrescible)	Food waste (small amounts)	From workers at site offices and workers accommodation	18 tonnes	• Offsite disposal: – nearest offsite disposal licenced facility is at Stotts Creek Resource Recovery Centre – distance from site is 30 km

Hazardous waste

Construction of the Proposal would generate hazardous wastes that may include chemical containers, electrical waste, grease or oil drums and oil filters. If stored incorrectly or dumped, hazardous waste could pose a significant risk to human and environmental health, including surface water, soil and groundwater.

During a rain event, contaminants could enter surface water runoff and impact the quality of water in surrounding waterways, including Doon Doon Creek and the Tweed River. Mitigation measures relevant to water quality and erosion and sedimentation control are discussed in detail in the surface water assessment (section 6.1 and Appendix G1) and soils and contamination (section 6.8 and Appendix M).

All hazardous wastes generated onsite would be classified and stored in sealed containers within a bunded area and would then be removed and disposed of in accordance with the appropriate regulations and guidelines for the removal of these materials. Hazardous materials may only be removed by suitably qualified and licenced contractors and disposed of at an appropriately licenced waste disposal facility. Management measures of hazardous waste are outlined in Table 6-78.

Storage lagoons and drying beds are not practicable for use in this Proposal due to terrain and high risk of water supply contamination if run-off is not adequately controlled and drains and storage locations are not adequately sized.

Restricted solid waste

Restricted solid waste is waste that has a chemical concentration that meets the requirements in the Waste Classification Guidelines Part 1: Classifying waste (NSW EPA 2014a).

The Proposal may generate restricted solid wastes through the use of chemicals onsite, spillages and leaks. No existing restricted solid waste requiring disposal is expected to be present onsite. Volumes of restricted solid waste that may be generated during construction will be confirmed during the detailed design phase. Restricted solid waste that is managed incorrectly or dumped illegally could pose a significant risk to human and environmental health, including surface water, groundwater and soil.

General solid waste (non-putrescible)

Construction of the Proposal will generate general solid waste (non-putrescible) from concrete, asphalt waste, vegetation, virgin excavated natural material (VENM), excavated natural material (ENM), demolition waste and recyclables. All general solid waste (non-putrescible) will be recycled, stored or disposed of at an appropriately licenced waste or resource recovery facility. General solid waste (non-putrescible) will be managed in accordance with the NSW EPA waste hierarchy outlined in Figure 6-67.

Potential impacts associated with the generation and incorrect waste storage, handling or disposal of general solid waste (non-putrescible) include increased erosion and sedimentation, lowered air quality and potential contamination of the construction activity area or surrounding downstream areas.

Table 6-77 outlines the sources of general solid waste (non-putrescible) and the associated potential impacts.

Table 6-77 General solid waste (non-putrescible) types, sources, impacts and approximate amounts

<table>
<tr><th>General solid waste (non-putrescible) type</th><th>Description</th><th>Sources and impacts</th></tr>
<tr><td>Virgin excavated natural material / excavated natural material</td><td>VENM is classified by the POEO Act as natural material (such as gravel, clay, soil, sand or rock fines):
that has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial, mining or agricultural activities, and
that does not contain any sulfidic ores or soils or any other waste, and
includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA Gazettal notice.
ENM is naturally occurring rock and soil (including sandstone, shale, soil and clay) that:
has been excavated from the ground
contains no less than 98% (by weight) natural material
does not contain potential or actual acid sulfate soils and
does not meet the definition of VENM</td><td>The sources and volume of VENM / ENM generated from excavation, and clear and grade activities as part of the Proposal include:<table><tr><th>Excavation, clear and grade locations</th><th>ENM/VENM volume generated (m³)</th></tr><tr><td>Site access road</td><td>3,500</td></tr><tr><td>Main compound</td><td>2,500</td></tr><tr><td>Spillway</td><td>5,500</td></tr><tr><td>Raised embankment construction compound</td><td>2,000</td></tr><tr><td>Quarry</td><td>12,000</td></tr><tr><td>Haul road</td><td>2,500</td></tr><tr><td>Concrete batching plant</td><td>6,000</td></tr><tr><td>Workers’ accommodation</td><td>13,500</td></tr><tr><td>McCabes Bridge and Commissioners Creek Road realignment</td><td>50,000</td></tr><tr><td>Total</td><td>Approximately 97,000</td></tr></table>The construction of the raised dam wall requires approximately 143,000 m³ of suitable excavated material, most of which would be derived from the nearby quarry. Excess excavated material from the remaining sources would be reused as fill where suitable. The exact quantity of excavated material that could be reused would depend upon the type of materials encountered during construction and would be determined through detailed design and construction.
The potential impacts associated with generation of VENM/ENM include increased risk of erosion and sedimentation or potential contamination of construction activity areas and surroundings. Soil and surface water runoff from uncontrolled storage or disposal of excavated soil could enter surface water runoff and impact the water quality of Doon Doon Creek and the Tweed River.</td></tr>
</table>

<table>
<tr><th>General solid waste (non-putrescible) type</th><th>Description</th><th>Sources and impacts</th></tr>
<tr><td></td><td></td><td>Where excess material cannot be reused, management would be required. This material would be stockpiled in dedicated waste storage areas that would be within the dedicated construction area footprint to limit potential environmental impacts beyond the construction impact area. The stockpiles would be located in dry, low-lying, flat areas in consideration of long-term stability. Materials would be tested to ensure they are suitable for stockpiling.
Sampling and analysis of ENM material would be undertaken by the construction contractor as per the excavated natural materials order 2014 (NSW EPA 2014b).
The Proposal site is located at an elevation of approximately 61 m AHD. There is no acid sulfate soil (ASS) data at the site, according to the NSW Department of Planning, Industry and Environment (eSPADE 2020d), and Tweed Shire Local Environment Plan ASS Risk Map sheet confirms that the Proposal site is in an area of no known occurrence of ASS. Given the site's elevation, there is a very low risk for the occurrence of ASS.</td></tr>
<tr><td>Comingled construction and demolition waste</td><td>General construction waste includes:
excess construction material (e.g. concrete, brick and rubble) resulting from the establishment of construction hardstand areas to support dam construction
packaging waste including pallets
excess material from establishing drainage areas.
Demolition waste includes:
concrete from demolition of current spillway
bricks from downstream buildings demolition
excess excavated material
cables from removed powerlines and utilities
reshaping or contouring of abutments.</td><td>Comingled construction and demolition waste would be stored in skips and segregated where possible for reuse, recycling or disposal at an appropriately licenced waste disposal facility in accordance with the NSW EPA waste hierarchy and managed in accordance with the measures outlined in Table 6-78.
Sources and volumes of construction and demolition waste include:
<table>
<tr><th>Type</th><th>Source</th><th>Volume (m^3/tonnes)</th></tr>
<tr><td>Concrete</td><td>Demolition of old dam structures and buildings</td><td>4,200 m^3</td></tr>
<tr><td>Rubble</td><td>Unsuitable material from spillway and access road excavation, overburden from quarry</td><td>84,000 m^3</td></tr>
<tr><td>Metal</td><td>Steel waste from concrete reinforcement (assuming 250 kg steel per cubic metre of concrete)</td><td>1,000 tonnes</td></tr>
<tr><td>Timber</td><td>Pallets and demolished buildings</td><td>500 m^3</td></tr>
<tr><td>Cables</td><td>Intake tower and decommissioned powerlines</td><td>2 tonnes</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>General solid waste (non-putrescible) type</th><th>Description</th><th>Sources and impacts</th></tr>
<tr><td>Vegetation</td><td>Vegetation waste includes woody material from tree removal, non-woody material from groundcover vegetation removal and any weed infested material requiring treatment.

Vegetation types include native forest, native plantations and planted native and exotic vegetation.</td><td>Areas of vegetation within the construction disturbance footprint may be cleared to allow construction of the Proposal and associated ancillary facilities including construction compounds, site offices, haul roads, utilities and realigned or upgraded road corridor areas.

Management of vegetation waste would be in accordance with NSW EPA waste hierarchy as follows:

<table>
<tr><th>Priority</th><th>NSW EPA waste hierarchy</th><th>Indicative maximum volumes required (tonnes)</th><th>Waste management activities</th></tr>
<tr><td>1</td><td>Avoid and reduce waste</td><td>2,700</td><td>Designing infrastructure to maximise reduction of ground disturbance</td></tr>
<tr><td>2</td><td>Reuse waste</td><td>420</td><td>Reusing cleared vegetation onsite or through rehabilitation to provide wildlife habitat</td></tr>
<tr><td>3</td><td>Recycle waste</td><td>1,900</td><td>Recycling cleared vegetation as mulch or compost for use onsite or offsite.</td></tr>
<tr><td>4</td><td>Recover energy</td><td>(Not proposed)</td><td>Using wood material as fuel for power generation of heat</td></tr>
<tr><td>5</td><td>Treat waste</td><td>–</td><td>Treating problematic weeds via biological control or herbicides</td></tr>
<tr><td>6</td><td>Dispose waste</td><td>5,400</td><td>Disposing of remaining vegetation at authorised landfills</td></tr>
</table>

Vegetation reuse: a portion of removed vegetation may be reused in the form of wooden logs for uses such as wildlife habitat, walkway delineation, silt control, etc. A preliminary estimate of 420 tonnes of cleared vegetation is expected to be available for reuse onsite. The volume of materials required for wildlife habitat and scour protection is not known at this time and would need to be developed through the detailed design phase.</td></tr>
</table>

General solid waste (non-putrescible) type	Description	Sources and impacts
		Vegetation recycling: most cleared vegetation would be recycled in the form of mulch, compost, or more readily as woodchips. The size of the area to be rehabilitated by the Proposal is sufficient to accommodate recycling of all vegetation waste that would be generated. Approximately 1,900 tonnes of cleared vegetation would be processed as mulch or compost onsite to recycle waste. **Treatment of weed infested vegetation:** weed coverage across the site varies from high to low coverage. High threat weeds and weeds of national significance have been identified as present in the area. Management of weed infested vegetation is discussed in section 6.2 and Appendix H. **Vegetation disposal:** residue from vegetation removal such as barks, stems, undergrowth and soil may also be generated during the construction of the Proposal and require disposal offsite at a licenced facility, where unsuitable for reuse. Approximately 5,400 tonnes of vegetation waste is estimated to be unsuitable for reuse onsite and would be disposed of accordingly. Storage of waste vegetation would be sited to minimise impacts to waterways. Vegetation located within the proposed inundation area may be removed and the extent will be determined during detailed design. The inundation zone is an area of 209 ha, of which approximately 85% is vegetated. This assessment has allowed for approximately 50%, or an area of approximately 88 ha, to be removed. This would generate an estimated 53,300 m^3 of vegetation waste. Management of this waste quantity is detailed in the table below. The exact areas and volumes of vegetation waste would be refined as part of the detailed design and construction phases.

<table>
<tr><th>General solid waste (non-putrescible) type</th><th>Description</th><th>Sources and impacts</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th></th><th>NSW EPA waste hierarchy</th><th>Indicative maximum volumes required (tonnes)</th><th>Waste management activities</th></tr>
<tr><td>1</td><td>Avoid and reduce waste</td><td>8,000</td><td>Designing infrastructure to maximise reduction of ground disturbance</td></tr>
<tr><td>2</td><td>Reuse waste</td><td>5,300</td><td>Reusing cleared vegetation onsite or through rehabilitation to provide wildlife habitat</td></tr>
<tr><td>3</td><td>Recycle waste</td><td>–</td><td>Recycling cleared vegetation as mulch or compost for use onsite or offsite</td></tr>
<tr><td>4</td><td>Recover energy</td><td>–</td><td>Using wood material as fuel for power generation of heat</td></tr>
<tr><td>5</td><td>Treat waste</td><td>–</td><td>Treating problematic weeds via biological control or herbicides</td></tr>
<tr><td>6</td><td>Dispose waste</td><td>40,000</td><td>Disposing of remaining vegetation at authorised landfills</td></tr>
</table>
</td></tr>
<tr><td>Recyclables</td><td>Recyclables including cardboard, paper, plastics, glass and aluminium cans would be generated from the construction areas, offices and workers accommodation areas.</td><td>Recyclables would be stored in designated labelled and covered recycling areas before being transported to an appropriately licenced facility for recycling. The nearest recycling facility is Stotts Creek Resource Recovery Centre. Mitigation and management measures for recyclable waste are outlined in Table 6-78.</td></tr>
<tr><td>Asphalt waste</td><td>Some minor generation of asphalt waste is expected. The waste would comprise a mixture of bitumen and aggregate.</td><td>The milling of existing roads is expected to produce approximately 6,800 m^3 of asphalt waste for Commissioner’s Creek Road and Clarrie Hall Dam Road.
Asphalt waste, including sediment, grit and other contaminants could run into surface water during a rain event if inappropriately stored or disposed of. This could contaminate construction areas and the downstream environment.
Reclaimed asphalt may be recycled during road upgrades via the reapplication to land for road construction or maintenance. Under Part 9 of the POEO Act, the application of reclaimed asphalt to land for the purposes of road construction or maintenance is exempt from certain provisions of the POEO Act, including:</td></tr>
</table>

General solid waste (non-putrescible) type	Description	Sources and impacts
		• section 48 of the POEO Act in respect to scheduled activities described in clauses 39, 40 and 42 of Schedule 1 of the POEO Act – requirement of an EPL in relation to waste disposal (application to land), waste disposal (thermal treatment) and waste storage • section 88 of the POEO Act – requirement of contributions to the EPA by the licensee of waste facility • part 4 of the POEO Regulation – tracking of certain waste transported within, out of or into NSW • clause 109 of the POEO Regulation – reporting requirements for non-paying waste facilities and landfill sites outside of regulated areas • clause 110 of the POEO Regulation – notification to EPA of newly established landfill sites where a licence is not required. Any excess asphalt waste would be temporarily stockpiled prior to disposal offsite. Mitigation and management measures for storage, handling and disposal of asphalt waste are provided in Table 6-78.

General solid waste (putrescible)

General solid waste (putrescible) would be generated from the construction workforce in the form of food waste. If stored incorrectly or dumped, food waste could result in pests and vermin at each construction area. This would present a hazard to human and environmental health.

Approximately 18 tonnes of putrescible waste is expected to be generated during the construction phase in the form of food waste from construction personnel at construction site offices and the workers accommodation. This type of waste would be stored in large, covered waste receptacles before being disposed offsite to an appropriately licenced facility. The management of solid waste (putrescible) is outlined in Table 6-78.

Potential construction waste storage locations

Potential storage areas for waste and material stockpiles would be at the construction compounds, as shown in Figure 6-68 and Figure 6-69.

Operational waste

Minimal changes to waste volumes generated during the operational phase of the Proposal are predicted to occur compared to waste volumes currently generated. It is expected that current waste disposal operations and practices will be maintained during the operational phase of the Proposal.

Waste streams that are expected to be generated during the operational phase of the Proposal are listed below:

- general solid waste (putrescible) including waste from operations staff and visitors
- liquid wastes including sewage, blackwater and grey water from recreational facilities, and maintenance waste including oils, fuels, and greases for machinery
- hazardous waste including batteries, fluorescent lights and e-waste from amenities facilities and operation of intake tower, tunnel and pipelines
- general solid waste (non-putrescible) including waste from maintenance of operational and recreational structures.

6.9.4 Mitigation measures

Table 6-78 identifies the mitigation measures that would be implemented during construction and operation of the Proposal to manage waste due to the Proposal.

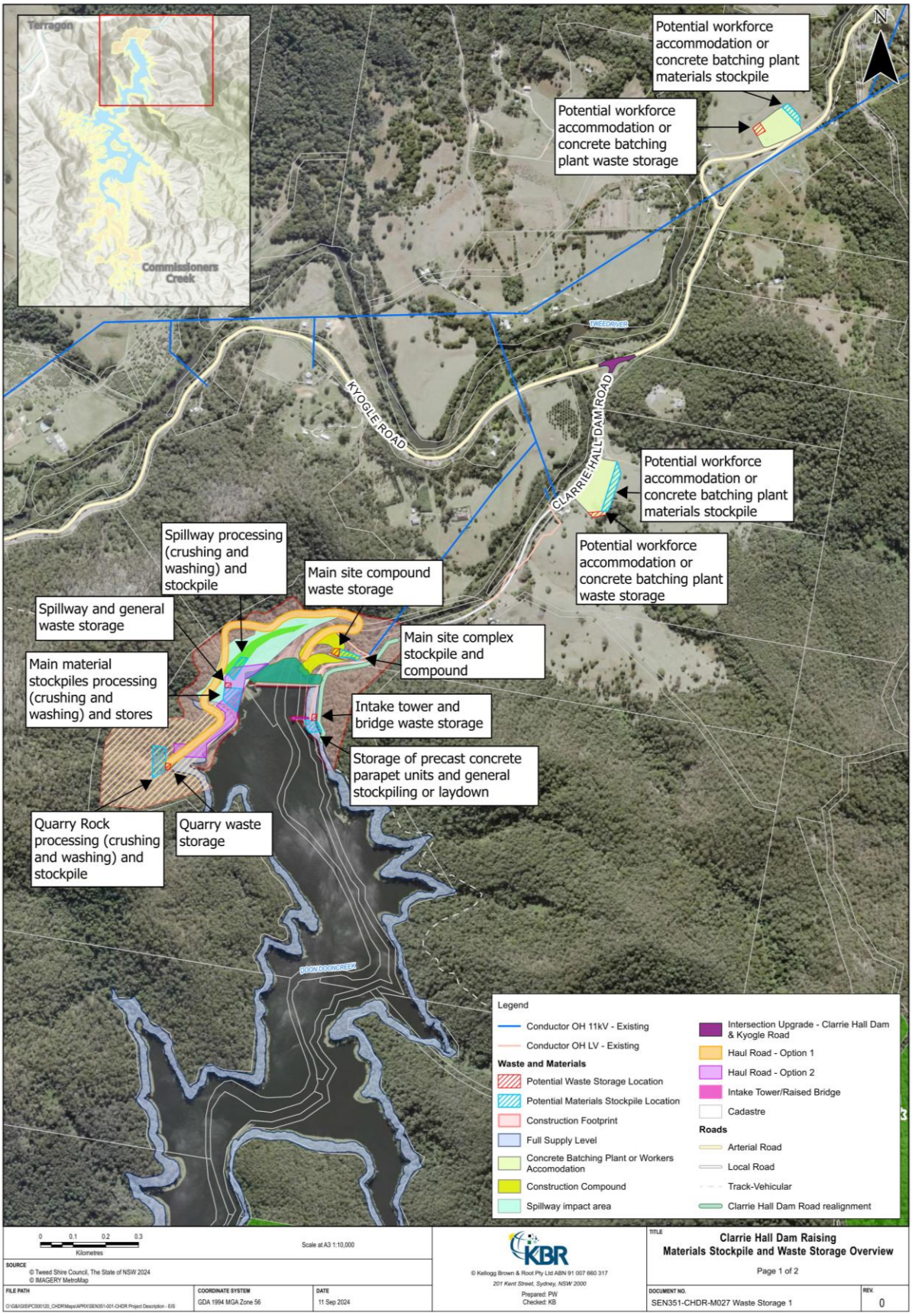


Figure 6-68 Potential waste storage and material stockpile locations (north)

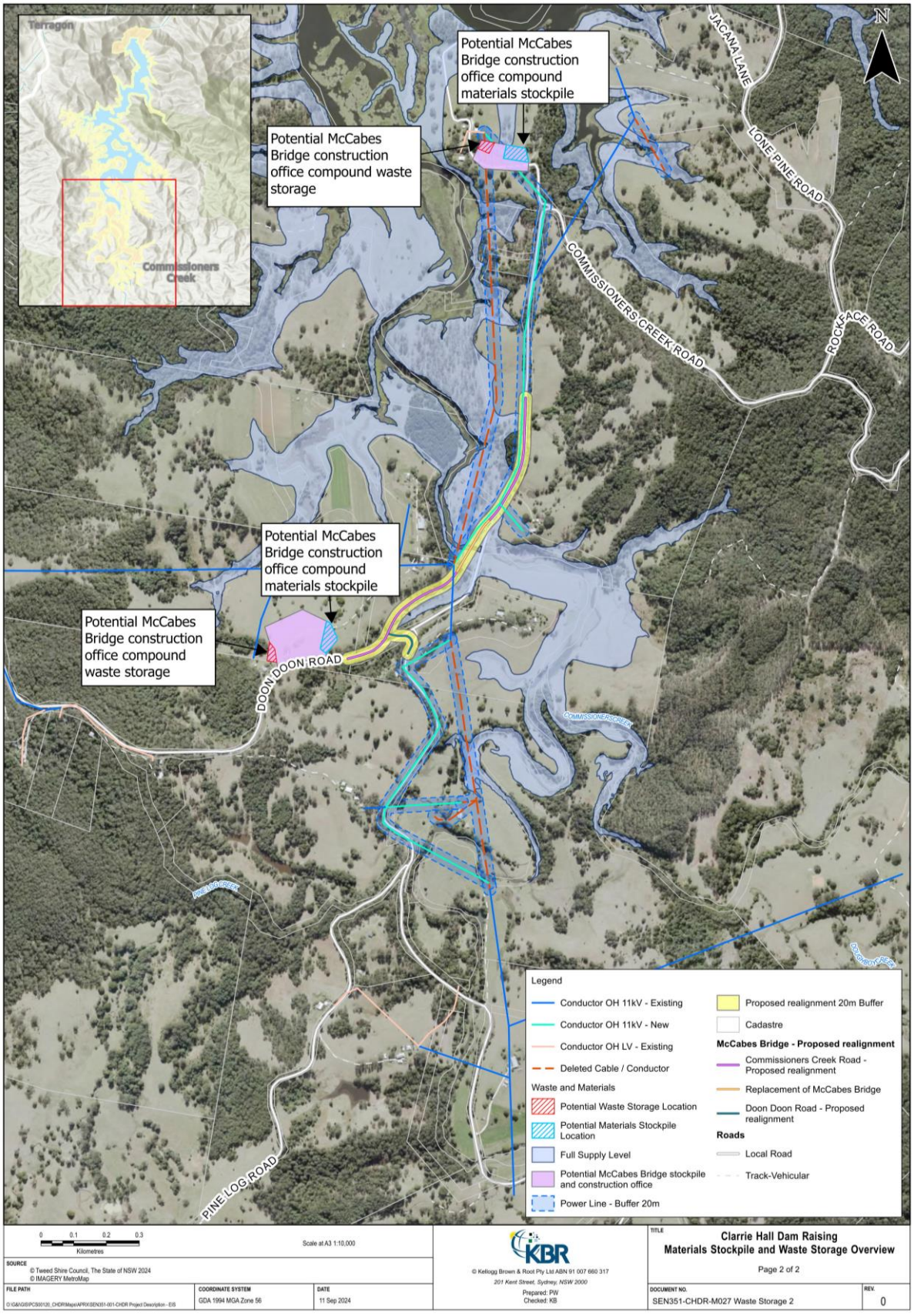


Figure 6-69 Potential waste storage and material stockpile locations (south)

Table 6-78 Waste mitigation measures

Reference	Impact	Mitigation measures	Responsibility	Timeframe
General waste minimisation, reuse and management measures				
W1	All waste	A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will detail the applicable regulations of the POEO Act, POEO Regulation and all applicable EPA guidelines. The WMP will include but not be limited to: • measures to avoid and minimise waste, and waste management targets, associated with the proposal • classification of wastes and management options (reuse, recycle, stockpile, disposal) • statutory approvals required for managing on- and offsite waste, or application of any relevant resource recovery exemptions • volume and type of waste streams to be generated by the Proposal • hazardous waste management • procedures for collection disposal of waste, including frequency and tracking requirements • contingency measures in the event that a facility (e.g. Stotts Creek Resource Recovery Centre) cannot accept any more waste or recycling – recommended facilities include Lismore City Council Recycling and Recovery Centre, followed by Ballina Shire Council Waste Management Centre • register of licenced waste and recycling facilities (consistent with Table 6-76 of the EIS) • resource and energy conservation • environmental mitigation and management measures • roles and responsibilities of site personnel, including training and communication of the WMP to construction staff • procedures for storage, transport, disposal, monitoring, record-keeping and reporting. The contractor is to assume responsibility for the appropriate disposal of any waste generated. Adequate procedures will be established and detailed in the WMP, including notification requirements to the EPA, for incidents that cause material harm to the environment. The WMP will also follow the resource management hierarchy principles embodied in the *Waste Avoidance and Resource Recovery Act 2001*, as follows: • Avoid unnecessary resource consumption. • Recover resources (including reuse, reprocessing, recycling and energy recovery). • Dispose (as a last resort).	Construction contractor	Pre-construction, construction
		All waste will be managed and disposed of in accordance with relevant Waste Classification Guidelines (NSW EPA 2014a) and government policies	Construction contractor	Construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
W2	Resource recovery	Construction waste management will prioritise resource recovery, including: • recovery of resources for reuse – reusable materials generated by the project will be segregated for reuse onsite, or offsite where possible, including: – the original parapet wall located at the crest of the dam will be dismantled, stored and used in construction of the dam wall raising – existing components at recreational facilities, such as benches, fences, shelters, for later reestablishment after completion of the main works the reuse of the major waste streams • recovery of resources for reprocessing – cleared vegetation will be mulched or chipped onsite and used for landscaping, in the absence of a higher beneficial use being identified • recovery of resources for recycling – recyclable resources (such as metals, plastics and other recyclable materials) generated during construction and demolition • segregation of resources for recycling – the resources will be sent to an appropriate recycling facility for processing.	Design contractor, construction contractor	Detailed design, pre-construction, construction
W3	Unexpected waste materials	During detailed design, suitable areas will be identified to allow for contingency management of unexpected waste materials, including contaminated materials. Lismore City Council Recycling and Recovery Centre could accept chemical and asbestos waste if Stotts Creek Resource Recovery Centre became unable to accept additional waste. Areas will be hardstand or lined areas that are appropriately stabilised and bunded, with sufficient space for stockpile storage.	Design contractor, Construction contractor	Detailed design, pre-construction, construction
W4	Unexpected waste materials	Materials will be ordered on an as needed basis to minimise waste with no over-ordering. The development of the WMP during the detailed design and construction phase will outline the details of the material management.	Design contractor, construction contractor	Pre-construction, construction
W5	Unlawful disposal of waste	No waste from the Proposal will be littered or illegally dumped. All waste will be collected by an appropriately licenced waste contractor or disposed of at an appropriately licenced waste disposal facility.	Construction contractor	Construction
W6	Erosion and sedimentation	An Erosion and Sediment Control Plan (ESCP) will be prepared by the construction contractor and will include detailed measures for mitigation of erosion and sedimentation regarding waste. The ESCP will include measures specific to the management of waste, such as: • excavation of spoil would occur in a manner that ensures slope stability and slope stabilisation methods would be utilised where required • waste would be handled as per guidance detailed by the NSW EPA Waste Classification Guidelines, Part 1: Classifying Waste (2014a)	Construction contractor	Pre-construction, construction

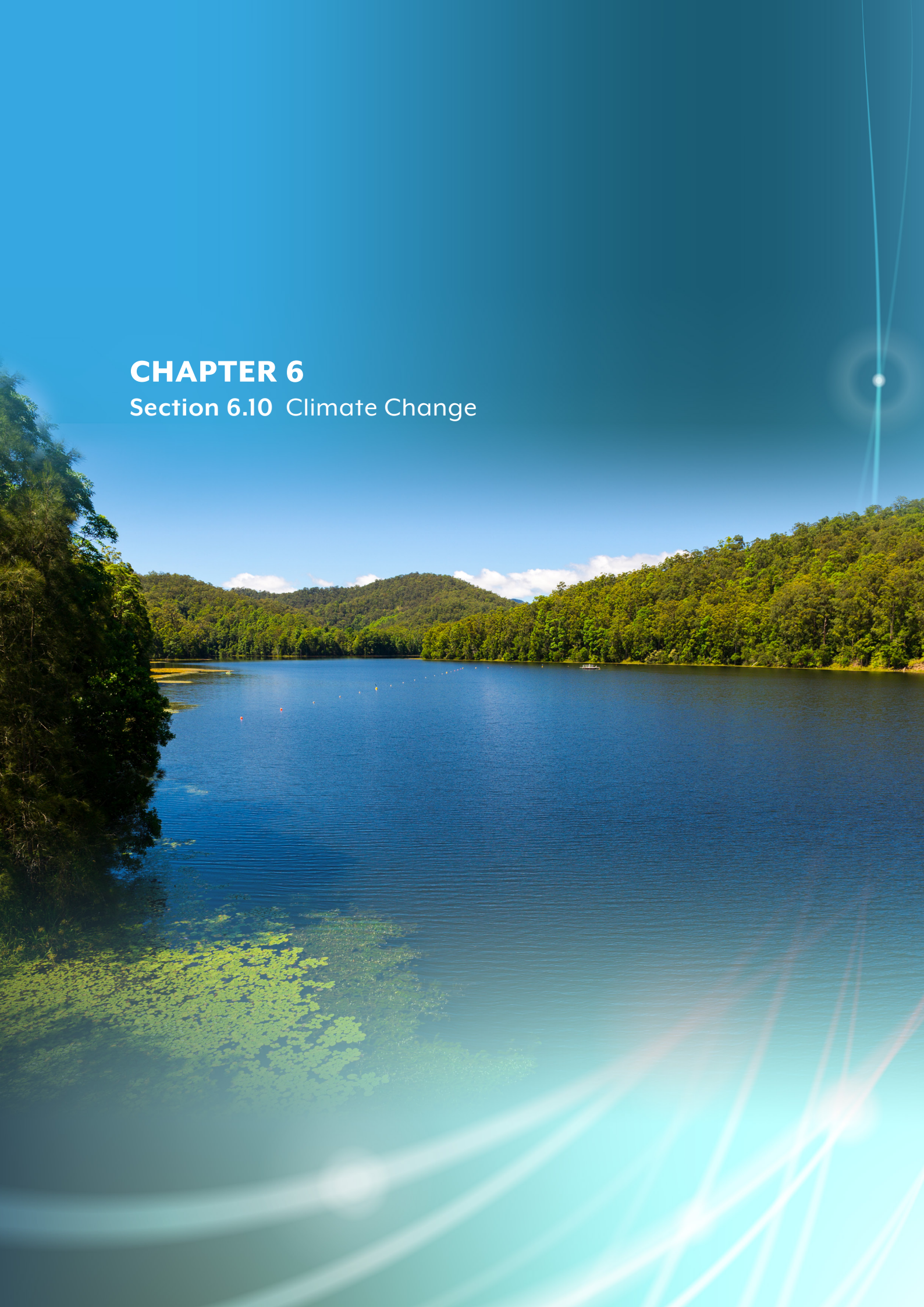
Reference	Impact	Mitigation measures	Responsibility	Timeframe
		• storage and stockpiling of wastes within hardstand areas and covering spoil stockpiles during heavy rain events to prevent erosion and sedimentation • storage of waste within impermeable areas/containers to prevent sedimentation entering the water supply • storage of hazardous waste within bunded areas to prevent contamination • transport of waste in covered and impermeable containers or truck bed to prevent leakage and sedimentation of waste.		
W7	Building and demolition waste	For building and demolition waste including concrete, VENM and/or ENM, and/or excavated material other than VENM, ENM or asbestos-containing material, for recycling, re-use, processing and/or disposal. Refer to the EPA 'construction and demolition waste' toolkit available at https://www.epa.nsw.gov.au/your-environment/waste/industrial-waste/construction-demolition Classify waste onsite using the EPA Waste Classification Guidelines and maintain the following records: • waste classification report • sampling results • statements of compliance • reuse options for VENM onsite as part of rehabilitation and restoration works (if practicable). Assess transportation requirements: • Identify if waste tracking requirements apply, i.e. >10 tonnes transported outside NSW • Loads must be covered during transport. Maintain the following records: • copy of the receival facility's EPL (available on public register), if required • if no EPL, records showing the facility can receive the waste lawfully, e.g. a copy of the receival facility's development consent • weighbridge receipts • invoicing and payment receipts from the receival facility.	Construction contractor	Pre-construction, construction
W8	Waste transport	Waste will be transported in covered trucks and containers where appropriate, and in accordance with relevant materials handling, transport and management standards.	Construction contractor	pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
General liquid waste				
W9	Grey water and sewerage	The amount of grey water and sewage to be generated from the construction workforce will be determined during detailed design. This will allow the quantity of portable toilets to be located at each construction area and accommodation site to be estimated.	Design contractor, construction contractor	Detailed design, pre-construction, construction
W10	Grey water and sewerage	Portable toilets will be utilised during the construction stage at each construction compound site, for which sewage will be collected by an appropriately qualified and licenced waste contractor. Any discharge to the existing sewage system will be agreed with the Local Council. The location and liquid waste management will be confirmed during the detailed design phase of the Proposal.	Construction contractor	Construction
W11	Grey water and sewerage	A Soil and Water Management Plan (SWMP) will be prepared for the Proposal to detail the management of grey water and sewage for the Proposal.	Construction contractor	Pre-construction, construction
General solid waste (non-putrescible)				
W12	Vegetation	Any cleared vegetation will be mulched and reused onsite where possible; otherwise, it will be temporarily stockpiled within the construction footprint and inundation area for future re-use, sale or composting.	Construction contractor	Pre-construction, construction
W13	Concrete washout waste and cementitious wastewater	The CEMP and SWMP will detail concrete washout and cementitious wastewater management measures including: • temporary storage in designated impervious areas in accordance with the ESCP • recycling or disposal to an appropriately licenced resource recovery facility.	Construction contractor	Pre-construction, construction
W14	Virgin excavated natural material (VENM) / excavated natural material (ENM)	The WMP will detail the management of VENM/ENM or spoil, including: • procedures for handling and storing excavated rock • stockpiling of material • management of potentially or known contaminated soil/fill in accordance with the POEO Act • procedures for characterising material not suitable for reuse prior to disposal • a register of licenced facilities for disposal or offsite reuse of spoil that cannot be appropriately reused onsite.	Construction contractor	Construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
W15	Recyclables	Designated, labelled and covered recycling areas will be made available to store recyclable materials for collection by an appropriately qualified waste contractor. The management of recyclable waste will be further detailed in the WMP. All construction compounds will have segregated receptacles for waste for landfill and comingled recycling at minimum.	Construction contractor	Construction
General solid waste (putrescible)				
W16	Food waste	Food waste will be segregated where possible and deposited into covered waste receptacles for collection by a licenced waste removal contractor for food organic and garden organic disposal at Stott's Creek Resource Recovery Centre.	Construction contractor	Construction
Hazardous waste				
W17	Chemical containers, grease/oil drums and oil filters	All hazardous wastes will be classified, stored in sealed contained within a bunded area and then removed and disposed of in accordance with the appropriate EPA regulations. Hazardous materials will only be removed by suitably qualified and licenced contractors for disposal at an appropriately licenced waste disposal facility. Storage of hazardous waste, restricted solid waste or liquid waste (or a combination of these) on site at any time is not to exceed 5 tonnes; otherwise, an EPL under the POEO Act is required.	Construction contractor	Construction
W18	Chemical spills	The SWMP will include the following mitigation measures: • Oils, greases, and fuels will be stored in appropriately bunded site compounds outside of the determined riparian zone, where practical, and outside the intertidal area. These bunded site compounds will be located in well-drained areas, away from flood-prone areas, including minor channels. Materials should be stored in a designated area, under cover where possible. Servicing and repairs to vehicles, equipment and plant will be undertaken either offsite or in the designated and appropriately bunded location onsite in order to contain liquid wastes. • Containment bunds should be constructed with provision for collection and storage of any spilt material. Designated waste containers will be clearly identified and regularly monitored and emptied. Liquid waste will be collected and disposed of by appropriately licenced contractors. Volumes and collection dates will be tracked and recorded. Final locations, bunding design and waste volumes will be identified in the CWMP and the Erosion and Sediment Control Plan at the detailed design phase of the Proposal. • Washdown of equipment will occur away from riparian and intertidal areas. Staff facilities will be located to ensure effluent, including wash-down water, can be totally contained and will be treated within the site management area. Induction and training of all staff outlining the location and use of each facility and of their obligation to use them will be undertaken.	Construction contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
		• Runoff from polluted hard surfaces including roadways and vehicle hardstand areas will be contained and treated prior to discharge.		
W19	Lead paint	Lead paint will be identified through chemical testing of paintwork to be removed. Paint will then be removed in a controlled manner to minimise dust and exposure. This waste will then be disposed of at an appropriate licenced waste facility (e.g. Stott's Creek Resource Recovery Centre).	Design contractor, construction contractor	Detailed design, pre-construction, construction
Special waste				
W20	Asbestos containing material	Hazardous building materials assessments will be completed on all structures proposed to be demolished. For asbestos waste (including asbestos containing soils) refer to the EPA 'construction and demolition waste' toolkit available at https://www.epa.nsw.gov.au/your-environment/waste/industrial-waste/construction-demolition Classify waste onsite using the EPA Waste Classification Guidelines and maintain the following records: • waste classification report • sampling results • asbestos audit • SafeWork NSW notification (if required) • asbestos removalist licence • clearance certificate • sampling results • statements of compliance. Maintain the following records: • WasteLocate consignment number (audit consignments) or consignment authorisation • transport records (e.g. GPS tracker) • copy of the receival facility's EPL (available on public register), if required • If there is no EPL, records showing the facility has planning approval and an EPL to dispose of asbestos waste. The disposal facility must have a QR plate to scan for WasteLocate consignment • weighbridge receipts • invoicing and payment receipts from the receival facility. A Hazardous Material and Asbestos Management Plan will be prepared accordance with relevant legislation for the handling and disposal of asbestos if relevant.	Construction contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
W21	Waste tyres	Waste tyres are to be disposed of to a licensed waste facility or removed from site by a certified waste contractor.	Construction contractor	Construction
Restricted solid waste				
W22	Restricted solid waste management	Prevention of spills and leaks that may cause restricted solid waste generation will be managed by using secure storage locations, bunding, and restrictions on the use, transfer and disposal of the chemicals onsite. Volumes of chemicals stored onsite will be minimised to prevent potential leaks and spills. Hardstand materials may be used to prevent contact with soil. Spill kits will be available onsite to manage spills if they may occur.	Construction contractor	Pre-construction, construction



CHAPTER 6

Section 6.10 Climate Change

6.10 CLIMATE CHANGE

This section provides a summary of the Climate Change Risk Assessment (CCRA) and Greenhouse Gas (GHG) Assessment (Appendix O) undertaken to:

- predict and assess climate change risks associated with construction and operation of the Proposal
- assess the future climate variability impacts on the operation and management of the Proposal
- estimate the GHG emissions due to construction and operation of the Proposal
- identify mitigation measures to manage climate change risks and GHG emissions, where possible.

The impact of climate change on hydrological flows is discussed in detail in the Surface Water Assessment (Appendix G1) and the Flood Assessment (Appendix F) and summarised in section 6.1.

The relevant SEARS and where they have been addressed are shown in Table 6-79.

Table 6-79 Relevant SEARs – climate change

Relevant key issue requirement/s	Where addressed
1. The Proponent must assess the risk and vulnerability of the proposal to climate change in accordance with the current guidelines, including any Regional Water Strategy and associated climate change modelling as relevant to the project.	Section 6.10.2, section 6.1 Appendix G1
2. The Proponent must quantify specific climate change risks with reference to the NSW Government's climate projections, including relevant data and information from NSW and ACT Regional Climate Modelling partnership (NARCLiM) (data, models, simulations, guidance), and incorporate specific adaptation actions in the design and operation where reasonable and feasible. NARCLiM 1.5 must be used, unless otherwise agreed by the Planning Secretary. Other data, projections, or information may also be used in addition to NARCLiM.	Section 6.10.2, section 6.1 Appendix G1
3. An assessment of potential future climate variability impacts on the operation and management of the dam and associated delivery works (such as water deliver by way of river operations, or pipe infrastructure), having regard to research on groundwater recharge and surface run-off and the NSW Climate Impact Profile.	Section 6.1 Appendix G1
4. Assessment of the greenhouse gas emissions from the construction and operation of the project for the life of infrastructure, including: (a) documentation and justification of an appropriate methodology for estimating greenhouse gas emissions for the project as a water storage, or water reservoirs project where permanent land use change occurs.	Section 6.10.3 Appendix O
(b) assessment of carbon dioxide, nitrous oxide and methane gas emissions, including gases emitted by decomposing plants and organic material within the dam inundation area.	Section 6.10.3 Appendix O
(c) quantitative assessment of Scope 1, 2 and 3 greenhouse gas emissions.	Section 6.10.3 Appendix O
(d) an assessment of reasonable and feasible measures to minimise greenhouse gas emissions and ensure energy efficiency.	Section 6.10.3 Appendix O
(e) project emissions as a proportion of NSW and Australia's greenhouse gas emissions budgets.	Section 6.10.3 Appendix O

Relevant key issue requirement/s	Where addressed
(f) details of all proposed mitigation, management and monitoring measures.	Section 6.10.4 Appendix O

6.10.1 Relevant legislation, standards, guidelines and data

A brief overview of the international and national policies, agreements and frameworks that regulate and manage climate change and GHG emissions that are relevant to the Proposal are provided below.

Legislation and policies relevant to the CCRA and GHG assessments are provided in sections 6.10.2 and 6.10.3 respectively.

International context

Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science in relation to climate change. The IPCC prepares comprehensive assessment reports (ARs) on the state of scientific, technical and socio-economic knowledge of climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. The First Assessment Report (AR1) served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC). The IPCC released its Sixth Assessment Report (AR6) in 2022. The IPCC also produces guidance documents and methodologies for assessing GHG emissions inventories, including, for example, the 2006 IPCC Guidelines for National GHG Inventories (IPCC 2006) and 2019 Refinements (IPCC 2019).

United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC entered into force in March 2004 and provides the basis for concerted international action to mitigate climate change and to adapt to its impacts. With 198 parties, the Convention has nearly a universal membership. The Conference of the Parties to the Convention (COP) is used to advance the implementation of the Convention. The objective of the Convention is to stabilise GHG emissions 'at a level that would prevent dangerous anthropogenic interference with the climate system' (UNFCCC 2004). It states that 'such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner' (UNFCCC 2004).

Paris Agreement

At the United Nations Climate Change Conference (COP21) held in Paris in December 2015, parties to the UNFCCC reached the Paris Agreement, a global climate change agreement aimed at reducing GHG emissions in order to limit global temperature rise this century to between 1.5 and 2°C above pre-industrial levels. Under the Paris Agreement, all parties are required to put forward GHG emission reduction targets through nationally determined contributions. All parties are required to report on national emissions, with a review of targets every 5 years from 2020. Australia ratified the Paris Agreement in November 2016. Australia's target under the Paris Agreement is to reduce GHG emissions by 26–28% below 2005 levels by 2030. In June 2022, a more ambitious target of a 43% reduction was set by the new Australian Government.

Australian context

The National Greenhouse and Energy Reporting Scheme

The National Greenhouse and Energy Reporting (NGER) scheme, established by the *National Greenhouse and Energy Reporting Act 2007* (NGER Act), is a single national framework for

reporting information about GHG emissions, energy production and energy consumption. Facilities or corporations must report under the NGER scheme if they emit GHG emissions or produce/consume energy at or above the following annual trigger thresholds:

- greater than 25 kilotonnes (kt) GHG emissions (as CO2-e) or produce/consume greater than 100 terajoules (TJ) of energy (facility level), or
- greater than 125 kt of GHG emissions (as CO2-e) or produce/consume greater than 500 TJ of energy (corporate level).

Clarrie Hall Dam does not currently report under the NGER scheme, given that its GHG emissions are well below the thresholds.

The NGER Act is underpinned by the National Greenhouse and Energy Reporting Regulations 2008 and the National Greenhouse and Energy Reporting (Measurement) Determination 2008.

New South Wales – Climate Change Policy Framework

The NSW Climate Change Policy Framework outlines the NSW Government objectives of achieving net-zero emissions by 2050 and increasing climate change resilience in NSW. The intent of the framework is to maximise the economic, social and environmental wellbeing of NSW. The framework sets out policy directions for the NSW Government to respond to climate change.

Further to the NSW Climate Change Policy Framework, NSW DPIE released the Net Zero Plan Stage 1: 2020-2030 (DPIE 2020b), which provided greater detail on initial strategies for the state to meet net-zero emissions by 2050 by delivering a 35% cut in emissions by 2030 compared with 2005 levels.

Implementation updates have been published (DPIE 2021c; OECC 2022), and these have revised the State's objective to achieve a 50% cut in emissions by 2030 compared to 2005 levels, a 70% cut by 2035, and net-zero emissions by 2050. These targets have been legislated in the *Climate Change (Net Zero Future) Act 2023.*

6.10.2 Climate change risk assessment

The approach taken for the CCRA was informed by the following standards, guidelines and data:

- Climate Change Impacts and Risk Management – A Guide for Business and Government (AGO, 2006)
- AS/NZS 31000:2018 Risk Management – Principles and Guidelines
- NSW and ACT Government Regional Climate Modelling climate change projections (NARCLiM)
- Guide to Climate Change Risk Assessment for NSW Local Government (DPIE 2019)
- International Standard ISO 31000:2009, Risk Management – Principles and Guidelines
- International Standard ISO/TS 14092:2020, Adaptation to climate change — Requirements and guidance on adaptation planning for local governments and communities
- Australian Standard 5334-2013, Climate change adaptation for settlements and infrastructure – A risk-based approach
- Climate Risk Ready NSW Guide, Practical guidance for the NSW Government sector to assess and manage climate change risks (DPIE 2021c)
- Climate Change Impacts & Risk Management – A Guide for Business and Government (Australian Government 2006)
- National Climate Risk Assessment Methodology (DCCEEW 2023c).

Methodology

The CCRA was conducted to determine the likely future impacts of climate change and the resilience of the operation of the Proposal in the future. The CCRA did not consider construction impacts due to the short duration of construction relative to the timeframe for changes in the climate.

The CCRA undertaken for the Proposal involved the steps and activities identified in Table 6-80.

Table 6-80 CCRA methodology

Step	Activities
1. Characterisation of the climate in the area	• Identification of key climate variables and metrics; the climate variables and metrics considered in the assessment were temperature, rainfall and droughts, fire danger and storms • Characterisation of the past climate, based on observations • Climate change projections, which describe how each variable may change over the design life of a project.
2. Identification of the broad impacts	Broad impacts of the changes in the climate variables on the operation of the Proposal, and the impacts on the environment where appropriate were identified.
3. CCRA	A climate risk and adaptation workshop was held in October 2023. The risk assessment considered the following for each identified impact: a) the likelihood of the impacts occurring b) the consequences of the impacts occurring c) the combination of the likelihood and consequences to define a risk rating. Further details on the risk workshop and outcomes are provided in Appendix O.
4. Mitigation measures	Identification of measures to mitigate, adapt or build resilience to the identified risks
5. Residual risk	Assessment of residual risks for the Proposal once the measures have been applied

Past and future climate

Data sources

The Proposal is located in the North Coast of NSW. The past climate in the region of the Proposal was characterised using long-term temperature and rainfall data from the Bureau of Meteorology (BoM) monitoring station at Murwillumbah (Bray Park) (ID: 058158), 13 km to the north-east of the Proposal.

The NSW Government's AdaptNSW website provides climate projection data from the NSW and Australian Regional Climate Modelling (NARCliM) project. For this assessment, climate parameters were taken from the AdaptNSW interactive climate change projections map. These projections mostly rely on the first generation of NARCliM projections released in 2014 (known as NARCliM 1.0). The application of NARCliM 1.0 projection iterations is discussed in detail in section 4.2.1 of Appendix O.

NARCliM generated data for over 100 weather and climate variables, including temperature, number of hot days and cold nights, rainfall and average forest fire danger index (FFDI), and at 10 km grid square resolution.

The simulations are for the following three 20-year periods:

- a historical (baseline) period (1990 to 2009)
- a near-future period (2020 to 2039)
- a far-future period (2060 to 2079).

The projections for temperature, rainfall and fire danger were extracted for a 10 km grid cell in which the Proposal is located. In addition, the data for the 8 grid cells around the Proposal grid cell were obtained to ensure that the wider catchment area for the dam was considered.

The raw monthly data for temperature, precipitation, and humidity, for both NARCliM 1.0 and NARCliM 1.5, were downloaded from the NSW Climate Data Portal. The RCP 8.5 emission trajectory was selected as being the most plausible. The data represented a single point at the Proposal location (longitude 153.3054; latitude -28.4377). An overview of the downloaded data and sensitivity checks of the data is provided in section 4.2.1 and Table 4.1 of Appendix O.

In addition, the Climate Change in Australia project (CSIRO & BoM 2015) developed projections of basic climate change variables. The corresponding website provides climate change projections of Australia's future climate at a national level, and associated work. The projections that are most relevant to this report are those for the 'East Coast' cluster and the 'East Coast south' sub-cluster, which comprises regions in the central part of the eastern seaboard of Australia (Dowdy et al. 2015).

Historical temperature

The North Coast region of NSW has a humid, subtropical climate. Historical temperature data was obtained for the BoM monitoring station at Murwillumbah (Bray Park). Figure 6-70 shows the annual mean maximum and minimum temperatures at Murwillumbah between 1995 and 2022. The values are calculated from the monthly mean maximum and minimum temperatures. The record shows that, at this location, there has been little change in the values over the period. The highest and lowest temperatures during the year (not shown) both tended to decrease slightly.

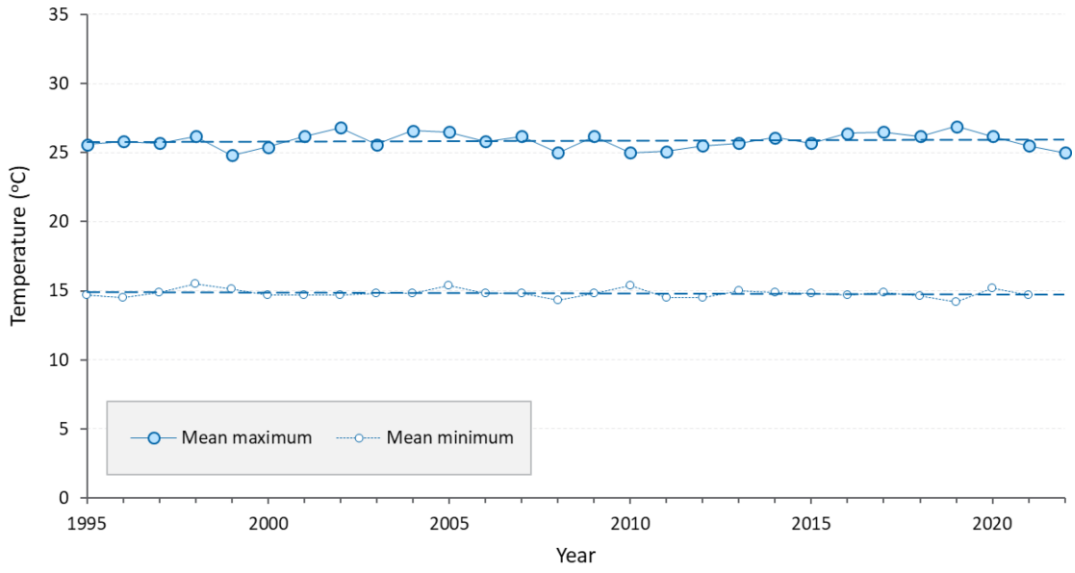


Figure 6-70 Historical temperature data for Murwillumbah (Bray Park)

Source: EMM Appendix O

For Murwillumbah, the temperature statistics for each month for a period in the data that corresponds closely to this baseline (1995–2009) are shown in Table 6-81. The area has hot summers, with a mean maximum temperature in the summer months of around 30°C. Winters are mild, with a mean minimum temperature of around 9°C.

Table 6-81 Temperature statistics for Murwillumbah (Bray Park) (1995-2009)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum (°C)	29.4	29.1	28.2	26.1	23.6	21.3	21.2	22.7	25.6	26.9	27.5	29.2	25.9
Highest (°C)	42,9	40.9	35.7	34.3	31.9	26.7	28.2	35.9	35.7	38.2	39.6	40.7	42.9
Mean minimum (°C)	20.0	20.0	18.4	15.8	12.7	10.4	8.7	9.4	12.2	14.6	17.0	18.8	14.8
Lowest (°C)	14.0	14.2	12.2	7.7	2.7	1.4	0.8	-1.4	3.2	7.9	9.7	12.9	-1.4

Rainfall, floods and droughts

Source: EMM Appendix O

The North Coast currently experiences considerable rainfall variability across the region and from year to year. The region can also be impacted by decaying tropical cyclones that can bring extreme rainfall. East Coast lows and persistent onshore flow can result in intense and prolonged flooding rains.

Historical rainfall data were obtained for Murwillumbah, where it has been measured since the early 1970s. Figure 6-71 shows the time series of annual total rainfall. The long-term record shows that, although the annual amount of rainfall is variable, there has been a general downward trend. There has been a substantial variation in annual rainfall associated with the El Niño Southern Oscillation and the corresponding La Niña events.

For comparison with the baseline period in the projections from AdaptNSW, the rainfall statistics for Murwillumbah between 1990 and 2009 are shown in Table 6-82.

CSIRO & BoM (2015) note that, for the East Coast South sub-cluster, the observed trends in rainfall are not as significant as those for temperature. While the sub-cluster experienced extended dry periods in the early 20th century, there is no long-term trend in annual rainfall during the available record.

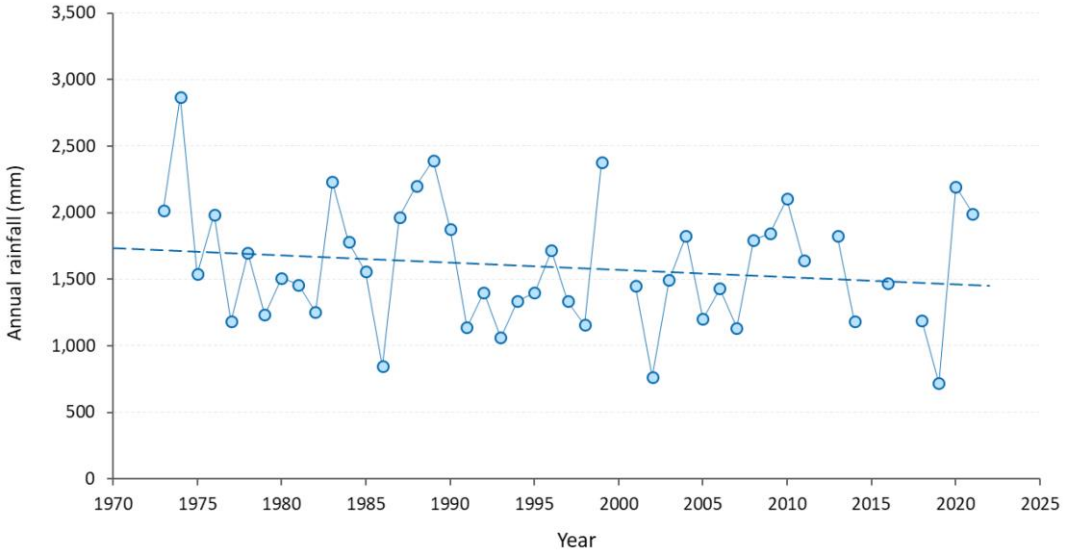


Figure 6-71 Historical rainfall data for Murwillumbah (Bray Park)

Source: EMM Appendix O

Table 6-82 Rainfall statistics for Murwilumbah (Bray Park) (1990–2009)

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
Mean (mm)	179.4	246.5	171.7	125.3	129.6	102.4	47.8	41.5	41.2	80.0	120.8	162.1	1460.3
Maximum (mm)	477.3	514.2	360.2	451.9	491.2	421.7	144.7	185.0	153.9	249.9	258.4	317.4	2376.3
Minimum (mm)	11.6	42.6	46.8	14.2	2.4	9.4	0.6	0.2	0.4	11.8	21.6	32.6	767.5

Source: EMM Appendix O

Historical fire danger

The Forest Fire Danger Index (FFDI) is used in NSW to quantify fire weather. The FFDI combines observations of temperature, humidity and wind speed with an estimate of the fuel state, with 17 stations in NSW and the ACT (OEH 2014a). FFDI estimates are available for 3 stations in the North Coast region: Lismore, Casino, and Coffs Harbour. The annual and seasonal FFDI values for the period 1990–2009 are summarised in Table 6-83. The average annual FFDI is lowest in Coffs Harbour (3.3) and highest in Casino (6.4). The highest average FFDI occurs in spring and the lowest in autumn (OEH 2014a).

Fire weather is classified as 'severe' when the FFDI is above 50, and most of the property loss from major fires in Australia has occurred when the FFDI reached this level. FFDI values below 12 indicate low to moderate fire weather, 12-25 high, 25-49 very high, 50-74 severe, 75-99 extreme and above 100 catastrophic. (OEH 2014b).

Table 6-83 FFDI at locations in the North Coast region (OEH2014a)

Statistic and location	Spring	Summer	Autumn	Winter	Annual
Mean FFDI					
Lismore	7.1	4.1	3.1	5.3	4.9
Casino	10.0	5.0	4.1	6.8	6.4
Coffs Harbour	4.3	2.8	2.0	4.0	3.3
Number of severe weather days					
Lismore	0.25	0.00	0.00	0.05	0.30
Casino	1.45	0.10	0.00	0.50	2.05
Coffs Harbour	0.15	0.10	0.00	0.00	0.25

Source: EMM Appendix O

Historical storms

Dowdy et al. (2015) note that there is a strong annual cycle of thunderstorms throughout the East Coast cluster, with a maximum during the warmer months and a minimum during the cooler months. The cluster has thunderstorms on about 20–50 days per year. Tropical cyclones can occur during the warmer months of the year. The eastern Australian region typically has 4 tropical cyclones per year, although there is a downward trend in their frequency.

The main causes of extreme storms along the NSW coast are East Coast lows (ECLs). A considerable proportion of the heavy rainfall events on the central eastern seaboard can be associated with ECLs, and they also provide important rainfall to fill catchments and reservoirs. Storms caused by ECLs vary from year to year, and decade to decade. This makes it difficult to predict when they will occur, how severe they will be, and how they might be affected by climate change. The literature suggests a decrease in the overall number of ECLs in the future, although the climate modelling predicts that there may be more extreme systems in the warmer months, and fewer small-to-moderate systems in the cooler months (CSIRO & BoM 2015).

Future projections for all climate variables

A summary of the climate projections for the Proposal, with the specific climate data projections adopted for the CCRA, is provided below and shown Table 6-84. Detailed discussion of the relevant NARCliM climate projections and the sensitivity checks undertaken for each climate variable is provided in Appendix O.

Overall, the most significant changes to the climate variables include:

- Temperature – increases in maximum, minimum and mean values, as well as the number of hot days per year. The changes are more severe in the far future than in the near future. The confidence in the temperature predictions is very high.
- Fire danger –- an increase in high fire danger days. The confidence level is high for harsher fire-weather in general, but low for the actual magnitude of the change.
- Rainfall – based on the latest NARCliM 1.5 data for the Proposal location:
  - an increase in annual rainfall in the near future, and a decrease in the far future
  - significantly reduced rainfall between the near and far future in autumn and winter
  - increased intensity of extreme rainfall events in the near and far future

The confidence in the rainfall projections is generally low, although there is high confidence of an increased intensity

- Drought – more frequent and prolonged droughts, with a low-to-medium level of confidence.
- Storms – a decrease in frequency of ECLs and tropical cyclones, but with an increase in intensity in warmer months. The predictions for tropical cyclones have a medium confidence level.

Table 6-84 Summary and interpretation of climate projections

Parameter statistic	Baseline (historical)	Near future (2020-2039)					Far future (2060-2075)				
		NARCLiM 1.0 (annual)	NARCLiM 1.5 (annual)	CCA (East Coast)	Interpretation for use in CCRA	Confidence (CCA)	NARCliM 1.0 (annual)	NARCliM 1.5 (annual)	CCA (East Coast)	Interpretation for use in CCRA	Confidence (CCA)
Change in temperature											
Daily average (°C)	-	+0.7	+1.1	+1.0	Moderate increase in average temp	Very high	+2.0	+2.9	+2.7	Large increase in average temp	Very high
Daily maximum (°C)	-	+0.7	+1.0	+1.1	Moderate increase in max. temp	Very high	+1.9	+3.1	+2.7	Large increase in max. temp	Very high
Daily minimum (°C)	-	+0.7	+1.2	+1.0	Moderate increase in min. temp	Very high	+2.1	+2.9	+2.6	Large increase in min. temp	Very high
Cold nights <2°C (days)	-	-0.3	-	-	Slight reduction in freq. of cold nights	High	-0.7	-	-	Slight reduction in freq. of cold nights	High
Hot days ≥35°C (days)	-	+1.7	-	-	Increased freq., severity & duration of extreme high temp	Very high	+6.0	-	-	Increased freq., severity & duration of extreme temp	Very high
Change in rainfall											
Change in rainfall (%)	-	+0.6	+6.0	-4.5	Rainfall projected to increase in near future	Low for both the size and sign of change	+6.5	-5.5	-8.2	Rainfall projected to decrease in far future	Low for both the size and sign of change

Parameter statistic	Baseline (historical)	Near future (2020-2039)					Far future (2060-2075)				
		NARCLiM 1.0 (annual)	NARCLiM 1.5 (annual)	CCA (East Coast)	Interpretation for use in CCRA	Confidence (CCA)	NARCliM 1.0 (annual)	NARCIIM 1.5 (annual)	CCA (East Coast)	Interpretation for use in CCRA	Confidence (CCA)
Change in max. 1-day rain (%)	–	–	–	+1.5	Increased intensity of extreme rainfall events	High for increase in intensity; low for size of increase	–	–	+5.2	Increased intensity of extreme rainfall events	High for increase in intensity; low for size of increase
Droughts											
Time spent in drought (%)	40	–	–	50	Longer periods of drought	Medium	–	–	55	Longer periods of drought	Medium
Duration of extreme drought (months)	26	–	–	28	Increase of 8% in duration	Low	–	–	34	Increase of 30% in duration	Low
Freq. of extreme drought (/20y)	1.3	–	–	1.8	Increase in frequency	Low	–	–	2.0	Increase in frequency	Low
Fire danger											
Change in high fire danger (days)	–	+0.05	–	–	Relatively small increase in frequency and severity of bushfires	High for harsher fire-weather in general; low for the magnitude of the change	+0.08	–	–	Relatively small increase in frequency and severity of bushfire	High for harsher fire-weather in general; low for the magnitude of the change

Parameter statistic	Baseline (historical)	Near future (2020-2039)					Far future (2060-2075)				
		NARCLiM 1.0 (annual)	NARCLiM 1.5 (annual)	CCA (East Coast)	Interpretation for use in CCRA	Confidence (CCA)	NARCliM 1.0 (annual)	NARCliM 1.5 (annual)	CCA (East Coast)	Interpretation for use in CCRA	Confidence (CCA)
Storms											
Thunderstorms	–	–	–	-	Decline in the number of ECLs, but with more extreme systems in warmer months	N/A	–	–	–	Decline in the number of ECLs, but with more extreme systems in warmer months	N/A
Tropical cyclones (TCs)	–	–	–	-	TCs are projected to become less frequent, but with an increase in the proportion of intense storms	Medium	–	–	–	TCs are projected to become less frequent, but with an increase in the proportion of intense storms	Medium

Source: EMM Appendix O

Risk assessment

Climate risk and adaptation workshop

The effects of the predicted future changes in climate were considered in relation to potential impacts on Proposal assets or functions, including areas such as physical structures, transport, and worker safety. In total, 31 potential impacts were identified.

A climate risk and adaptation workshop was held on 24 October 2023. Further details on the workshop and the full risk rating framework are outlined in Appendix O.

Impacts

The initial risk profile for the Proposal found most of the risk ratings were 'low' or 'medium', as summarised in Table 6-85.

Table 6-85 Initial risk profile for the Proposal

Risk Rating	Near future	Far future (2060–2079)
Low	21	18
Medium	8	10
High	1	2
Extreme	1	1
Total	31	31

The potential climate change impacts with 'extreme' or 'high' initial risk are summarised in Table 6-86, along with the current or proposed control measures.

Table 6-86 Climate change impacts with extreme or high risk

Risk ID	Climate hazard	Potential impact	High risk	Extreme risk	Current/proposed measures
T03	Increase in mean and maximum temperatures	Increased temperatures cause higher demand for water, particularly in drought years, which can result in water shortages.	✓ (2030 and 2070)		Risk mitigated (i.e. the project itself) by the raising of the dam wall. Every 4 years the secure yield and demand projections of the system are reviewed to determine if a variation is required
T04		More frequent hot days and heatwaves cause evaporation and evapotranspiration losses to increase, which could result in water shortages		✓ (2030 and 2070)	As above, tracking every 4 years
T07		Extreme heat stress on workers, leading to impacts on safety and the functioning of the asset	✓ (2070)		Occupational health and safety (OHS) procedures in place.

Identification of current/proposed and additional measures

Identification of the current and/or proposed measures to mitigate, adapt or build resilience to the identified risks from an operational perspective was completed. This included an evaluation of the likely effectiveness of these measures, using the following categories:

- substantially effective
- partially effective
- largely ineffective.

Where current and/or proposed measures were identified as partially or largely ineffective, additional measures were considered to eliminate or reduce the likelihood or consequence of the identified risks and associated impacts (refer to the full climate change risk register in Appendix O).

By considering risks in the near future (2030) and far future (2070), this process considered whether the measures would remain effective over time as climate change risks increase.

Residual risk

Residual risks were assessed once all measures had been applied. The residual risk ratings are provided in the full climate change risk register in Appendix O. For most potential climate change impacts, the residual risk was determined to be 'low'. For these risks, it is therefore considered that additional contingencies would not need to be considered. The impacts with a residual risk above 'low' are identified in Table 6-87.

Table 6-87 Climate change impacts with residual risk above 'low'

Risk ID	Climate hazard	Potential impact	Residual risk
T03	Increase in mean and maximum temperatures	Increase in mean and maximum temperatures	Medium (2030 and 2070)
T04		More frequent hot days and heatwaves cause evaporation and evapotranspiration losses to increase, which could result in water shortages.	High (2030 and 2070)

Mitigation measures are provided in section 6.10.4.

6.10.3 Greenhouse gas assessment

The following legislation, standards, sources and guidelines have been applied as part of the GHG assessment:

- NGER Act
- National Greenhouse and Energy Reporting (Measurement) Determination 2008, as amended (Australian Government Clean Energy Regulator 2008)
- National Greenhouse and Energy Reporting (NGER) Technical Guidelines 2017– 18 (Australian Government Clean Energy Regulator 2017)
- Australian National Greenhouse Accounts Factors, August 2023, Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW 2023e)
- Australia's emissions projections 2023, November 2023, Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW 2023d)
- GHG Reservoir (G-res) Tool.

Methodology

The methodology for the assessment of GHG emission impacts during construction and operation of the Proposal and development of measures to mitigate and manage the identified impacts is discussed below.

Accounting of GHG emissions

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect', and further categories according to scopes 1, 2 and 3. Examples of categorisation of GHG emissions are provided in Figure 6-72.

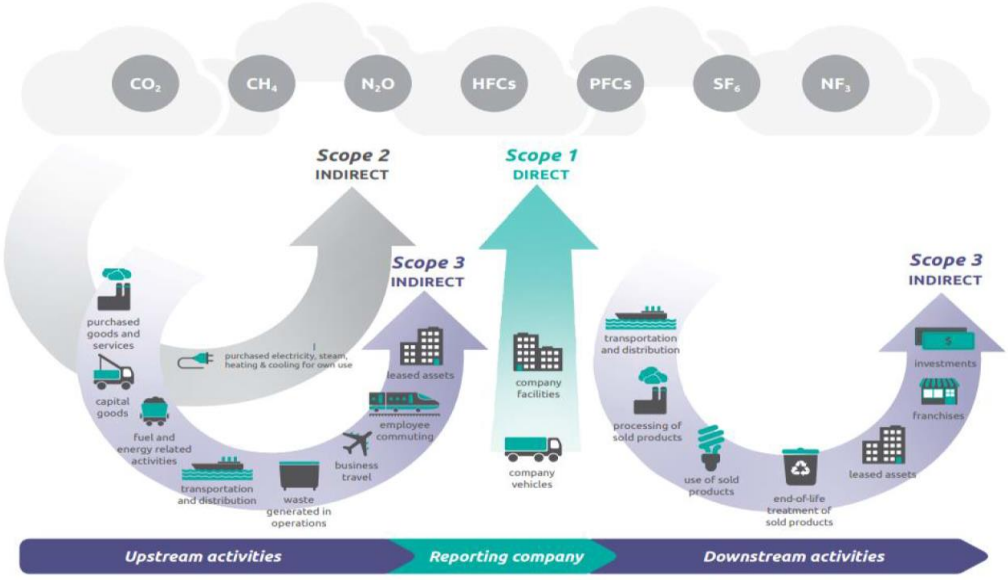


Figure 6-72 Overview of GHG emission scopes

Source: WRI & WBCSD 2013 (Appendix O)

In this assessment, GHG emissions are presented as carbon dioxide equivalents (CO_2-e) and include emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Emissions of sulfur hexafluoride (SF_6), hydrofluorocarbons (HCFs), perfluorinated compounds (PFCs) and nitrogen trifluoride (NF_3) are not considered relevant to the Proposal and were therefore not included in the emissions calculations.

Direct emissions (also referred to as scope 1 emissions) occur within the boundary of an organisation and are a result of the organisation's activities (DCCEEW 2023e). In the context of the Proposal, scope 1 emissions during the construction phase would arise from, for example, diesel combustion in onsite plant and vehicles, and the loss of an existing carbon sink resulting from the removal of existing vegetation. Scope 1 emissions during the operation of the Proposal would be from diesel combustion in maintenance equipment, and the relatively complex mix of sources and sinks associated with the reservoir.

Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DCCEEW 2023e). Indirect emissions are further defined as scope 2 and scope 3 emissions.

Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. During the construction of the Proposal, electricity would be used to power, for example, concrete batching plant, lighting and site offices. During the operation of the Proposal, electricity would be used to power water intakes and lighting.

Scope 3 emissions occur from upstream activities (such as the extraction and production of fuels and raw materials) and downstream activities (such as the use of products and services). In the context of the Proposal, scope 3 emissions include upstream emissions associated with the diesel used on site, diesel use for transporting materials to site, electricity consumption, and 'embodied' emissions associated with construction materials.

Calculation of GHG emissions

The GHG assessment covered both the construction and operation of the Proposal and considered both direct (scope 1) and indirect (scope 2 and scope 3) emissions.

The most significant emission-generating activities were considered in the assessment. Table 6-88 summarises the GHG emission sources for the Proposal during the construction and operation phases, along with their corresponding emission scopes.

Table 6-88 GHG emission sources for the Proposal

Proposal phase	Activity	Source (or sinks) of GHG emissions	GHG emissions scope		
			Direct	Indirect	
			Scope 1	Scope 2	Scope 3
Construction	Dam construction, land clearing	Fuel combustion (diesel) in plant and vehicles, including earthwork equipment, pumps, generators, etc.	Yes	–	Yes
	Vegetation removal	Removal of carbon sink	Yes	–	–
	Transport of materials to and from site	Diesel combustion in trucks	–	–	Yes
	Concrete batching plant, lighting, site offices and other activities	Purchased electricity from grid	–	Yes	Yes
	Construction materials	Embodied emissions associated with the production and transport of construction materials	–	–	Yes
Operation	Maintenance, weed control	Fuel combustion (diesel) in equipment	Yes	–	Yes
	Reservoir	Carbon sink provided by flooded vegetation is removed Organic material in the dam water releases CO_2 and CH_4 as it decomposes	Yes	–	–
	Operation of water intakes and lighting	Purchased electricity from grid	–	Yes	Yes

The construction of the Proposal would take place over a relatively short timeframe (18 months).

The main GHG-generating activities during construction would be:

- fuel combustion in vehicles and equipment used for construction activities within the disturbance area, including establishing/realigning roads, constructing the spillway and clearing land
- the loss of vegetation (a carbon sink) from the raised inundation area
- fuel combustion in trucks transporting materials and waste to and from the site
- the purchase of electricity to power the concrete batching plant, lighting, the site offices and other activities
- embodied emissions associated with the production and transport of construction materials.

Quarrying activities would require the use of explosives for blasting. However, this activity was excluded from the GHG assessment, as it would be limited.

The operational phase of the Proposal would span several decades. GHG emissions were therefore calculated for both the first year after completion and as an annual time series for several decades into the future. The period from 2029 to 2128 was taken to be the 'lifetime' of the Proposal for the purpose of this assessment.

The main GHG-generating activities during operation would be:

- emissions associated with the reservoir
- fuel combustion associated with vehicles and equipment used for maintenance
- the purchase of electricity to power water intakes, security lighting and amenities.

For this assessment, estimates of the net GHG emissions associated with the reservoir were made using the G-res tool. Adaptations in the use of G-res were implemented to reflect the fact that the Proposal is not a new dam, but a dam raising that would increase the total reservoir water surface area by approximately 67%. The calculations involved the running of 2 scenarios in G-res:

- Scenario S1 – represented a 'business-as-usual' case for the existing reservoir system and dam, from 1984 (the first year after the original opening of the dam in 1983) to 2128 (100 years after the completion of the Proposal)
- Scenario S2 – represented the incremental emissions for the Proposal itself.

The calculation approaches for construction and operation are described in more detail in Appendix O.

Impacts

Proposal construction

The GHG emissions for the construction phase were calculated for the 18-month period of construction and were not allocated to a particular year. The results for the construction phase are summarised in Table 6-89. The 'combined gases' column represents sources for which the emission factor did not distinguish between the individual gases. In such cases, the emission is likely to be mainly (or solely) CO_2.

Construction of the Proposal would emit around 21,000 tonnes of CO_2-e, with scope 1 emissions representing around 86% of the total. The main contributors to construction emissions would be diesel combustion and vegetation removal (i.e. lost carbon sink).

Table 6-89 GHG emissions – Proposal construction

Activity	GHG emissions (t CO_2-e) (18 month period)				
	CO_2	CH_4	N_2O	Combined gases	Total
Scope 1					
Diesel combustion (dam construction and land clearing)	7824.6	11.2	22.4	–	7858.2
Vegetation removal (removal of carbon sink)	–	–	–	10382.4	10382.4
Scope 2					
Consumption of purchased electricity[1]	–	–	–	65.0	65.0
Scope 3					
Diesel combustion (dam construction and land clearing)	–	–	–	1936.6	1936.6
Diesel combustion (transport of materials to and from site)	–	–	–	101.7	101.7
Consumption of purchased electricity [11]	–	–	–	5.0	5.0
Construction materials (embodied emissions)	–	–	–	875.6	875.6
Totals					
Scope 1	7824.6	11.2	22.4	10382.4	18240.6
Scope 2	–	–	–	65.0	65.0
Scope 3	–	–	–	2918.9	2918.9
All scopes	**7824.6**	**11.2**	**22.4**	**13366.3**	**21224.5**

[1]*Based on the emission intensity of the NSW electricity grid in 2028.*

Proposal operation (first year)

The GHG emissions for the operational phase were initially calculated for a nominal first year after construction of 2028. The results are summarised in Table 6-90.

In the first year of operation of the Proposal, there would be an increase in all-scope GHG emissions of around 4,700 t CO_2-e/year. By far the largest component would be the reservoir (and hence scope 1 emissions), which represented 98% of the total emissions.

The contribution from the reservoir is the result for the Proposal increment in scenario S_2, which is due mainly to an increase in diffusive emissions of CO_2 and CH_4. CH_4 emissions from bubbling (bubbles released from bottom sediments that reach the atmosphere – also referred to as ebullition – are relatively low, and CH4 emissions from degassing (removal from the water) are zero. According to the G-res output, this is because the depth at which water is drawn from the reservoir is shallow.

Table 6-90 GHG emissions - Proposal operation (first year)

Activity		GHG emissions (t CO_2-e)				
		CO_2	CH_4	N_2O	Combined gases	Total
Scope 1						
Diesel combustion (maintenance, weed control)	54.0		0.1	0.2	–	54.2
Reservoir[1]	CO_2 diffusion	–	–	–	2773.6	2773.6
	CH_4 diffusion	–	–	–	1550.8	1550.8
	CH_4 bubbling	–	–	–	298.3	298.3
	Reservoir subtotal	–	–	–	4622.7	4622.7
Scope 1 subtotal		*54.0*	*0.1*	*0.2*	*4622.7*	*4676.9*[2]
Scope 2						
Consumption of purchased electricity[3]		–	–	–	5.9	5.9
Scope 2 subtotal		–	–	–	*5.9*	*5.9*
Scope 3						
Diesel combustion (maintenance, weed control)		–	–	–	13.4	13.4
Consumption of purchased electricity[3]		–	–	–	0.5	0.5
Scope 3 subtotal		–	–	–	*13.8*	*13.8*
Total – all scopes		**54.0**	**0.1**	**0.2**	**4642.4**	**4696.6**

[1]Based on emissions from G-res for scenario S2 and in 2029 (the first year for which G-res res outputs for the Proposal were available).

[2]For comparison, Benbow Environmental (2021) obtained – using a much simpler method – a GHG emission for 'inundation' due to the Proposal of 5,748 t CO2-e/year.

[3]Based on the emission intensity of the NSW electricity grid in 2028.

Proposal operation (lifetime)

GHG emissions from operation of the Proposal were considered over a period of 100 years (between 2029 and 2128) to reflect its operational lifetime.

The results for the reservoir from G-res are shown in Figure 6-73.

Pane (a) shows the following for scenario S1:

- the gross post-impoundment emissions for CO_2 diffusion, CH_4 diffusion and CH_4 bubbling, taken from G-res
- the net emissions (post-impoundment minus pre-impoundment), taken from G-res
- the gross pre-impoundment emissions, calculated based on the above.

Pane (b) shows the incremental results for scenario S2 from 2029 onwards, which represent the effects of the dam raising Proposal itself.

Pane (c) shows the full time series of net GHG emissions from the reservoir system between 1984 and 2128. In this pane, scenario S1 was used as the 'real' emissions baseline for the reservoir system from 1983, and then from 2029 the increment for the Proposal from scenario S2 was added.

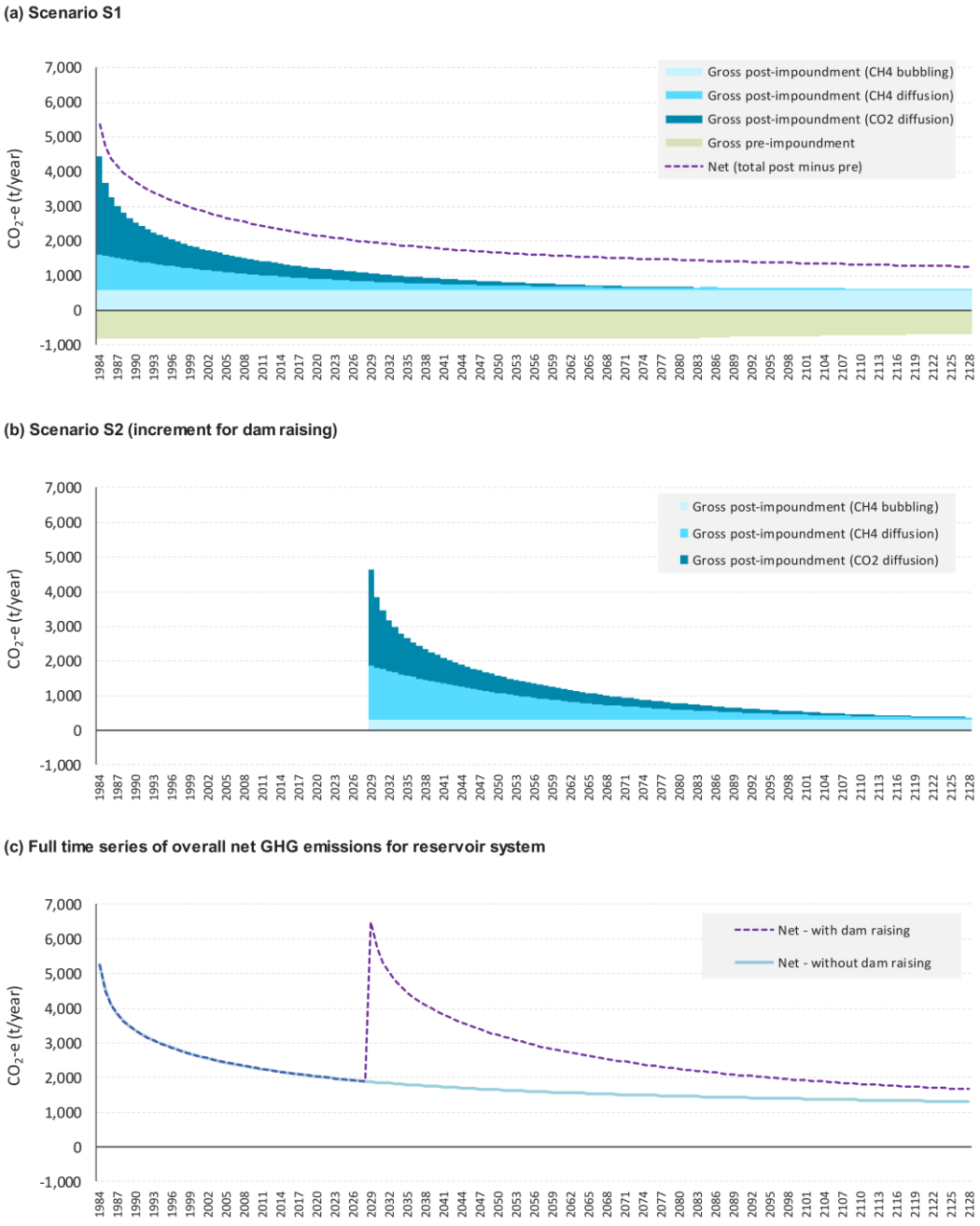


Figure 6-73 Annual GHG emissions from the reservoir over the lifetime of the Proposal

Source: EMM Appendix O

In Figure 6-74, the reservoir increment from S2 is combined with the other GHG components. It can be seen that overall operational GHG emissions were dominated by the reservoir, although the reservoir contribution was projected to decrease from around 4,700 t CO_2-e/year (98% of the total) in 2029 to around 360 t CO_2-e/year by 2128 (84% of a much lower total).

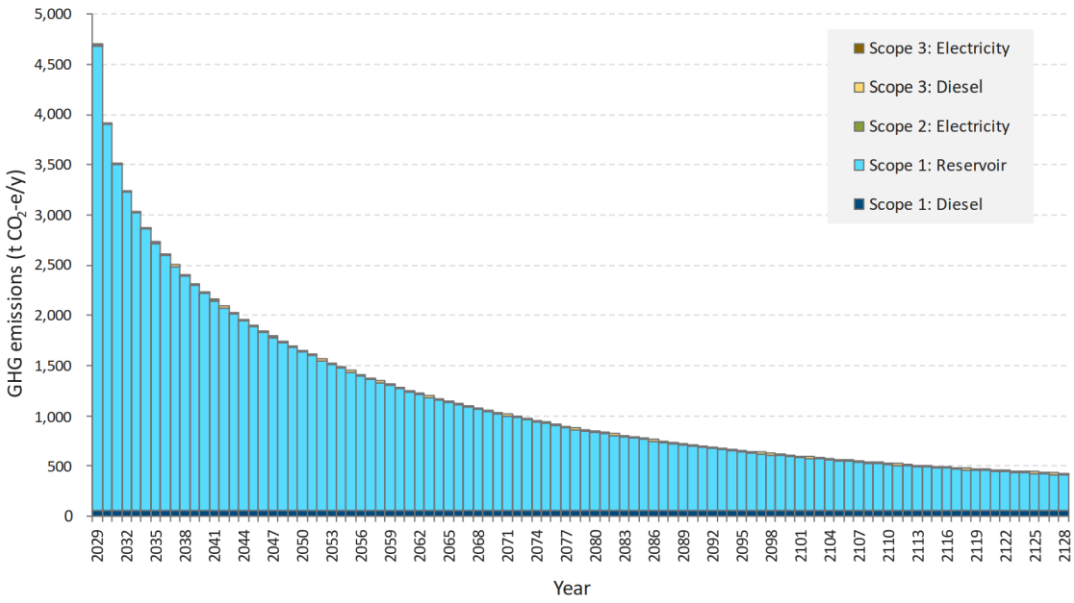


Figure 6-74 Components of annual GHG emissions over the lifetime of the Proposal

Source: EMM Appendix O

Summary

Scope 1, 2 and 3 GHG emissions were calculated for the 18-month period of construction for the Proposal, and on an annual basis over the Proposal's operational lifetime (assumed in G-res to be 100 years).

Construction of the Proposal would emit around 21,000 tonnes of CO_2-e, with scope 1 emissions representing around 86% of the total. The main contributors to construction emissions would be diesel combustion and vegetation removal (i.e. lost carbon sink).

For the operation of the Proposal, in the nominal opening year of 2028 there would be an increase in all-scope GHG emissions of around 4,700 t CO_2-e/year. By far, the largest component would be the reservoir (and hence scope 1 emissions), which represented 98% of the total. Over the operational lifetime of the Proposal, the impact of the Proposal would decrease, again due almost entirely to a reduction in emissions from the reservoir. The reservoir contribution was projected to decrease from around 4,700 t CO_2-e/year at opening to around 360 t CO_2-e/year by 2128.

For construction, the total (all scope) GHG emission for the Proposal would represent a very small percentage of emissions in NSW and Australia in 2028, at around 0.02% and 0.005% respectively. The operation of Proposal would also represent a very small contributor to GHG emissions in NSW and Australia in 2029, at around 0.006% and 0.001% respectively. The contribution would remain small further into the future.

6.10.4 Mitigation measures

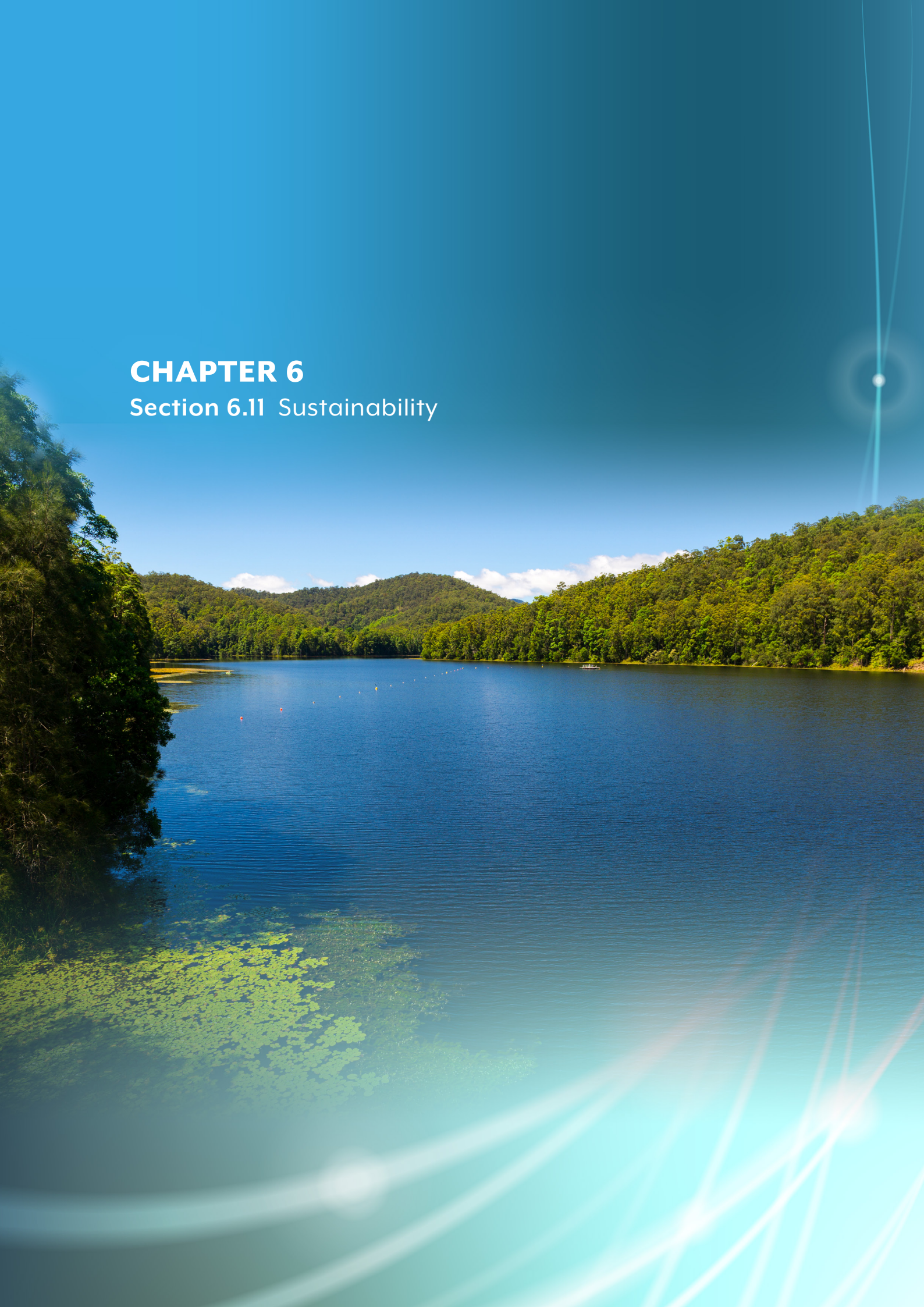
This section identifies the mitigation measures that would be implemented during detailed design, construction and operation of the Proposal to manage climate change and GHG emissions. The mitigation measures are outlined in Table 6-91 for climate change and Table 6-92 for GHG emissions.

Table 6-91 Climate change risk mitigation measures

Identifier	Impact	Mitigation measures	Responsibility	Timeframe
CC-1	Design-related impacts	Review and consider the planned and additional measures that have been identified in the climate change risk assessment and risk register and identify where specific design changes are potentially required to be addressed in the detailed design stage.	Design contractor	Detailed design
CC-2	Operational-related impacts	Take steps to identify and integrate relevant planned and additional measures into operational requirements, as well as ensuring the ongoing monitoring and review of the climate change risk through design, construction and operational phases.	Tweed Shire Council	Operation
CC-3	Climate change risk assessment and climate projection data review	Monitor the need to review and update the climate change risk assessment in alignment with the release of revisions to the NSW NARCliM modelling dataset (i.e. NARCliM 2.0).	Design contractor Construction contractor	Detailed design, pre-construction, construction

Table 6-92 GHG emissions mitigation measures

Identifier	Impact	Mitigation measures	Responsibility	Timeframe
GG-1	Construction related GHG emissions	The construction works would be conducted to minimise GHG emissions as follows: • Construction materials would be sourced, as much as possible, from within or close to the Proposal site to reduce fuel use from transport. • The re-use of cleared material will be maximised. • Appropriately sized equipment will be used for construction activities. • Construction vehicles and equipment will be maintained in good working order, and according to manufacturers' specifications.	Construction contractor	Pre-construction, construction
GG-2	Operation related GHG emissions (decomposition of organic matter)	Partial clearing of the new FSL would be undertaken during construction to reduce GHG emissions associated with inundation of the reservoir. The clearing would not include all trees, but selected areas or trees may be removed to improve water quality. The removal of some trees would not be possible due to, for example, landslip hazards or erosion. The locations of trees for removal would be decided during detailed design.	Design contractor Construction contractor	Detailed design, pre-construction, construction



CHAPTER 6

Section 6.11 Sustainability

6.11 SUSTAINABILITY

This chapter provides a detailed outline of the requirements, considerations and options for the delivery of the sustainability aspects of the SEARs as outlined Table 6-93. It includes details on how the principles of ESD can be applied and reviewed during the design, construction and operation of the Proposal.

Table 6-93 Relevant SEARs -- sustainability

Relevant Key Issue Requirement/s	Where addressed
1. The Proponent must assess the proposal against the current guidelines including targets and strategies that are in place to improve government efficiency in use of water, energy and transport.	Section 6.11.4
2. The Proponent must detail the power generation of any hydro power component of the proposal.	The proposal to construct a mini-hydro plant to generate electricity from discharges from the raised dam was investigated. The optimal mini-hydro size was determined by comparing the frequency of various discharge and spilling flows from the dam to the operating range of various mini-hydros. It was found that the best option was a mini-hydro with a maximum output of 359kW and a flow range of 460 to 1380 L/sec. The cost of the mini-hydro plus upgrades to the transformer and electricity network to receive the power generated was estimated in 2019 at approximately $3m. It was estimated the annual return would be approximately $60,000. As a comparison a $3m investment in solar would provide a 2+MW solar farm and the return from that solar farm in terms of kWhs would be 3 times that of the mini-hydro. Further, a solar farm would provide energy to be used “behind” the meter providing further savings to Council. Based on this assessment the proposal to construct as mini-hydro was not considered further.
3. An assessment must be conducted against an accredited ESD rating system or an equivalent program of ESD performance. This should include a minimum rating scheme target level.	Section 6.11.3 to section 6.11.6
4. Identify how ESD principles (as defined in section 193 of the EP&A Regulation) are incorporated in the design and ongoing operation of the project.	Section 6.11.1
5. Demonstrate how the project minimises greenhouse gas emissions (reflecting the Government’s goal of net zero emissions by 2050) and consumption of energy, water (including water sensitive urban design) and material resources.	Section 6.10 - Climate Change Risk (including assessment of greenhouse gas emissions from construction and operation of the project)

6.11.1 Assessment approach

Incorporating ESD principles in the design, construction and operation phases of the Proposal

ESD principles would be incorporated into the design, construction and ongoing operation of the Proposal through focused design that considers environmental impacts and includes the recommendations provided in section 6.11.6.

This section describes how ESD principles (as defined in Part 8, Division 5, section 193 of the EP&A Regulation) would be incorporated in the design, construction and ongoing operation phases of the Proposal. The ESD principles are outlined below, as well as how each principle will be satisfied for the Proposal:

a) The precautionary principle

The precautionary principle is 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, any 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.

Assessments have been undertaken to understand the potential environmental impacts during construction and operation of the Proposal. The Proposal has been designed to avoid environmental impacts where practicable, and mitigation measures are proposed to mitigate and manage the impacts where unavoidable. Any Proposal-related decisions would be guided by careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment and by assessment of the risk-weighted consequences of various options.

b) Intergenerational equity

Intergenerational equity is that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

Future generations would benefit from the improved security of the water supply to the Tweed Shire. The vulnerability of the Proposal to climate change risks has been assessed in Chapter 6 section 6.10. Appropriate mitigation and/or management of risks have been identified to ensure that the Proposal is resilient to climate change risks and that operations are maintained in future time periods.

This EIS has been prepared to meet the SEARs (Appendix A), which require that the EIS meet the minimum form and content requirements in section 190 and section 192 of the EP&A Regulation. Accordingly, assessments have been undertaken to understand the potential impacts that may occur during the construction and operational phases of the Proposal, as required by the SEARs. Matters assessed are included in Chapter 6.

Appropriate mitigation measures have been identified in Chapter 6 to minimise environmental impacts during construction and operation. A summary of mitigation measures is provided in Chapter 7.

c) Conservation of biological diversity and ecological integrity.

Conservation of biological diversity and ecological integrity should be a fundamental consideration.

The BDAR (Appendix H) and Aquatic Ecology impact assessment (Appendix I) have been prepared in accordance with relevant legislation and aim to minimise significant impacts on any threatened

species, endangered communities or their habitat as far as practical. Any significant residual impacts on biodiversity would be offset.

d) Improved valuation and pricing of environmental resources.

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 Proposal has been designed to minimise adverse environmental impacts through an option selection process that includes the consideration of environmental factors and avoidance, mitigation or management of environmental impacts where impacts may potentially occur.

In 2009, Council commissioned an options study to augment the Tweed District water supply (MWH 2009), detailed in section 2.4.1.

The options selection study adopted a multi-criteria analysis (MCA) of options, which included the following environmental factors as part of the assessment criteria:

- planning obligations
- established technologies and feasibility
- environmental constraints
- social acceptability
- legislative acceptability
- cultural heritage impacts
- greenhouse gas and energy consumption.

The 2009 options study has been supplemented with another MCA of options commissioned by Council in 2024 and is further detailed in section 2.4.2.

Any Proposal-related decisions would consider environmental factors in a cost-effective way and be guided by the whole-of-life costs of providing goods and services.

Relevant ESD performance measures

The United Nations World Commission on the Environment and Development, in its report *Our Common Future* (UNWCED 1987), describes ecologically sustainable development (ESD) as 'a concept that aims to meet the needs of the present generation without compromising the ability of future generations to meet their own needs, while also ensuring the protection and preservation of the natural environment'. It involves finding a balance between economic growth, social progress and environmental protection.

The most well-known and commonly applied ESD rating tool for infrastructure projects in Australia is the infrastructure sustainability (IS) rating tool. It is facilitated by the Infrastructure Sustainability Council and applies to large infrastructure projects with a capital value over $100 million.

The rating tool includes 16 categories covering environmental, economic, social and governance performance measures. For projects with a capital value between $20 million and $100 million, a smaller assessment tool is available, called IS Essentials. In addition to the IS rating, the Hydropower Sustainability Standard assesses the sustainability performance of hydropower projects. It is facilitated by the International Hydropower Association and has 12 ESD performance requirements. These rating tools and their applicability to the Proposal are discussed in section 6.11.3.

The NSW Government Resource Efficiency Policy (GREP) (NSW Office of Environment 2014) was released in 2014 and updated in 2019 to help the NSW Government to achieve its commitment to making the State more sustainable, liveable and resilient. The policy applies to NSW government agencies only; however, local governments are encouraged to adopt the policy. The GREP sets minimum standards to drive efficiency in energy, water, waste and air quality. The SEARs require the Proposal to be assessed against current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.

ESD assessment

The approach to assess the Proposal against an accredited ESD rating system or equivalent and the NSW GREP is as follows:

- Identify relevant ESD-related legislation and accredited ESD assessment systems (section 6.11.2)
- Assess the applicability to the Proposal and SEARs including doing a gap analysis and consistency check against GREP, relevant legislation and the ESD assessment SEARs (section 6.11.3)
- Assess the Proposal using the IS materiality assessment to identify a target score (section 6.11.4)
- Make a recommendation on how to apply an accredited ESD rating system or an equivalent program of ESD performance during Proposal delivery (section 6.11.6).

6.11.2 Identification of relevant ESD legislation, guidelines and assessment systems

The following section outlines relevant Commonwealth, NSW and Council ESD-related legislation, guidelines and assessment systems. This material provides a baseline for evaluating ESD assessment frameworks and identifies specific ESD targets for the Proposal to deliver.

Relevant legislation

The ESD-related legislation detailed in Table 6-94 has been deemed relevant to the Proposal.

Table 6-94 Relevant ESD-related NSW and Commonwealth legislation

Legislation	Description
Environmental Planning and Assessment Act 1979 (EP&A Act)	The EP&A Act aims to 'facilitate ecologically sustainable development by integrating relevant, economic, environmental and social considerations in decision making about environmental planning and assessment'.
Environmental Planning and Assessment Regulation 2000 (EP&A Regulation)	The EP&A Regulation aims to guide the development of infrastructure projects to minimise environmental and ecological impacts. ESD principles (as defined in Part 8, Division 5, section 193 of the EP&A Regulation) have been recommended to be incorporated in the design and ongoing construction and operation phases of the Proposal. ESD principles and the response to each are outlined in section 6.11.1.

Legislation	Description
Water Management Act 2000 (WM Act)	The WM Act aims to 'provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular: (a) to apply the principles of ecologically sustainable development'.
Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) (EPBC Act)	The EPBC Act aims to 'promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources'.
National Greenhouse and Energy Reporting Act 2007 (Commonwealth) (NGER Act)	The NGER Act provides a national framework for reporting on greenhouse gas emissions, energy production and consumption.

National policies

Two national ESD-focused policies are relevant to the Proposal, as outlined in Table 6-95. Waste and procurement are also discussed in section 6.9.

Table 6-95 National sustainability guidelines

Guideline	Description
National Waste Policy: Less Waste, More Resources (Environment Protection and Heritage Council (EPHC) 2009)	The policy provides a framework for government, business and industry to improve waste management nationally.
Sustainable Procurement Guide (Commonwealth of Australia 2013)	The guide provides a framework for sustainable procurement and purchasing within infrastructure projects.

NSW policies

The NSW policies relevant to sustainability are outlined in Table 6-96.

Table 6-96 NSW sustainability guidelines

Guideline	Description
NSW Climate Change Policy Framework (OEH 2016b)	The framework facilitates the NSW Government's planning for climate risks and includes the assessment and management of climate change risks to government-owned assets.
NSW Waste and Resource Strategy (NSW Environment Protection Authority 2014)	The policy aligns with the NSW Government's waste reforms that encourage innovation and improve recycling behaviour.
NSW Government Resource Efficiency Policy 2019	The policy provides leadership in resource efficiency and is aimed at reducing the operating costs of NSW Government agencies.

An assessment of climate change is provided in section 6.10 and an assessment of waste is provided in section 6.9.

The SEARs specifically require the Proposal to be assessed against the GREP. The aim of GREP is to reduce the NSW Government's operating costs and lead by example in increasing the efficiency of its resource use. The objectives of the GREP 2019 and the relevance of each objective to the proposal are noted in Table 6-97.

Table 6-97 Government Resource Efficiency Policy objectives and their relevance to the Proposal

Area of focus	Objective	Relevant to the Proposal (Y/N)	Relevant Proposal phase
Energy	Save energy across all government sites	Y	Construction and operation
	Minimum National Australian Built Environment Rating System (NABERS) Energy ratings for offices and data centres	N	N/A
	Minimum standards for new electrical appliances and equipment	Y	Design
	Minimum standards for new buildings and fit outs	N	N/A
	Whole-of-government solar target	N	N/A
	Minimum fuel efficiency standards for new light vehicles	N	N/A
	Purchase 6% GreenPower	Y	Construction and operation
Water	Report on water use	Y	Construction and operation
	Minimum water standards for office buildings	N	N/A
	Minimum standards for new water-using appliances	N	N/A
Waste	Report on the top three waste streams	Y	Construction and operation
Clean air	Air emission standards for mobile non-road diesel plant and equipment	Y	Construction
	Low-VOC (Volatile Organic Compounds) materials	Y	Design

The policy will continue to drive resource efficiency by NSW Government agencies in the four focus areas. Adopting the policy could assist the Proposal in delivering more sustainable outcomes in energy usage, water usage, waste generation and air emissions. An assessment of the overlap between the GREP and the IS rating is provided in section 6.11.3.

Tweed Shire Council sustainability

The Council Sustainability Program is delivered through the Sustainability and Environment Unit and focuses on climate change, sustainable living, saving energy and sustainable operations.

Council has developed *the Sustainable Design Guidelines for Council Buildings and Infrastructure* (TSC 2018h) for consideration by asset owners, project managers and designers, to ensure the best environmental performance possible is achieved for Council buildings. These guidelines include requirements for energy and water efficiency, waste minimisation, the use of local native plant species for landscaping, and design that reduces reliance on the motor vehicle for facility access.

Council has implemented a range of initiatives to embed sustainability into the procurement process. Council implements an Environmental Performance Schedule, which includes environmental and sustainability criteria for certain purchases. In addition, Council also implements a Procurement Standards Sustainable Procurement Product List which outlines minimum requirements for certain products.

Council is committed to reducing the environmental footprint of its operations. Council has developed specific strategies, such as Towards Zero Waste. This strategy embeds circular economy principles across Council operations and maximises recovery of resources.

Council's *Climate Change Management Policy* (TSC 2020b) aims to communicate Council's principles, objectives, targets and priorities in addressing climate change, and establishes a framework to build resilience within the organisation, the community and landscape. Council has prepared an Interim Climate Change Action Plan and Climate Change Risk Assessment to reduce Council's environmental footprint and enhance the resilience of its operations.

Council publishes an annual Environmental Sustainability Performance Report, which provides an annual snapshot of greenhouse gas emissions (scope 1 and scope 2 emissions), electricity use, materials and waste tracking from Council operations. Environmental Sustainability Performance Reports since 2019 are accessible on the Council website.

6.11.3 Relevant accredited ESD rating systems

The suitability of four sustainability frameworks for assessing the ESD performance of the Proposal include:

- Hydropower Sustainability Standard (accredited)
- IS v2.1 (accredited)
- IS Essentials (accredited)
- Sustainability self-assessment (equivalent program of ESD performance).

As outlined in the SEARs, the Proposal is required to include an assessment against an accredited ESD rating system or an equivalent program of ESD. This is to ensure that sustainability and ESD performance is applied from design to operation and that the Proposal aligns with relevant legislation, policy and guidelines outlined in section 6.11.2.

The following section reviews the applicability of the identified sustainability assessments to the Proposal.

Hydropower Sustainability Standard

The Hydropower Sustainability Standard is the only global certification scheme aimed at certifying and identifying the sustainability expectations for hydropower projects around the world. As such, it is the driving mechanism to making sustainable hydropower the norm. Projects that are eligible to be assessed and certified include:

- run-of-the-river hydropower
- storage hydropower
- pumped storage hydropower
- multipurpose dams with a hydroelectrical component.

The framework consists of 26 guideline topics and measures performance above and below defined good practice. This enables projects to benchmark performance in a comprehensive way. In addition, the Hydropower Sustainability ESD Gap Analysis tool launched in 2018 can be used to check for gaps against good practice on targeted topics and includes a gap management plan.

Applicability

The Hydropower Sustainability Standard provides a comprehensive framework to assess ESD performance. This framework is closely matched to the relevant legislative, policy and frameworks captured by the Proposal and provides a measure of performance above or below a baseline level.

The Hydropower Sustainability Standard does not align with the GREP, as it does not include specific targets around the reduction of energy and materials. This presents a risk of not addressing all the SEARs.

Additionally, as the Proposal does not include or plan to generate hydropower, it falls outside of the required criteria for using the Hydropower Sustainability Standard. This standard is therefore not applicable.

Infrastructure Sustainability Council rating tools

The IS Rating Scheme supports infrastructure projects to be delivered more socially, culturally, environmentally and economically sustainable. It is intended for use by stakeholders, including proponents, designers, and construction and operation project team members to guide sustainable design, procurement, construction and operation of infrastructure projects and assets.

The IS Rating Scheme aims to promote leading sustainability practices to support broader shifts in the market. This is to be achieved and validated through an evidence-based assessment and independent verification. The scheme addresses a broad spectrum of asset types, including, but not limited to, airports, energy, ports, water, rail, waste and roads.

The IS Rating Scheme has been built to support the delivery of best practice sustainable outcomes, allowing for independent assessment and rewarding sustainability at each stage of the infrastructure lifecycle, from early planning through to design and construction and into the operational stage. The timeline to which the IS rating tools can be applied is mapped out Figure 6-75.

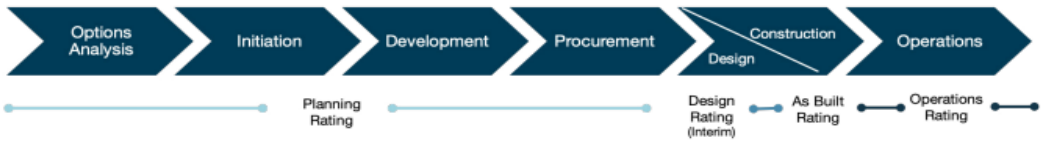


Figure 6-75 IS delivery timeline Source: ISv2.1 Infrastructure Sustainability Technical Manual

Source: Infrastructure Sustainability Council 2021

As seen above, the Design and As Built ratings can be undertaken with or without having completed an IS Planning rating. This allows the Design rating to act as an interim verification step to follow the completion of the Proposal design. When the As Built component of the rating has been verified, the Design rating score is replaced with the final Design and As Built rating score.

The IS Rating Scheme assesses sustainability performance using a point score across 16 categories, each of which addresses a specific aspect of sustainability performance. Each category has one or more corresponding credits. Each of the credits (other than Innovation) contain criteria that address a specific aspect of sustainability performance. The themes, categories and credits assessed in the IS rating are included in Table 6-98.

Table 6-98 Infrastructure sustainability themes and categories

Theme	Category	Credit	Credit intent
Governance	Place (Pla)	Pla-2 Urban and Landscape Design	To create infrastructure that has been influenced by the local context, fits its setting, and meets the needs of the people that will use it, while preserving and enhancing scenic, aesthetic, cultural, community and environmental resources and values.
	Leadership and Management (Lea)	Lea-1 Integrating Sustainability	To embed the Proposal's sustainability commitment, objectives and targets into governance and continuous improvement processes, and to publicly commit to and report on progress.
		Lea-2 Risks and Opportunities	To identify, assess and manage key sustainability risks and opportunities relevant to the Proposal context and meaningful to affected stakeholders.
		Lea-3 Knowledge Sharing	New or updated knowledge on issues and outcomes important to infrastructure sustainability is shared between projects and more widely within industry.
	Sustainable Procurement (Spr)	Spr-1 Sustainable Procurement Strategy	To establish a procurement framework which enables achievement of the Proposal's sustainability objectives through managing the material sustainability risks and opportunities in the supply chain.
		Spr-2 Supplier Assessment and Selection	To select suppliers, goods or services that contribute to achieving the Proposal's sustainability objectives and engage with the market to drive innovation.
		Spr-3 Contract and Supplier Management	To manage and reward supply chain performance against the Proposal's sustainability objectives and targets.
	Resilience (Res)	Res-1 Climate Change and Natural Hazards Risks	To identify, assess and treat risks to the asset associated with climate change and natural hazards.
		Res-2 Resilience Planning	To develop resilient infrastructure that contributes to broader community resilience.
	Innovation (Inn)	Inn-1 Innovation	To reward innovative initiatives and outcomes in delivering sustainable infrastructure.
Economics	Options Assessment (Ecn)	Ecn-1 Options Assessment and Significant Decisions	To incorporate sustainability criteria and whole of life considerations into decision making processes for significant Proposal initiatives developed in the design and construction phases and hence increase sustainability outcomes.
Environment	Energy and Carbon (Ene)	Ene-1 Energy Efficiency and Carbon Reductions	To reduce energy use and carbon emissions across the infrastructure life cycle and drive towards net zero carbon.
		Ene-2 Renewable Energy	To drive towards net zero carbon by increasing the development and use of renewable energy.

Theme	Category	Credit	Credit intent
		Ene-3 Offsetting	To drive towards net zero carbon through offsetting any residual carbon emissions from a project's construction and operational activities.
	Environmental Impacts (Env)	Env-1 Receiving Water Quality	To maintain or improve the environmental quality of local streams, rivers and water bodies.
		Env-2 Noise	To manage noise impacts and improve amenity for noise receptors.
		Env-3 Vibration	To manage vibration impacts and improve amenity for vibration receptors.
		Env-4 Air Quality	To manage air quality impacts and improve air quality for receptors.
		Env-5 Light Pollution	To minimise light pollution and improve amenity for light receptors.
	Resource Efficiency and management (Rso)	Rso-1 Resource Strategy Development	To identify, implement and manage resource efficiency expectations for each phase of the infrastructure life cycle and to achieve positive circular economy outcomes.
		Rso-2 Management of Contaminated Material	To eliminate or control risks to people and the environment from contaminated material and to maximise use of sustainable remediation options for the management of such material.
		Rso-3 Management of Acid Sulfate Soil	To minimise adverse impacts on people and the environment when addressing the risks associated with acid sulfate soils.
		Rso-4 Resource Recovery and Management	To drive beneficial reuse of resource outputs and reduce the volume of resources sent to landfill.
		Rso-5 Adaptability and End of Life	To plan for the adaptation of infrastructure assets as their utilisation requirements change and for sustainable disassembly of infrastructure assets at end of life.
		Rso-6 Material Life Cycle Impact Measurement and Management	To design and construct the Proposal in ways that reduce the environmental impacts of materials across the life cycle of the infrastructure asset.
		Rso-7 Sustainability Labelled Products and Supply Chains	To utilise sustainability labelled products and supply chains to address supply chain risks and opportunities.
	Water (Wat)	Wat-1 Avoiding Water Use	To reduce water demand across the life cycle of the infrastructure asset.
		Wat-2 Appropriate Use of Water Sources	To use water sources of suitable quality for the Proposal's water end uses, while minimising demand on potable water supply, protecting the environment and supporting the use of alternative water sources.
	Ecology (Eco)	Eco-1 Ecological Protection and Enhancement	To identify, protect and enhance ecological value.

Theme	Category	Credit	Credit intent
Social	Stakeholder Engagement (Sta)	Sta-1 Stakeholder Engagement Strategy	To design and implement a stakeholder engagement strategy which recognises key stakeholder and community values, interests and concerns, and promotes inclusive, participatory approaches.
		Sta-2 Stakeholder Engagement and Impacts	To implement high-quality stakeholder engagement where key stakeholders can contribute to and have influence on project outcomes.
	Legacy (Leg)	Leg-1 Leaving a Lasting Legacy	To implement high-quality stakeholder engagement where key stakeholders can contribute to and have influence on project outcomes.
	Heritage (Her)	Her-1 Heritage Protection and Enhancement	To maintain or enhance local heritage values across all infrastructure phases and raise awareness of these values with Proposal stakeholders and the community.
	Workforce Sustainability (Wfs)	Wfs-1 Jobs, Skills and Workforce Planning	To increase industry capacity and capability through identifying skill needs and gaps, leveraging employment opportunities, and improving outcomes for people.
		Wfs-2 Workplace Culture and Wellbeing	To increase industry capacity and capability through identifying skill needs and gaps, leveraging employment opportunities, and improving outcomes for people.
		Wfs-3 Diversity and Inclusion	To support a positive workplace culture and employee health and well-being.
		Wfs-4 Sustainable Site Facilities	To support the development of a diverse and inclusive working environment.

Projects completing an IS rating are scored out of 100 points, with 10 bonus points available for innovation. Scores are divided into four award categories:

- Scores from 20 to <34.9 points: Bronze – indicates that a project is achieving better than business as usual
- Scores from 35 to <59.9 points: Silver – indicates that a project is achieving good sustainability practices well beyond business as usual
- Scores from 60 to <79.9 points: Gold – indicates that a project is generally achieving best practice in sustainability within Australia
- Scores from 80 to 100 points: Platinum – indicates the project is close to world's best practice.

The final score for projects targeting an IS rating is calculated through completing a four-stage process during which sustainability performance is reviewed:

1. First stage: Registration – establishes a formal agreement between the Infrastructure Sustainability Council and the registrant.
2. Second stage: Assessment – requires the project or asset management team to measure and evaluate their sustainability performance and determine their rating achievement using the IS rating tool and associated guidelines. Assessment will continue as the project or asset proceeds through the relevant infrastructure life cycle phases.
3. Third stage: Verification – verification of the project or asset assessment occurs over two rounds.
    i. Round 1 – the verifiers review the submitted self-assessment including all evidence and agree a verified level and score. They also advise projects and what is needed to meet the target level.
    ii. Round 2 – provides a second opportunity to update any amended target levels and include any additional evidence to address the comments from round one. The outcomes of the round 2 verification will be provided to the assessor by the IS project manager.
4. Fourth stage: Certification – following the verification process, the verifiers will provide a recommendation to the Infrastructure Sustainability Council on the score and rating level the Proposal has achieved. Following certification, rating partners will be able to publicly claim an IS rating for the infrastructure asset.

The is rating process is outlined in Figure 6-76.

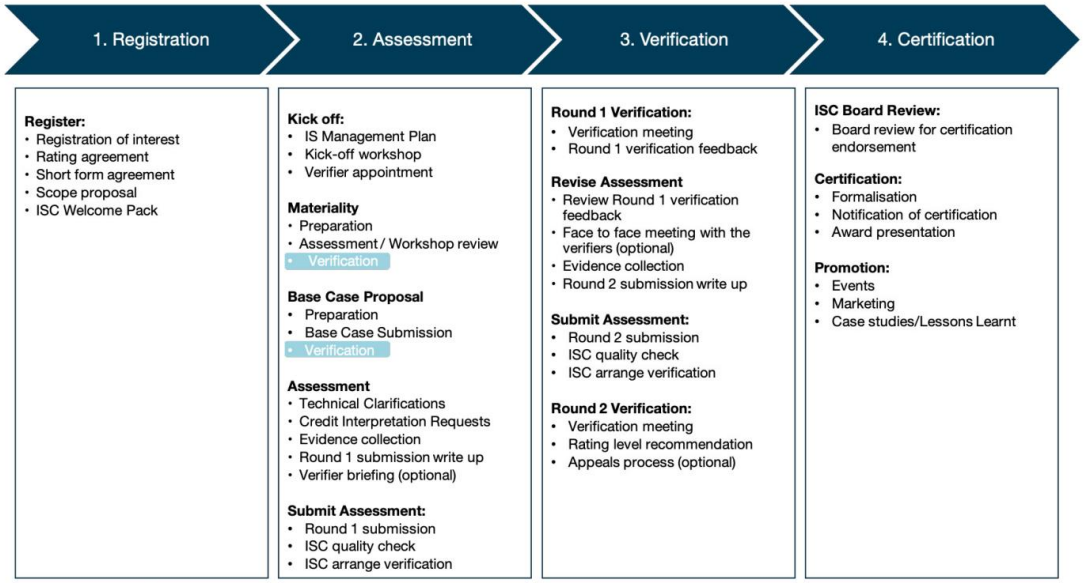


Figure 6-76 IS rating process Source: ISv2.1 Infrastructure Sustainability Technical Manual

Source: Infrastructure Sustainability Council 2021

Two IS rating tools are applicable to the Proposal:

1. IS v2.1.
2. IS Essentials.

IS v2.1

The IS v2.1 rating framework is built to assess sustainability within large infrastructure projects valued at over $100 million. The rating tool includes 16 categories, which include environmental, economic, social and governance performance measures. Historically, this rating framework has been applied across different projects. It provides a proven method for assessing sustainability performance.

IS v2.1 is built upon the initial v1.2 rating framework and provides an up-to-date comprehensive scheme for assessing sustainability. Any changes to the categories and evidence required for assessment have been implemented to reflect compliance with the best practice sustainability initiatives and incorporated feedback from the original v1.2 rating system. This means that the IS v2.1 sustainability categories are now more closely aligned with the United Nations (UN) Sustainable Development Goals (SDGs).

Projects that register to undertake a rating after 31 December 2023 will be required to pursue a version 2.1 rating. Version 1.2 is retired and will no longer be applied to new registrations, including the Proposal.

Applicability

The IS rating tools provide a comprehensive and proven framework to address legislation, Acts and guidelines related to the Proposal. Table 6-99 outlines how specific categories within the IS rating framework are related to the relevant legislation, policy and guidelines identified in section 6.11.2.

Table 6-99 Legislation, policies and guidelines related to IS v2.1 categories and credits

Legislation, policy or guideline	Relevant IS v2.1 credits and levels (L)*	
Protection of Environment Administration Act 1991 (POEA Act)	Env-1 L1 Env-2 L1 Env-3 L1	Wat-2 L1 Eco-1 L1 Env-4 L1
Environmental Planning and Assessment Act 1979 (EP&A Act)	Pla-2 L1 Lea-1 L1 Env-1 L1 Env-2 L1 Env-3 L1	Wat-2 L1 Eco-1 L1 Her-1 L1 Env-4 L1
Environmental Planning and Assessment Regulation 2000 (EP&A Reg)	Pla-2 L1 Lea-1 L1 Env-1 L1 Env-3 L1 Env-2 L1 Env-4 L1	Wat-2 L1 Eco-1 L1 Her-1 L1 Rso-2 L1
Water Management Act 2000 (WM Act)	Pla-2 L1 Wat-1 L1	Her-1 L1 Wat-2 L1
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Commonwealth)	Env-1 L1 Env-2 L1 Env-3 L1	Wat-2 L1 Eco-1 L1 Env-4 L1
National Greenhouse and Energy Reporting Act 2007 (NGER Act) (Commonwealth)	Ene-1 L1 Ene-2 L1	Ene-3 L1 Rso-6 L1
National Waste Policy: Less Waste, More Resources (Environment Protection and Heritage Council (EPHC) 2009)	Rso-1 L1 Rso-4 L1	Rso-6 L1
Sustainable Procurement Guide (Commonwealth of Australia 2013)	Spr-1 L1 Spr-2 L1 Spr-3 L1 Rso-1 L1	Rso-4 L1 Rso-5 L1 Rso-6 L1 Rso-7 L1
NSW Climate Change Policy Framework (OEH 2016b)	Ene-1 L1 Ene-2 L1	Ene-3 L1 Res-1 L1
NSW Government Resource Efficiency Policy 2019	Spr-1 L1 Spr-2 L1 Spr-3 L1 Rso-1 L1	Rso-4 L1 Rso-5 L1 Rso-6 L1 Rso-7 L1
NSW Waste and Resource Strategy (NSW Environment Protection Authority 2014)	Rso-1 L1 Rso-4 L1	Rso-5 L1 Rso-6 L1
Tweed Shire Council Climate Change Management Policy (2020)	Ene-1 L1 Ene-2 L1 Ene-3 L1	Res-1 L1 Res-2 L1

** See Table 1.6 for credit detail*

The IS rating tools additionally provide a comprehensive and accepted framework through which sustainability can be assessed. The framework incorporates the aims of the GREP as outlined in Table 6-100.

Table 6-100 Government Resource Efficiency Policy aims mapped to IS v2.1 credits

Area of focus	Target	IS rating v2.1 credit	IS rating v2.1 credit target or requirement
Energy	Implement energy savings projects at eligible sites or achieve aggregate energy savings of at least 10%.	Ene-1 L1	Reduce energy use and carbon emissions across the infrastructure life cycle and drive towards net zero carbon.
	All new electrical equipment purchased by the government must be at least 0.5 stars above the market average star rating or comply with high-efficiency standards specified.	Ene-1 L1-L3	Energy and carbon emissions reduction opportunities have been investigated across the infrastructure life cycle.
	Purchase a minimum of 6% GreenPower.	Ene-2 L0.18 (equivalent level for 6% Greenpower)	Drive towards net zero carbon by increasing the development and use of renewable energy.
Water	Report on water use. Agencies are strongly encouraged to set targets to reduce water use.	Wat-1 L1-3	Monitoring of water consumption during the construction.
Waste	Report on top three waste streams by both total weight and total cost. Agencies are strongly encouraged to take measures to reduce waste.	Rso-4 L1	Project resource output performance has been monitored and reported.
Clean air	Comply with European Union (EU) or United States Environmental Protection Agency (US EPA) standards when purchasing or leasing non-road diesel plant and equipment. Agencies will consider air emissions from contractor-supplied non-road diesel plant and equipment in tender processes for new buildings and infrastructure.	Env-4 L1	Construction measures to mitigate air quality impacts and meet the air quality goals established in Design have been implemented and monitored.
	All surface coatings and other VOC emitting products will comply with the Property NSW Guidance Note on Low-VOC Emission Materials.	Env-4 L1	Pollutants relevant to the project's scale, context and risk profile should be included in baseline studies, including volatile organic compounds (VOCs).

The IS v2.1 framework, outlined above, addresses the SEARs and provides a comprehensive and accepted framework under which ESD performance can be assessed. The framework is aligned with the NSW GREP – as such, it addresses material topics relevant to the Proposal (Table 6-100).

IS v2.1 provides a comprehensive and proven framework to address legislation, Acts and guidelines relevant to the Proposal (Table 6-99).

For these reasons, IS v2.1 is deemed applicable to the proposal.

IS Essentials

IS Essentials has been developed for projects with a capital value less than $100 million. It is currently in the pilot phase (as of Nov 2023).

The framework aims to provide sustainability leadership and performance assurance that is accessible, scalable and cost-effective for smaller-scale infrastructure. IS Essentials is driven by materiality and aligns with the UN SDGs.

IS Essentials is based on the existing IS v2.1 Technical Manual and was developed to specifically address market feedback by reducing the number of credits and criteria required for a rating. This aims to fit the needs of smaller projects without compromising on sustainability outcomes. As such, the IS Essentials rating provides significant manoeuvrability regarding which credits are pursued and can be tailored to delivering specific Proposal sustainability outcomes. The number of credits to be scoped in depends on the materiality assessment and capital costs associated with the Proposal, as outlined in Table 6-101.

Table 6-101 Number of credits required for each capex band (as of November 2023)

Capex band	Minimum number of credits to be scoped in
<$20 million	20
$20 million to <$50 million	25
$50 million to $100 million	30

Ten permanent credits are included in IS Essentials, with an additional 10 to 20 screened in as a result of the IS materiality assessment capital expenditure (capex) band. The Infrastructure Sustainability Council is working with proponents to pilot the tool and ensure that it is fit for purpose.

IS Essentials provides a cost-effective solution for projects under $100m in capex. Compared to IS v2.1, the requirements are the same; however, there are less credits to achieve the same number of points (100). As IS Essentials is focused on key material topics, it is likely to directly address key sustainability risks and opportunities and can be used to achieve the aims of the GREP and SEARs.

Applicability

The Proposal's current estimated capital expenditure exceeds 100 million. As a result, IS Essentials is not applicable.

Sustainability self-assessment

A sustainability self-assessment can be developed in alignment with, and equivalent to, IS v2.1. The sustainability self-assessment is conducted internally, rather than through external verification. The approach is commonly used to keep costs down while still delivering sustainability outcomes bespoke to the Proposal. It can be applied to projects of any capital value and a project can self-assess against the key material areas of sustainability to the equivalent outcomes of IS v2.1.

By completing a self-assessment, a project is ineligible to be verified and accredited with ISC, but it can engage a third party to verify or audit the sustainability outcomes. The self-assessment approach can be just as effective at delivering sustainability outcomes while reducing the significant costs associated with ISC verification. The self-assessment, however, must be developed to meet outcomes that are equivalent to those of IS v2.1, as required in the SEARs.

Applicability

The sustainability self-assessment approach provides a comprehensive framework under which ESD performance can be assessed as an alternative framework to the IS rating framework, while being equivalent to that framework. This process effectively addresses the SEARs outlined for the Proposal.

The self-assessment approach requires the development of bespoke sustainability performance requirements equivalent to that of the IS rating. This approach can generally deliver the same sustainability outcomes as an IS rating, while reducing the significant costs associated with registration and verification. It also has the added value of allowing a project to focus only on the

areas of most significance without impacting the ability to get verified and certified, further reducing the cost of implementation.

The sustainability self-assessment approach is deemed applicable to the Proposal.

Summary of applicability

Table 6-102 summarises the applicability of the assessed ESD tools to the Proposal.

Table 6-102 Applicability of ESD assessment tools

ESD assessment tool	Applicability
Hydropower Sustainability Standard	Not applicable
IS v2.1 rating tool	Applicable
IS Essentials	Not applicable as capital value is above $100 million
Sustainability self-assessment	Applicable

6.11.4 IS v2.1 materiality assessment

A materiality assessment can be completed for infrastructure projects to identify the most material areas of sustainability. The materiality assessment through an IS rating is informed by input from stakeholders on what is deemed to be the most material areas of sustainability that should be actively addressed throughout the Proposal lifecycle.

For this preliminary assessment, a desktop IS v2.1 materiality assessment was undertaken. The assessment asks a series of questions to calculate the materiality of each credit and allocates a 'materiality score'. The IS scorecard calculates a materiality score from 0 to 4 as follows:

- 0 – not material (scoped out)
- 1 – low materiality (half as important as moderate)
- 2 – moderate materiality
- 3 – high materiality (50% more important than moderate)
- 4 – very high materiality (twice as important as moderate).

A materiality score is used to redistribute the points, so credits which are assessed as high materiality (a materiality score of 3 or 4) are allocated more points, and credits with default or low materiality (2 or 1) are allocated fewer points. Any credits assessed as having a materiality score of 0 is 'scoped out' and removed from the rating requirements.

A preliminary materiality assessment has been completed for the Proposal using the IS v2.1 materiality assessment. The most material IS credits identified, receiving a materiality score of 4, are:

- Res-1: Climate change
- Res-2: Resilience planning
- Eco-1: Ecology
- Her-1: Heritage.

The second most material IS credits, receiving a materiality score of 3, are:

- Pla-2: Urban and Landscape Design
- Rso-1: Resource Strategy Development

- Rso-2: Management of Contaminated Materials
- Rso-4: Resource Recovery and Management
- Rso-5: Adaptability and End of Life
- Sta-1: Stakeholder Engagement Strategy
- Sta-2: Stakeholder Engagement and Impacts.

The materiality scores and points available for each credit in the v2.1 rating framework are outlined in Table 6-103.

The material topics identified above are addressed in both this sections and other sections of Chapter 6, which focuses on impacts to place, environment and culture. For the Proposal to achieve best practice ESD performance, it will require addressing and assessing its performance against these material topics.

A comparison of the Proposal's material topics and the default IS topics is outlined in Figure 6-77. The graph outlines the reallocation of points from areas of low materiality to areas of high materiality, compared to the default point allocation.

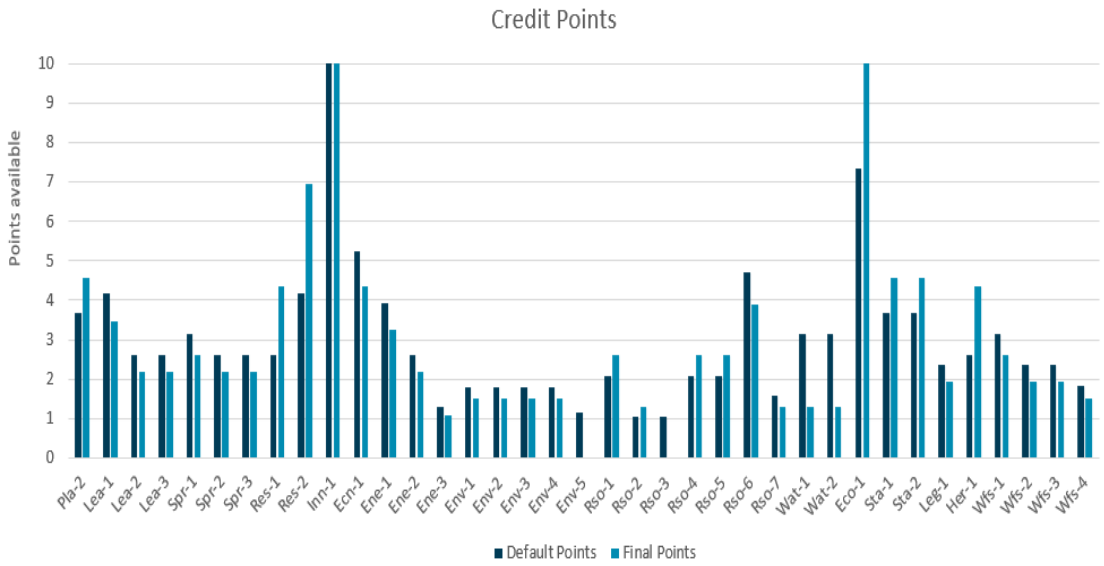


Figure 6-77 Materiality assessment and material topics for the Proposal

The IS v2.1 materiality assessment has been applied, and the results are outlined in Table 6-103, with the most material credits highlighted in orange.

Table 6-103 IS v2.1 materiality scores

Category	Credit	Default materiality	Final materiality	Default points	Final score
Place	Pla-2	2	3	3.67	4.56
	TOTAL			**3.67**	**4.56**
Leadership and Management	Lea-1	2	2	4.19	3.47
	Lea-2	2	2	2.62	2.17
	Lea-3	2	2	2.62	2.17
	TOTAL			**9.43**	**7.82**

Category	Credit	Default materiality	Final materiality	Default points	Final score
Sustainable Procurement	Spr-1	2	2	3.14	2.61
	Spr-2	2	2	2.62	2.17
	Spr-3	2	2	2.62	2.17
	TOTAL			**8.38**	**6.95**
Resilience	Res-1	2	4	2.62	4.34
	Res-2	2	4	4.19	6.95
	TOTAL			**6.81**	**11.29**
Innovation	Inn-1	2	2	10.00	10.00
	TOTAL			**10.00**	**10.00**
Economics	Ecn-1	2	2	5.24	4.34
	TOTAL			**5.24**	**4.34**
Energy and Carbon	Ene-1	2	2	3.93	3.26
	Ene-2	2	2	2.62	2.17
	Ene-3	2	2	1.31	1.09
	TOTAL			**7.85**	**6.51**
Environmental impacts	Env-1	2	2	1.81	1.50
	Env-2	2	2	1.80	1.49
	Env-3	2	2	1.80	1.49
	Env-4	2	2	1.80	1.49
	Env-5	2	0	1.15	0.00
	TOTAL			**8.37**	**5.98**
Resource Efficiency and Management	Rso-1	2	3	2.09	2.61
	Rso-2	2	3	1.05	1.30
	Rso-3	2	0	1.05	0.00
	Rso-4	2	3	2.09	2.61
	Rso-5	2	3	2.09	2.61
	Rso-6	2	2	4.71	3.91
	Rso-7	2	2	1.57	1.30
	TOTAL			**14.66**	**14.33**
Water	Wat-1	2	1	3.14	1.30
	Wat-2	2	1	3.14	1.30
	TOTAL			**6.28**	**2.61**
Ecology	Eco-1	2	4	7.33	12.16
	TOTAL			**7.33**	**12.16**
Legacy	Leg-1	2	2	2.36	1.95
	TOTAL			**2.36**	**1.95**

Category	Credit	Default materiality	Final materiality	Default points	Final score
Stakeholder engagement	Sta-1	2	3	3.67	4.56
	Sta-2	2	3	3.67	4.56
	TOTAL			**7.33**	**9.12**
Heritage	Her-1	2	4	2.62	4.34
	TOTAL			**2.62**	**4.34**
Workforce sustainability	Wfs-1	2	2	3.14	2.61
	Wfs-2	2	2	2.36	1.95
	Wfs-3	2	2	2.36	1.95
	Wfs-4	2	2	1.83	1.52
	TOTAL			**9.69**	**8.03**

6.11.5 Summary of the assessment

A summary of the results from the ESD assessment is provided in Table 6-104.

Table 6-104 Summary of the results from the ESD assessment

ESD assessment	Benefits	Disadvantages	Recommendation
Hydropower Sustainability Standard	Not applicable to the Proposal		
IS rating tool v2.1	Broad range of sustainability topics covered. Gives the most comprehensive application of sustainability and meets the SEARs most thoroughly.	Very expensive to implement. Limits innovation due to the strict nature of the credit requirements.	It is not recommended to undertake an IS v2.1 rating unless an IS certification is desired for reasons outside the SEARs.
IS Essentials	Not applicable to the Proposal		
Sustainability assessment	Lowest-cost option to deliver the SEARs. Can focus only on the areas of sustainability that are most material and are required to meet the SEARs.	Certification by the ISC is not possible; however, the Proposal could engage a third party to audit or verify the sustainability performance of the Proposal.	It is recommended to undertake a sustainability self-assessment for the Proposal, as outlined in section 6.11.3.

The sustainability self-assessment approach is the most cost-effective and flexible and does not limit innovation, unlike the certified versions. It is also effective in meeting the Proposal's SEARs, and because of its flexibility, there is allowance for potential additional sustainability objectives as agreed by the Proposal team.

The sustainability self-assessment equivalent to the IS v2.1 score of 42.6 points provides the Proposal with a sustainability framework that addresses the relevant legislation, guidelines and Acts. It provides a framework to which ecologically sustainable design principles can be applied and supports sustainable design, construction and operation of the Proposal.

6.11.6 Recommendations

Recommendation 1: Undertake a sustainability assessment

When considering the four ESD assessment options summarised in Table 6-104, it is recommended that the Proposal proceeds with a sustainability assessment equivalent to an IS v2.1 rating to embed sustainability and address the SEARs. This assessment cannot be completed until detailed design has commenced. This meets the 'or equivalent program of ESD performance' requirement of the SEARs, which state that '[a]n assessment must be conducted against an accredited ESD rating system or an equivalent program of ESD performance. This should include a minimum rating scheme target level'. It is recommended that the sustainability self-assessment aligns with the equivalent of an IS v2.1 score of 42.6 (Silver).

To meet the SEARs, the requirements that are equivalent to that of the IS credits and levels mentioned in Table 6-105 are recommended to be applied to the Proposal from early-phase detailed design as a minimum.

Table 6-105 IS v2.1 credits and levels that meet the requirements of the SEARs

Performance outcome	Secretary's Environmental Assessment Requirements	Current guidelines	Equivalent IS v2.1 credit and level to meet SEARs
Sustainability & ESD	1. The Proponent must assess the proposal against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	Government Resource Efficiency Policy (GREP) (State of NSW and EES, 2014)	Ene-1 L1 Ene-2 L0.18 Wat-1- L1 Rso-4 L1 Env-4 L1
	3. An assessment against an accredited ESD rating system or an equivalent program of ESD performance. This should include a minimum rating scheme target level.	Infrastructure Sustainability Rating Tool scorecard relating to energy and carbon for large infrastructure projects, ISCA – where relevant	Ene-1 L1 Ene-2 L0.18 Rso-6 L1
	4. Identify how ESD principles (as defined in section 193 of the EP&A Regulation) are incorporated in the design and ongoing operation of the project.		Environment category, all credits L1 Res-1 L1 Res-2 L1 Ecn-1 L1 Spr-1 L1 Spr-2 L1 Spr-3 L1
	5. Demonstrate how the project minimises greenhouse gas emissions (reflecting the Government's goal of net zero emissions by 2050) and consumption of energy, water (including water sensitive urban design) and material resources.		Ene-1 L1 Ene-2 L0.18 Wat-1- L1 Rso-4 L1

It is recommended that credits and levels are aligned to relevant legislation outlined in Chapters 4 and 6, and the most material areas of sustainability as identified in Table 6-103 are addressed in addition to the SEARs. As a result, it is recommended that the equivalent IS v2.1 credits and levels outlined in Table 6-106 are targeted as part of a sustainability self-assessment and that the Proposal targets an equivalent score of 42.6 (Silver). This table uses the weighted score, which is the score calculated through the materiality assessment as outlined in section 6.11.4, to calculate the targeted score.

Recommendation 2: Engage a Sustainability Manager

It is recommended that a Sustainability Manager be engaged post approval during detailed design and construction to ensure sustainability objectives are embedded. This approach will allow sustainability opportunities to be embedded into the design of the Proposal and considered from Proposal commencement.

Recommendation 3: Include the sustainability self-assessment requirements in design and delivery contracts

It is recommended that a requirement to undertake a sustainability self-assessment be included in design and delivery contracts. The contract should also include requirements for review and auditing needed to verify contract compliance.

Recommendation 4: Report sustainability objectives and achievements publicly

It is recommended that sustainability objectives be developed for the Proposal and be stated publicly. It is also recommended that achievements against the objectives be reported publicly at least annually.

Table 6-106 Recommended equivalent IS v2.1 credits to undertake in a sustainability assessment

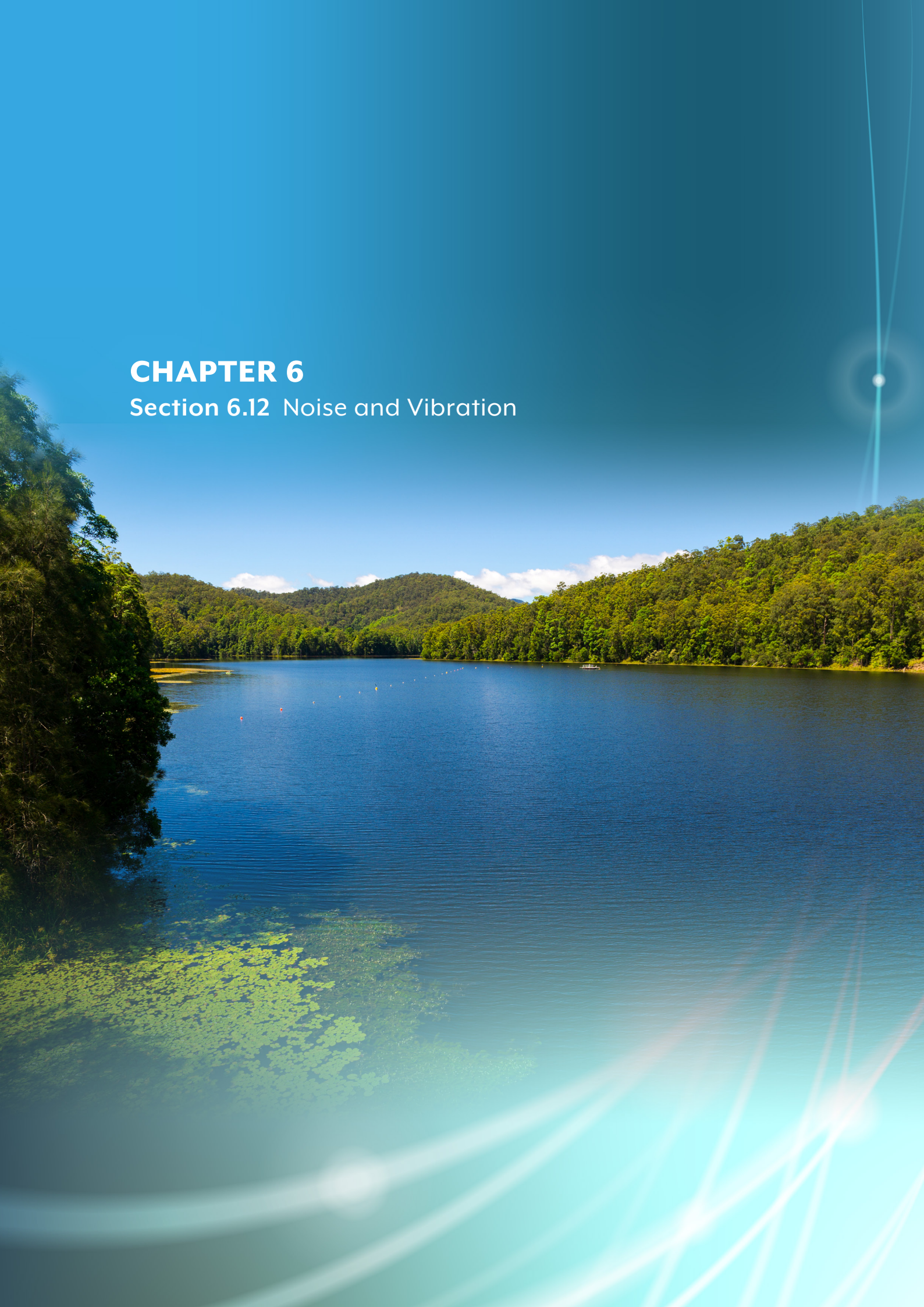
IS v2.1 category	IS v2.1 credit	Recommended equivalent min level	Weighted score	Alignment/justification
Place	Pla-2: Urban and Landscape Design	Level 1	1.52	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. Environmental Planning and Assessment Regulation 2000 (EP&A Reg). Environmental Planning and Assessment Act 1979 (EP&A Act).
Leadership and Management	Lea-1: Integrating Sustainability	Level 2	2.32	A Sustainability Management Plan and/or Strategy provides an overarching plan for delivery of the sustainability objectives.
	Lea-2: Risk and Opportunity	Level 2	1.45	It is good practice to consider sustainability-related risks and opportunities in standard project management risk and opportunity processes.
	Lea-3: Knowledge Sharing	Not targeted	0	This credit is not considered good value for money as it does not generate sustainability outcomes for the project or deliver the SEARs.
Sustainable Procurement	Spr-1: Sustainable Procurement Strategy	Level 1	0.87	NSW Government Resource Efficiency Policy 2019. Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation.
	Spr-2- Supplier Assessment and Selection	Level 2	1.45	NSW Government Resource Efficiency Policy 2019. Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation.
	Spr-3: Contract and Supplier Management	Level 2	1.45	NSW Government Resource Efficiency Policy 2019. Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation.
Resilience	Res-1: Climate and Natural Hazards Risks	Level 1	1.45	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. NSW Climate Change Policy Framework (OEH 2016a). Tweed Shire Council Climate Change Management Policy (2020).
	Res-2: Resilience Planning	Level 1	2.32	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. Tweed Shire Council Climate Change Management Policy (2020).

IS v2.1 category	IS v2.1 credit	Recommended equivalent min level	Weighted score	Alignment/justification
Innovation	Inn-1: Innovation	Not targeted	0	Innovations can be applied to the Proposal outside the IS v2.1 sustainability self-assessment.
Economics	Ecn-1: Options Assessment and Significant Decisions	Level 1	1.45	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation.
Energy and Carbon	Ene-1: Energy Efficiency and Carbon Reductions	Level 1	1.09	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. GREP – 'Save energy across all government sites' and 'Minimum standards for new electrical appliances and equipment' requirement. National Greenhouse and Energy Reporting Act 2007 (NGER Act) (Commonwealth). NSW Climate Change Policy Framework (OEH 2016a). Tweed Shire Council Climate Change Management Policy (2020).
	Ene-2: Renewable Energy	Level 0.18 (6% green electricity)	0.13	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. GREP 'Purchase 6% GreenPower' requirement. NSW Climate Change Policy Framework (OEH 2016a). Tweed Shire Council Climate Change Management Policy (2020).
	Ene-3: Offsetting	Not targeting	0	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. Not targeting this credit; however, the Proposal should consider a Net Zero Plan if aligned with the Proposal's sustainability objectives.
Environmental Impacts	Env-1: Receiving Water Quality	Level 1	0.50	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. Protection of Environmental Administration Act 1991 (POEA Act). Environmental Planning and Assessment Act 1979 (EP&A Act). Environmental Planning and Assessment Regulation 2000 (EP&A Regulation). Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)
	Env-2: Noise	Level 1	0.50	
	Env-3: Vibration	Level 1	0.50	
	Env-4: Air Quality	Level 1	0.50	
	Env-5: Light Pollution	Scoped Out	0	

IS v2.1 category	IS v2.1 credit	Recommended equivalent min level	Weighted score	Alignment/justification
Resource Efficiency	Rso-1: Resource Strategy Development	Level 2	1.74	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. National Waste Policy: Less Waste, More Resources (Environment Protection and Heritage Council (EPHC) 2009). NSW Waste and Resource Strategy (NSW Environment Protection Authority 2014).
	Rso-2: Management of Contaminated Materials	Level 1	0.65	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. Environmental Planning and Assessment Regulation 2000 (EP&A Regulation).
	Rso-3: Management of Acid Sulfate Soils	Scoped Out	0	
	Rso-4: Resource Recovery and Management	Level 1	0.87	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. National Waste Policy: Less Waste, More Resources (Environment Protection and Heritage Council (EPHC) 2009). GREP 'Report on top three waste streams' requirement.
	Rso-5: Adaptability and End of Life	Not targeted	0	Noting this credit is identified as having high materiality in the IS materiality assessment, it is still recommended to not target, given the nature of the asset.
	Rso-6: Material Life Cycle Impact Measurement and Management	Level 1 (15% reduction)	1.30	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. National Greenhouse and Energy Reporting Act 2007 (NGER Act) (Commonwealth). National Waste Policy: Less Waste, More Resources (Environment Protection and Heritage Council (EPHC) 2009). Sustainable Procurement Guide (Commonwealth of Australia 2013). NSW Government Resource Efficiency Policy 2019. NSW Waste and Resource Strategy (NSW Environment Protection Authority 2014).
	Rso-7: Sustainability Labelled Products and Supply Chains	Not targeting	0	The Proposal could choose to apply this credit at a later date if aligned with its sustainability approach.

IS v2.1 category	IS v2.1 credit	Recommended equivalent min level	Weighted score	Alignment/justification
Water	Wat-1: Avoiding Water Use	Level 1 (10% reduction)	0.43	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. Water Management Act 2000 (WM Act).
	Wat-2: Appropriate Water Use	Level 1	0.43	Protection of Environmental Administration Act 1991 (POEA Act). Environmental Planning and Assessment Act 1979 (EP&A Act). Environmental Planning and Assessment Regulation 2000 (EP&A Regulation). Water Management Act 2000 (WM Act). Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Commonwealth).
Ecology	Eco-1	Level 3	12.16	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. Protection of Environmental Administration Act 1991 (POEA Act). Environmental Planning and Assessment Act 1979 (EP&A Act). Environmental Planning and Assessment Regulation 2000 (EP&A Regulation). Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Commonwealth).
Stakeholder Engagement	Sta-1: Stakeholder Engagement Strategy	Level 2	3.04	Aligned with the stakeholder engagement strategy for the Proposal.
	Sta-2: Stakeholder Engagement and Impacts	Level 1	1.52	
Legacy	Leg-1: Leaving a Lasting Legacy	Not targeting	0	The Proposal could choose to apply this credit later if aligned with its sustainability approach.
Heritage	Heritage Protection and Enhancement	Level 1	1.45	Environmental Planning and Assessment Act 1979 (EP&A Act). Environmental Planning and Assessment Regulation 2000 (EP&A Regulation). Water Management Act 2000 (WM Act).

IS v2.1 category	IS v2.1 credit	Recommended equivalent min level	Weighted score	Alignment/justification
Workforce Sustainability	Wsf-1: Jobs, Skills and Workforce Planning	Not targeting	0	The Proposal could choose to apply this credit later if aligned with its workforce approach.
	Wfs-2: Workplace Culture and Wellbeing	Not targeting	0	The Proposal could choose to apply this credit later if aligned with its workforce approach.
	Wfs-3: Diversity and Inclusion	Not targeting	0	The Proposal could choose to apply this credit later if aligned with its workforce approach.
	Wfs-4: Sustainable Site Facilities	Level 3	1.52	Aligns with the definition of ESD as defined in Part 8, Division 5, section 193 of the EP&A Regulation. Temporary site offices can be leased in alignment with the credit requirements to enhance energy and water outcomes.
Total points to target	**42.6 (silver)**			



CHAPTER 6

Section 6.12 Noise and Vibration

6.12 NOISE AND VIBRATION

This section provides a summary of potential noise and vibration impacts of the Proposal. The summary is based on the detailed Noise and Vibration Impact Assessment (NVIA) prepared to assess potential impacts due to construction and operation of the Proposal and is provided in Appendix P. The relevant SEARs and where they are addressed are provided in Table 6-107.

Table 6-107 Relevant SEARs – noise and vibration

Relevant key issue requirement/s	Where addressed
1. The Proponent must assess construction noise and vibration impacts in accordance with current NSW noise and vibration guidelines including consideration of noise characteristics (tonal, intermittent and low frequency noise) and the impact on sensitive receivers.	Sections 6.12.1, 6.12.2 and 6.12.3 Appendix P sections 4, 5 and 6
2. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Sections 6.12.2 and 6.12.3 Appendix P section 6.6.4
3. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Sections 6.12.1, 6.12.2 and 6.12.3 Appendix P section 6.5s

6.12.1 Methodology

The assessment of potential noise and vibration impacts of the proposed works has been prepared in accordance with the methodology outlined in the NSW Noise Policy for Industry (NPfI), Interim Construction Noise Guideline (ICNG) (DECC 2009), as well as other relevant guidelines and standards described in section 1.3.1 of Appendix P.

The assessment included two scenarios for the location of staff accommodation and the concrete batching plant as follows:

- Scenario 1 –workers accommodation potentially located at the site adjacent to Tarcoola Lane and the Concrete Batching Plant at the site adjacent to Clarrie Hall Dam Road.
- Scenario 2 –workers accommodation potentially located at the site adjacent to Clarrie Hall Dam Road and the Concrete Batching Plant at the site adjacent to Tarcoola Lane.

Construction

The assessment of construction noise and vibration consisted of:

- identifying noise sensitive receivers with the potential to be affected by noise and vibration
- characterising the existing acoustic environment through:
  - review and adoption of background and ambient noise levels
  - review and adoption of meteorological conditions
- reviewing the construction and operational aspects of the Proposal that have the potential to generate noise and vibration impacts
- determining noise and vibration assessment criteria such as:
  - identification of noise management levels (NMLs)
  - identification of the rating background level (RBL)

  - criteria for noise assessment purposes and including the median of the average background levels
  - identification of sleep disturbance screening criteria
- blasting overpressure and ground vibration assessment
- identifying appropriate mitigation and management measures.

Construction noise levels due to the Proposal were predicted using a computer-generated model using DGMR iNoise modelling software (the model). This noise modelling software is commonly accepted by the NSW EPA for the modelling and assessment of large-scale projects.

The model was populated with 3-D topography of the Proposal area and its surrounds, extending out to all assessment locations. Construction plant and equipment representing the range of proposed construction scenarios were placed at locations which would represent worst case noise levels throughout construction of the Proposal.

As the Proposal's core construction hours are planned to be between 7 am and 6 pm, 7 days per week, part of these construction hours fall outside of the ICNG standard construction hours (OOH). Given this, the assessment was based on construction works during ICNG daytime construction hours and works outside of the ICNG standard construction hours, including daytime OOH, evening and night-time periods. Night time works will only be required occasionally.

Modifying factor corrections as per Fact sheet C of the NPfI (EPA 2017) have been used in project-noise trigger level calculations to account for noise emissions with characteristics, such as tonality, intermittence or dominant low-frequency content, that may be considered more annoying than other noise at the same level.

Equipment sound power levels were assessed using plant and equipment sound power levels from the Department of Environment, Food and Rural Affairs (DEFRA) report *Update of Noise Database for Prediction of Noise on Construction and Open Sites (2005),* where available. Otherwise, data was sourced from an EMM database of similar equipment, which is based on measurements at other construction sites as indicated.

Safe working distances for typical items of vibration intensive plant were referenced from both British Standard BS 7385 and British Standard BC 6472-1.

Construction road traffic noise was assessed using the US Environmental Protection Agency Federal Highway Administration traffic noise model given its sensitivity to low traffic volumes.

Indicative vibration levels from blasting have been predicted using the guidance given in *AS2187-2-2006: Explosives – Storage and Use Part 2: Use of Explosives and formulae provided in Imperial Chemical Industries (ICI) – Explosives Blasting Guide* (ICI Technical Services 1995).

Operation

Operational noise levels were assessed using the EPA's noise trigger levels for intrusiveness and amenity.

6.12.2 Existing environment

Sensitive receivers

Sensitive receivers, which have the potential to be affected by noise from the Proposal, mainly include residential receivers in the areas surrounding the proposed construction works. Sensitive receivers are listed in Table 3.1 of Appendix P, and locations are shown in Figure 6-78. Each location was assessed, and if noise levels were predicted to satisfy the criteria at all assessment locations, they are expected to satisfy the criteria at all other more distant noise-sensitive receivers, such as recreational users.

The majority of assessment locations are residential dwellings in the areas of Doon Doon, Terragon and Uki. There is also a passive recreation area (Crams Farm Reserve) in the vicinity of the Proposal.

There are several Aboriginal and historic heritage locations of significance in and surrounding the Proposal area, which have been considered in the construction vibration and blasting assessment in section 6.12.3.

Background noise levels

Noise monitoring

Long-term unattended noise monitoring was conducted in April 2020. The results showed that background noise in the rural residential areas surveyed in the Clarrie Hall Dam area was at or below the NSW Noise Policy for Industry (EPA 2017) (NPfI) minimum background noise levels. It is expected that this would apply to the assessment locations shown in Figure 6-78. Therefore, the NPfI minimum background noise levels have been applied for the purposes of the assessment. This is a conservative assumption, leading to the most stringent noise criteria available being applied, and no further noise monitoring was conducted as part of the NVIA.

Meteorology

Noise propagation over distance can be significantly affected by the prevailing weather conditions. Of most interest are source to receiver winds, the presence of temperature inversions, and drainage flow effects, as these conditions can enhance received noise levels. For the purposes of noise modelling, the assessment adopted the noise-enhancing meteorological conditions as outlined in the NPfI, shown in Table 6-108.

Table 6-108 Meteorological parameters adopted for the noise modelling

Assessment period	Meteorological conditions	Air temperature	Relative humidity
Day	ISO 9613	20˚C	70%
Evening	ISO 9613	10˚C	90%
Night	ISO 9613	10˚C	90%

Notes: 1. Day: 7:00 am–6:00 pm Monday to Saturday; 8:00 am–6:00 pm Sundays and public holidays; evening: 6:00 pm–10:00 pm; night: 10:00 pm–7:00 am Monday to Saturday, and 10:00 pm–8:00 am Sundays and public holidays.

Source Appendix P

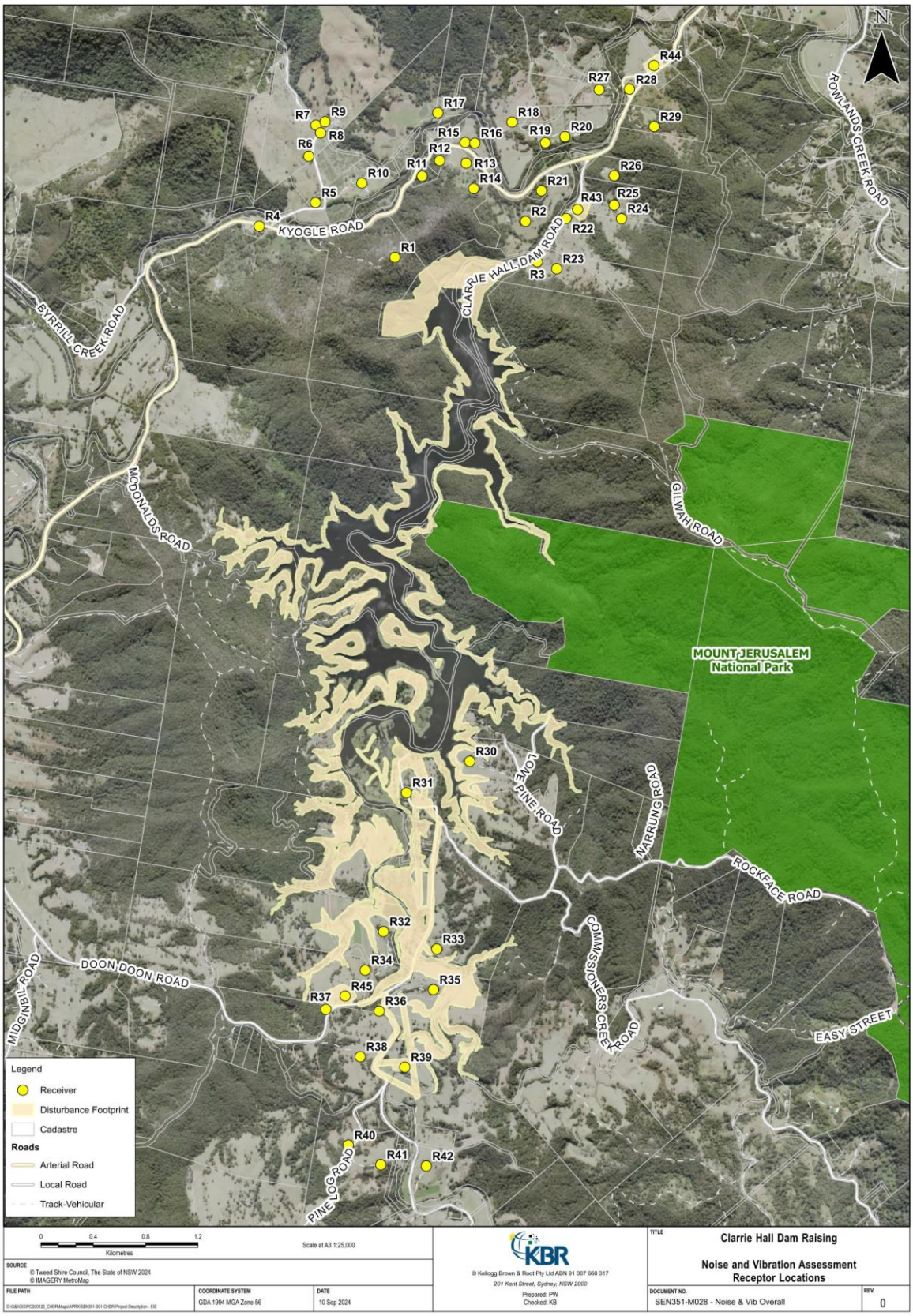


Figure 6-78 Noise sensitive receivers and assessment locations

Source Appendix P

6.12.3 Impact assessment

Construction noise

Noise management levels

The construction noise management levels (NMLs) for the assessment locations presented in Figure 6-78 are shown in Table 6-109. The NMLs are based on the background noise levels outlined in section 6.12.2 and in accordance with the ICNG.

Table 6-109 Construction NMLs for residential locations

Assessment location	Period [2,3]	RBL[1], dB	NML, $L_{Aeq, 15mimute}$, dB
All residential assessment locations	Day (standard hours)	35	45 75 (highly affected)
	Day (outside of standard hours)	35	40
	Evening	30	35
	Night	30	35

Notes:

1. *Minimum assumed RBL as per the NPfI.*
2. *Standard hours are 7:00 am to 6:00 pm Monday to Friday, 8:00 am to 1:00 pm Saturday.*
3. *Outside of standard hours is 6:00 pm to 7:00 am Monday to Friday and 1:00 pm Saturday to 7:00 am Monday.*

Sound power levels

The assessment adopted plant and equipment sound power levels from the *Update of Noise Database for Prediction of Noise on Construction and Open Sites* (UK Government Department of Environment, Food and Rural Affairs (DEFRA), 2005), where available. Otherwise, data was sourced from an EMM database of similar equipment, which is based on measurements at other construction sites as indicated.

Acoustically significant fixed and mobile equipment items were considered in the model for each construction area and adopted typical worst-case operating scenarios and utilisation. A summary of the cumulative sound power level (Lw) for each component is presented in Table 5.1 of Appendix P, acknowledging that multiple activities may occur simultaneously. Appendix A of Appendix P provides further clarity on how these activities were modelled.

Predicted construction noise levels

Prediction of construction noise levels for typical construction activities were assessed for standard and OOH periods. The level presented in the NVIA report for each assessment location represents the energy average noise level over a 15-minute period during noise-enhancing meteorological conditions and assumes all listed plant operating concurrently. The predicted exceedance of the ICNG noise affected noise management level (NML) at each assessment location is also provided – see Table 6.1 in Appendix P.

Scenario 1 (concrete batching plant at Clarrie Hall Dam Road; accommodation at Tarcoola Lane)

ICNG standard construction hours

Construction noise levels under noise-enhancing weather conditions are predicted to satisfy the relevant NMLs at most of the 45 assessment locations during ICNG standard construction hours. However, noise levels above NMLs are predicted at 14 assessment locations in total:

- 9 assessment locations (R1-R3, R19-R22, R25 and R26) in the northern section (associated with the Clarrie Hall Dam wall raising construction works)

- 5 assessment locations (R30, R32, R33, R35 and R36) in the southern section (associated with the McCabes bridge replacement and road realignment works).

The noise contours for this scenario are shown in Figure 6-79 (northern section) and Figure 6-83 (southern section).

Daytime outside of standard construction hours

During daytime outside of standard construction hours, construction noise levels under noise-enhancing weather conditions are predicted to satisfy NMLs at most of the 45 assessment locations. However, noise levels above NMLs are predicted at 16 assessment locations in total:

- 10 assessment locations (R1-R3, R18-R22, R25 and R26) in the northern section (attributed to the Clarrie Hall Dam wall raising construction works)
- 6 assessment locations (R30 and R32-R36) in the southern section (attributed to the McCabes Bridge replacement and road realignment works).

Evening and night-time periods

Construction noise levels under noise-enhancing weather conditions are predicted to satisfy NMLs at 22 of the selected 45 assessment locations during evening and night-time periods. However, noise levels above NMLs are predicted at 23 assessment locations in total:

- 17 assessment locations (R1-R3, R12-16, R18-R23 and R25-27) in the northern section (attributed to the Clarrie Hall Dam raising construction works)
- 6 assessment locations (R32-R36 and R38) in the southern section (attributed to the McCabes Bridge replacement and road realignment works).

The noise contours for this scenario are shown in Figure 6-80 (northern section) and Figure 6-84 (southern section).

Scenario 2 (accommodation at Clarrie Hall Dam Road; concrete batching plant at Tarcoola Lane)

ICNG standard construction hours

Construction noise levels under noise enhancing weather conditions are predicted to satisfy the relevant NMLs at most of the 45 assessment locations during ICNG standard construction hours. However, noise levels above NMLs are predicted at 9 assessment locations in total:

- 4 assessment locations (R1 and R27-R29) in the northern section (attributed to the Clarrie Hall Dam wall raising construction works)
- 5 assessment locations (R30, R32, R33, R35 and R36) in the southern section (attributed to the McCabes Bridge replacement and road realignment works).

The noise contours for this scenario are shown in Figure 6-81 (northern section) and Figure 6-83 (southern section).

Daytime outside of standard construction hours

During daytime OOH, construction noise levels under noise enhancing weather conditions are predicted to satisfy NMLs at most of the 45 assessment locations. However, noise levels above NMLs predicted at 12 assessment locations in total:

- 6 assessment locations (R1, R3, R22 and R27-R29) in the northern section (attributed to the Clarrie Hall Dam wall raising construction works)
- 6 assessment locations (R30 and R32-R36) in the southern section (attributed to the McCabes Bridge replacement and road realignment works).

Evening and night-time periods

Construction noise levels under noise enhancing weather conditions are predicted to satisfy NMLs at most of the selected 45 assessment locations. However, noise levels above NMLs are predicted at 17 assessment locations in total:

- 11 assessment locations (R1-R3, R19, R20, R22, R23 and R26-29) in the northern section (attributed to the Clarrie Hall Dam wall raising construction works)
- 6 assessment locations (R32-R36 and R38) in the southern section (attributed to the McCabes Bridge replacement and road realignment works).

The noise contours for this scenario are shown in Figure 6-81 (northern section) and Figure 6-84 (southern section).

Noise management

The construction contractor will be required to manage construction noise levels where exceedances of NMLs have been identified. Although NMLs are not mandatory, exceedances trigger feasible and reasonable measures to be applied in accordance with the ICNG. Noise mitigation measures are provided in section 6.12.4.

The ICNG recommends the following where NMLs are predicted to be exceeded:

- application of feasible and reasonable work practices to minimise noise
- informing potentially impacted residents of the nature of the works to be carried out, expected noise levels and duration and relevant contact details
- negotiation with the community where noise from work outside standard hours is found to exceed the relevant NML by more than 5 dB.

The construction contractor should notify the owner/occupier of these assessment locations of the construction works and the potential noise impacts and discuss options for mitigating impacts. Noise monitoring should be undertaken during the initial stages of construction to determine if actual construction noise levels are above NMLs. If this initial testing identifies exceedances, the contractor will identify feasible and reasonable mitigation measures that reduce construction noise levels as far as practicable to NMLs.

The above will be determined depending on the measured level of exceedance and the availability of feasible and reasonable noise mitigation and management measures.

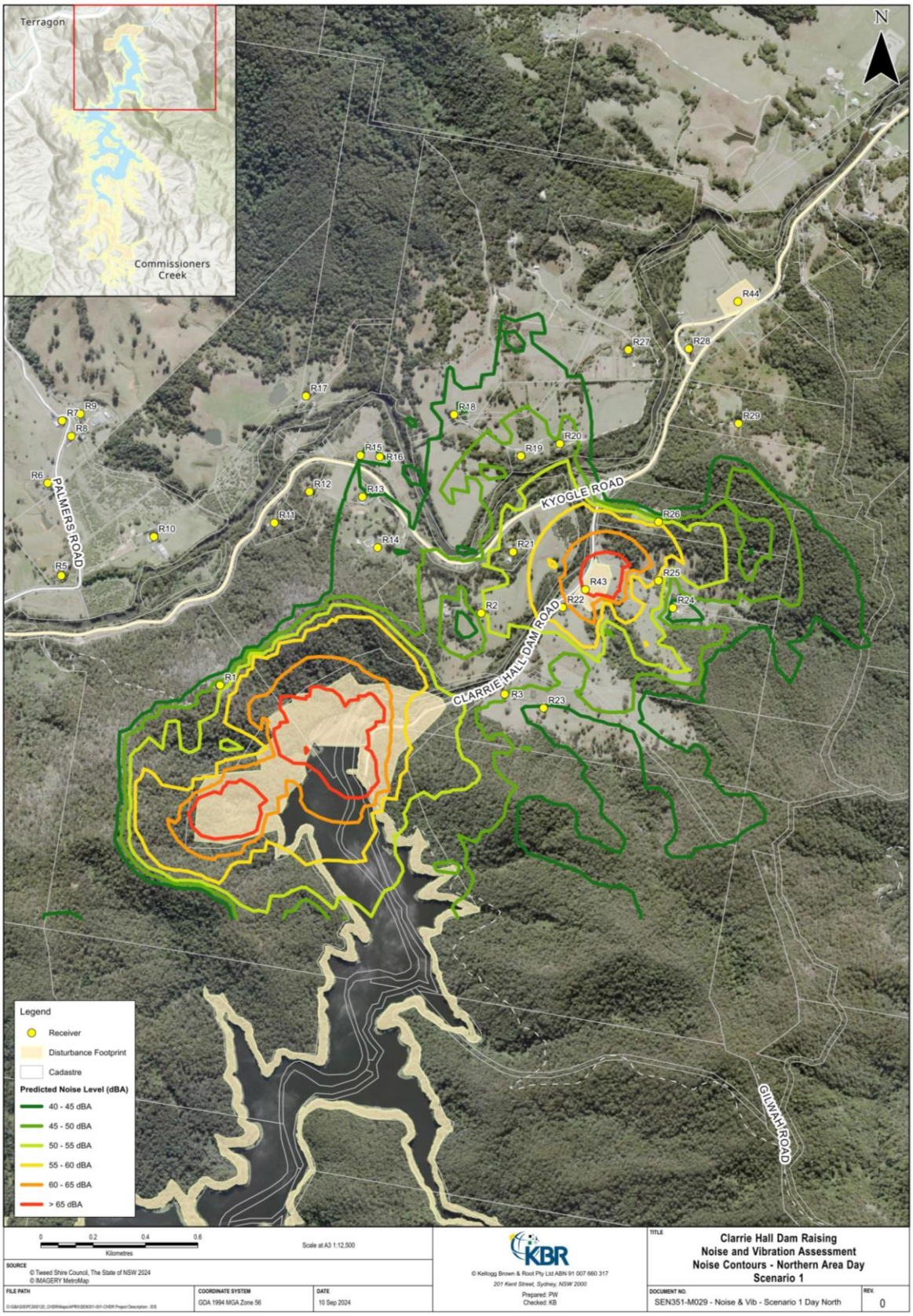


Figure 6-79 Noise contours – northern area, day (Scenario 1)

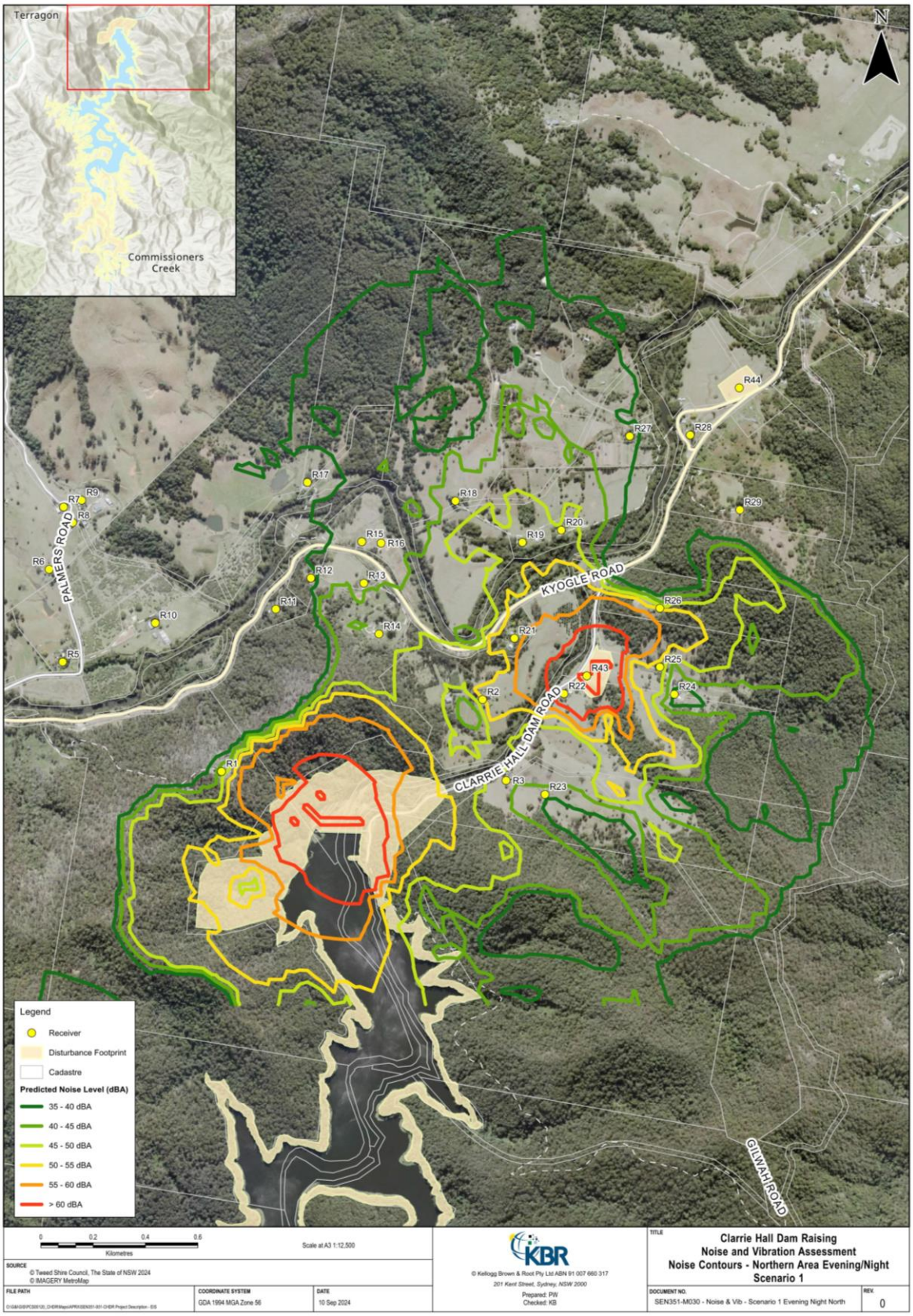


Figure 6-80 Noise contours – northern area, evening/ night (Scenario 1)

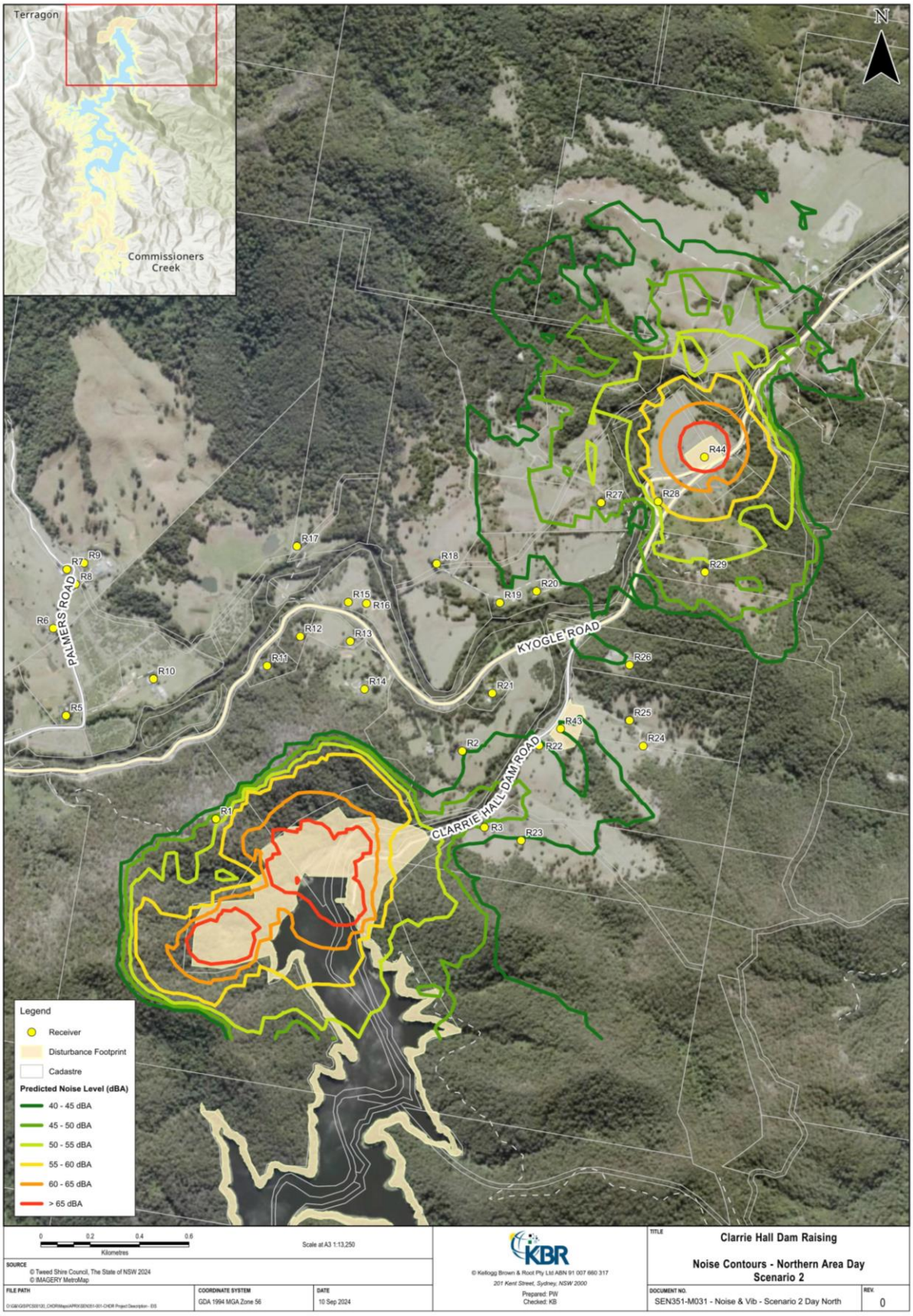


Figure 6-81 Noise contours – northern area, day (Scenario 2)

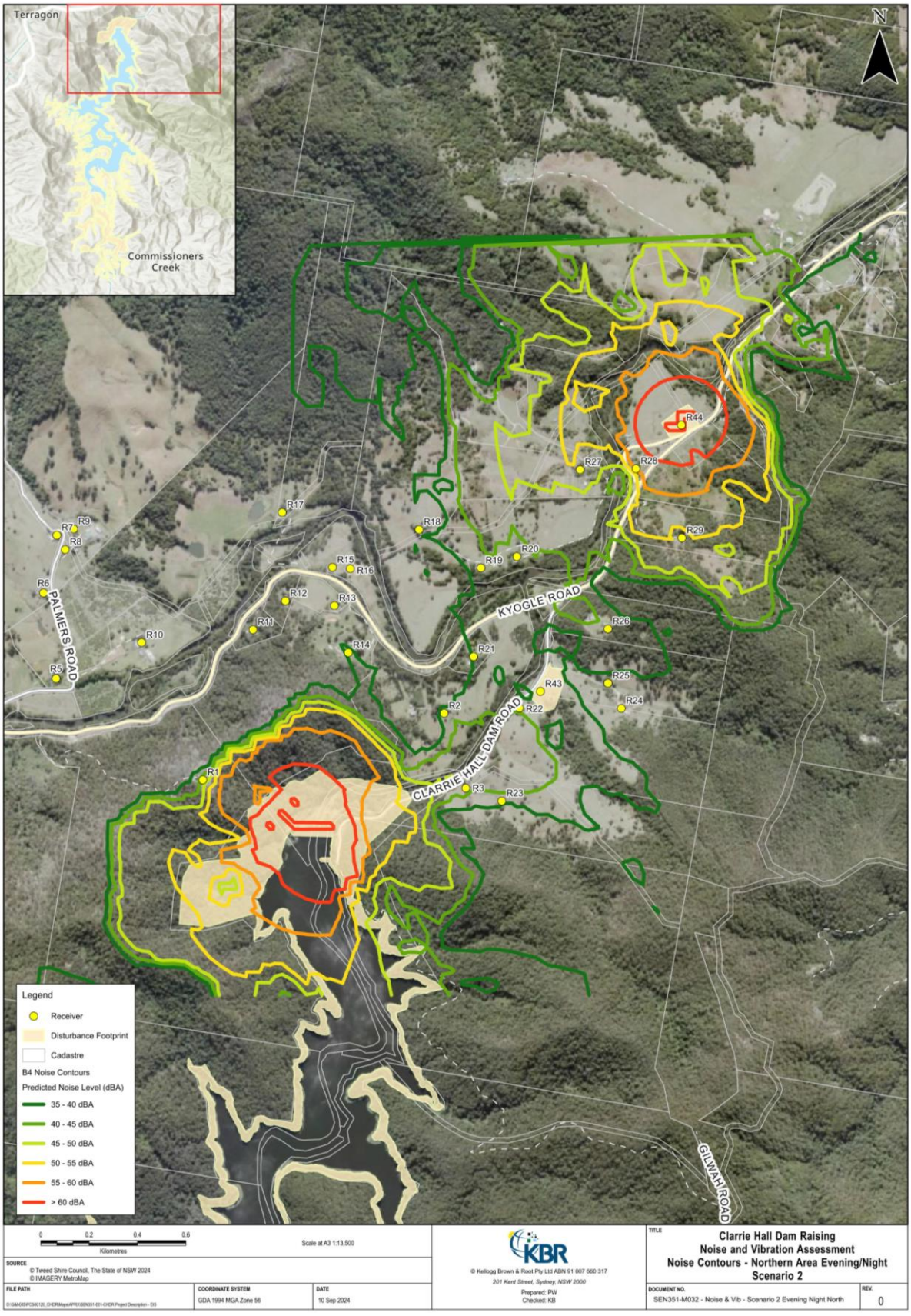


Figure 6-82 Noise contours – northern area, evening/night (Scenario 2)

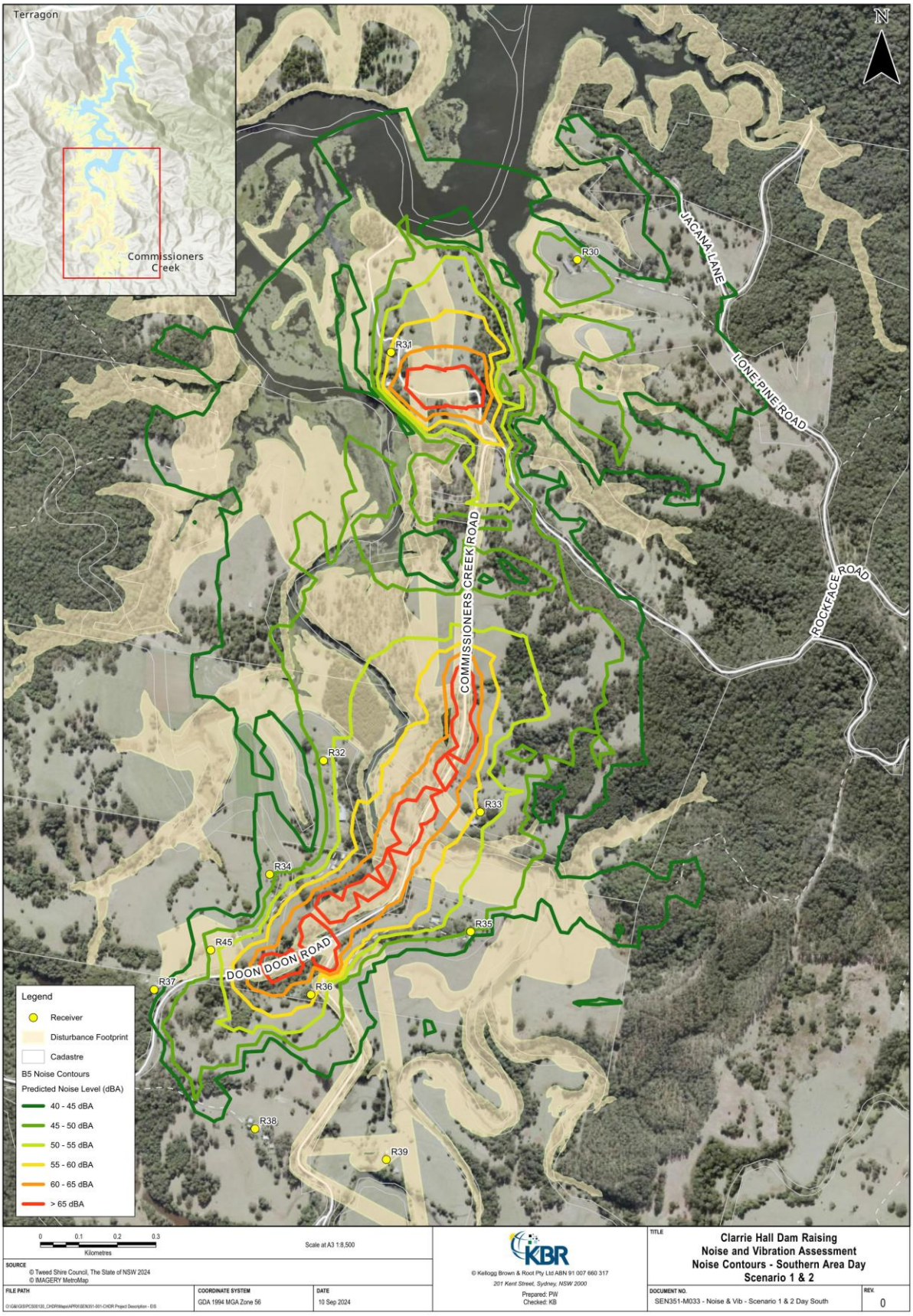


Figure 6-83 Noise contours – southern area, day (Scenario 1 & 2)

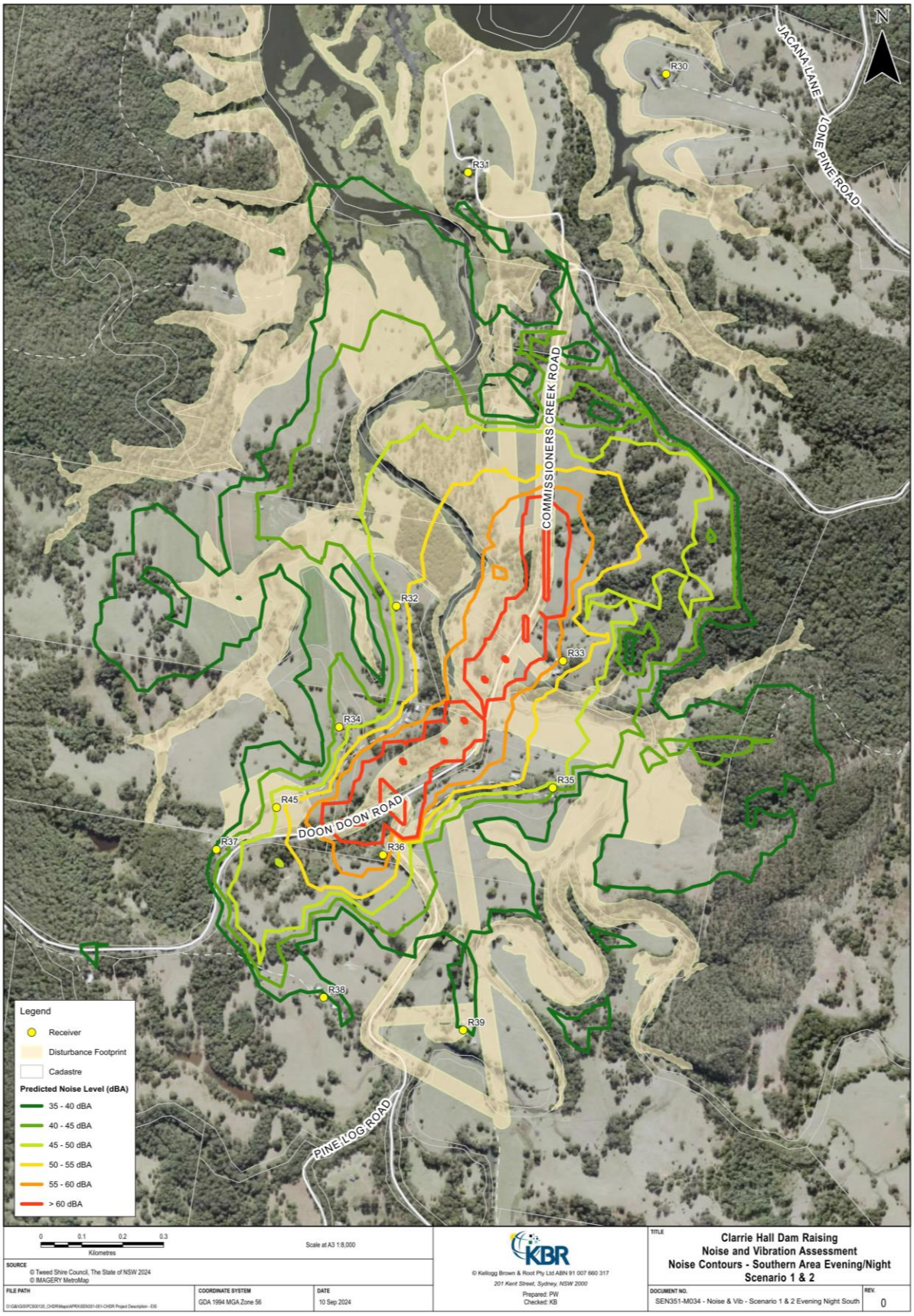


Figure 6-84 Noise contours – southern area, evening/night (Scenario 1 & 2)

Sleep disturbance

Noise level event screening criteria for the residential assessment locations is shown in Table 6-110. Details of the background to these criteria are provided in section 4.2 of Appendix P.

Table 6-110 Sleep disturbance screening criteria at residences[1]

Assessment location	Adopted night RBL, dB	Night-time maximum noise level event screening criteria, dB	
		$LA_{eq,\ 15\ minute}$	LA_{max}
All residential assessment locations	30	40	52

Notes:

1. *Does not apply to project-related accommodation, or commercial or passive recreation.*

Maximum construction noise levels were assessed for the night-time period under noise-enhancing meteorological conditions at the 41 residential assessment locations.

The prediction of maximum construction noise levels and predicted level above the sleep disturbance screening criteria at each assessment location for night-time works are provided below. Further details are provided in Table 6.2 of Appendix P.

Scenario 1 (concrete batching plant at Clarrie Hall Dam Road; accommodation at Tarcoola Lane)

Maximum $L_{Aeq,15minute}$ construction noise levels under noise-enhancing weather conditions are predicted to satisfy the $L_{Aeq,15minute}$ sleep disturbance screening criteria at 25 of the 41 residential assessment locations.

Maximum L_{Amax} construction noise levels under noise-enhancing weather conditions are predicted to satisfy the L_{Amax} sleep disturbance screening criteria at 39 of the 41 residential assessment locations. However, noise levels above the L_{Amax} sleep disturbance screening criteria are predicted at 2 assessment locations in total – R22 and R36.

Scenario 2 (accommodation at Clarrie Hall Dam Road; concrete batching plant at Tarcoola Lane)

Maximum $L_{Aeq,15minute}$ construction noise levels under noise-enhancing weather conditions are predicted to satisfy the $L_{Aeq,15minute}$ sleep disturbance screening criteria at 31 of the 41 residential assessment locations.

Maximum L_{Amax} construction noise levels under noise-enhancing weather conditions are predicted to satisfy the L_{Amax} sleep disturbance screening criteria at 40 of the 41 residential assessment locations. However, noise levels above the L_{Amax} sleep disturbance screening criteria are predicted at one assessment location – R36.

Sleep disturbance noise management.

Works outside normal hours may be required due to the construction methodology and concrete pour requirements. This may occur where concrete pours or other works are required to continue into the out-of-hours periods. It is recommended that an out-of-hours works protocol be developed for the construction of the Proposal. To reduce potential impacts during these periods, it is recommended that high noise-generating activities be limited during more sensitive periods.

Vibration

The nearest residence to construction activity is assessment location R1, which is approximately 300 m away from the spillway. This is beyond the safe working distances for human response considerations. Vibration impacts from construction at residential assessment locations are therefore unlikely.

The nearest heritage structures of significance are the former Cram residence (assessment location R31), Dairy & Bails and the Doon Doon Hall, which are located approximately 800 m away from the McCabes Bridge and Commissioners Creek Road realignment works. This is well beyond the safe working distances for both human response and structural damage consideration from construction vibration.

However, these sites are located between 60 m and 115 m north to north-west of the McCabes Bridge and Commissioners Creek road works. Given that limited scope of vibration-generating activities occurring at the southern construction compound, structural vibration impacts at these heritage structures are considered unlikely.

There are no heritage items/locations of recorded significance that fall within the required safe working distances presented in the Noise and Vibration Impact Assessment report.

Road traffic noise

Predicted construction traffic noise levels demonstrate an increase in road traffic noise levels for the nearest residences on all roads associated with the Proposal. Given the rural locality and the nature of the associated road network, it is not unlikely that increases of road traffic noise would be experienced for a project of this scale. Such changes result in levels above the NSW Road Noise Policy (RNP) criteria for residences along Clarrie Hall Dam Road and Doon Doon Road/Commissioners Creek Road; hence, feasible and reasonable measures must be considered, in the context of the temporary, albeit longer-term, nature of the works. The application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts related to construction activities.

Blasting

Blasting during the construction period may be required or preferred during construction as part of the excavation of the spillway and quarrying area depending on the material encountered.

The nearest sensitive receiver (R1) is located approximately 300 m to the nearest potential construction blasting area (the spillway). Table 6-111 provides the highest maximum instantaneous charge (MIC) value corresponding to overpressure and vibration levels that satisfy the criteria (see Appendix P section 6.6.1) at the nearest receiver to the relevant blasting location.

Table 6-111 Predicted blast overpressure and vibration levels

Blast location	Nearest receiver	Approximate distance (m)	Highest MIC (kg)	Derived overpressure (dB(L)peak)	Derived vibration PPV (mm/s)
Spillway	R1	300	19	115.0	1.4
Quarry	R1	420	54	115.0	1.8

The predicted blast overpressure and vibration levels identify that, when blasting in the spillway area, the use of a MIC of up to 19 kg is likely to result in compliance with relevant overpressure and vibration criteria at the nearest residence (R1). When blasting in the relevant quarrying area, MICs of up to 54 kg result in overpressure and vibration levels below criteria at the nearest residences.

The ANZEC blasting guideline recommends that blasting be conducted during the day period (9:00 am to 5:00 pm Monday to Saturday) to avoid potential impacts during the more sensitive evening and night periods.

The ANZEC guideline goes on to state that restrictions on the time and frequency of blasting would not apply if the effects were not perceived at noise sensitive sites. Furthermore, ANZEC states that in some circumstances, blasts may not be able to comply with emission level, time and frequency

requirements. In these instances, environmental authorities would apply appropriate controls based on individual project circumstances.

Several specific areas of significance have been identified in the Aboriginal Cultural Heritage Assessment (section 6.5) and Historic Heritage Assessment (section 6.6) and are considered high-value and worth protecting. Of these locations, several include grinding grooves, scar tree and rock shelters. These areas are located well outside of the blast offset zones.

These areas are summarised in Appendix P (Table 6.5) and are located well outside of blast offset zones, with the exception of a scar tree which is located immediately adjacent to the proposed spillway. Management of potential impacts to the scar tree will be included in the construction noise and vibration management plan.

Impacts on fauna

Very little evidence is available on the direct impacts that steady state noise and ground vibration have on fauna. There are no current government policies or guidelines that recommend thresholds or criteria in relation to fauna.

In general, increased activity levels are likely to result in reduced fauna activity around work areas and heavily trafficked road segments. Noise will be generated throughout the construction period by way of operation of machinery, plant, vehicles and blasting. Fauna species that occur in the vicinity of construction sites and main traffic routes are expected to leave the immediate area of noise impact. It would be anticipated that following completion of the construction period, fauna could return to the previous habitat.

However, it is likely that if levels are suitable for humans, they would also be largely tolerable for fauna.

Operational noise

Intrusiveness noise levels

The intrusive noise trigger levels shown in Table 6-112 are based on the adopted RBLs (refer to section 4.3 of Appendix P). Given the rural nature of all assessment locations and the results of sample ambient noise monitoring, it has been assumed that the ambient acoustic environment at all assessment locations is similar, and the adopted RBLs are consistent with the minimum RBLs provided in the NPfI. It is noted that intrusive noise levels are applicable at residential assessment locations only.

Table 6-112 Project intrusiveness noise levels

Assessment location	Period[1]	Adopted RBL[2], dB	Project intrusiveness noise level dB, $L_{Aeq,15minute}$
All residential assessment locations	Day	35	40
	Evening	30	35
	Night	30	35

Notes:

1. *Day: 7:00 am–6:00 pm Monday to Saturday; 8:00 am–6:00 pm Sundays and public holidays; evening: 6:00 pm–10:00 pm; night: remaining periods.*
2. *Minimum RBL as per the NPfI has been assumed for all time periods.*

Amenity noise levels

Residential assessment locations potentially affected by operation of the Proposal have been categorised in the NPfI rural amenity categories. As per the definitions provided in the NPfI, all

residential assessment locations were classified as “rural” since they were deemed to be in “an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels”.

The corresponding project amenity noise levels for the sites are given in Table 6-113.

Table 6-113 Project amenity noise criteria

Type of receptor	Indicative noise amenity area	Time of day[1]	Recommended amenity noise level, $L_{Aeq,period}$ dB
Residence	Rural	Day	50
		Evening	45
		Night	40

Notes:

1. *Day: 7:00 am–6:00 pm Monday to Saturday; 8:00 am–6:00 pm Sundays and public holidays; evening: 6:00 pm–10:00 pm; night: remaining periods.*

Noise trigger levels

The project-noise trigger level (PNTL) is the lower of the calculated intrusive or amenity noise level. It is provided in Table 6-114 for all assessment locations.

Preliminary noise calculations determined that satisfying the intrusive noise level at the most exposed point of residential assessment locations will also satisfy PNTLs at assessment locations further away from the Proposal.

To standardise the time periods for the intrusiveness and amenity noise levels, it has been assumed that the LAeq,15 minute will be taken to be equal to the $LA_{eq,period}$ + 3 dB. This is consistent with NPfI methodology.

Table 6-114 Project noise trigger levels

Assessment location	Time period	Intrusive noise level dB, $L_{Aeq,15minute}$	Amenity noise level[2], dB, $L_{Aeq,15minute}$	Project noise trigger level (PNTL), dB
Nearest residence	Day	40	48	40 $L_{Aeq,15minute}$
	Evening	35	43	35 $L_{Aeq,15minute}$
	Night	35	38	35 $L_{Aeq,15minute}$

Notes:

1. *Day: 7:00 am–6:00 pm Monday to Saturday; 8:00 am–6:00 pm Sundays and public holidays; evening: 6:00 pm–10:00 pm; night: remaining periods.*
2. *Amenity noise level = NPfI recommended amenity noise level – 5 dB (to account for any additional industrial noise) + 3 dB (to standardise time periods)*

The daily operation and maintenance of the Clarrie Hall Dam is not expected to change as a result of the Proposal. As such, no additional noise or vibration impact is expected from the operation of the Proposal and operational noise and vibration have not been assessed.

6.12.4 Mitigation measures

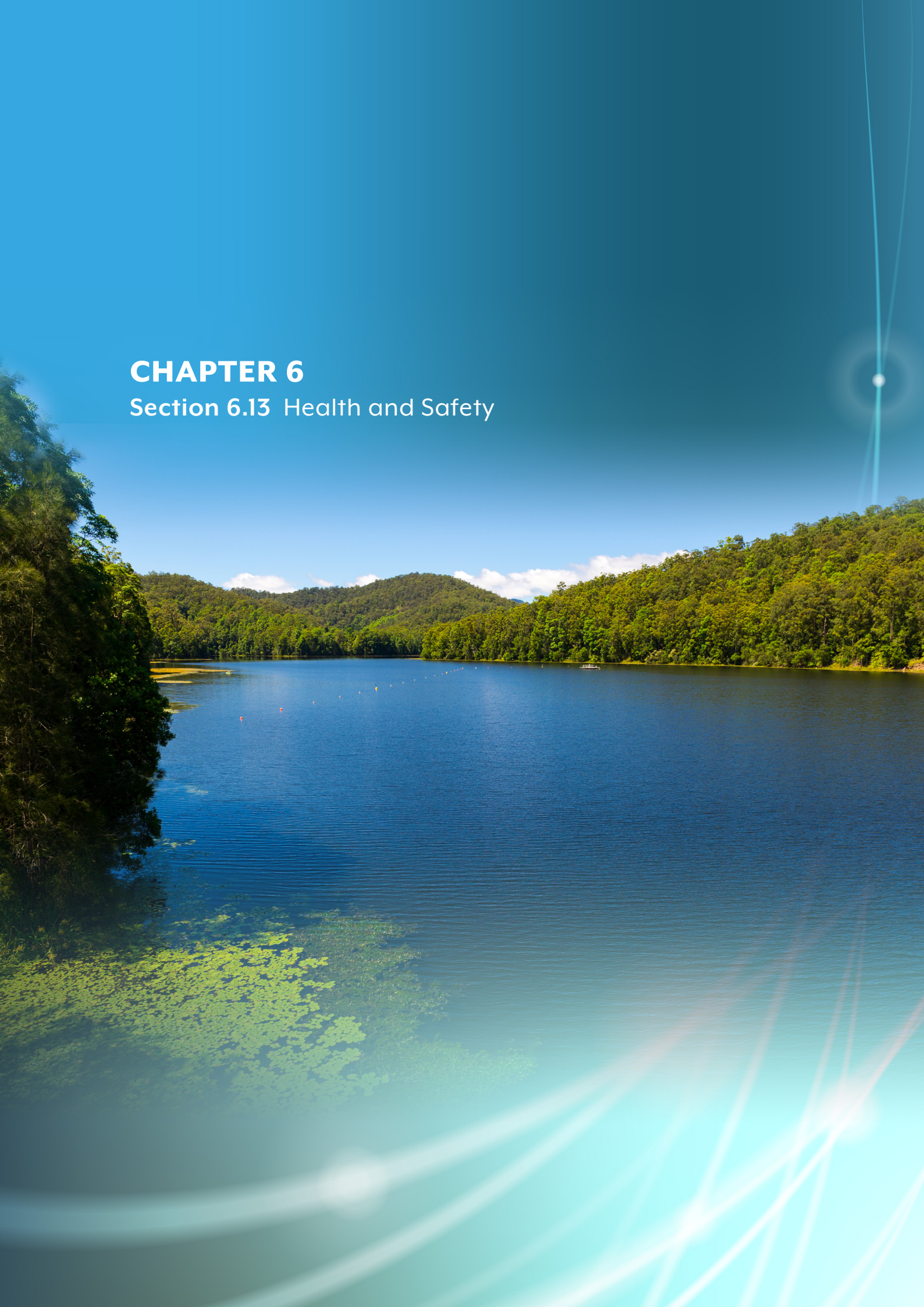
It is likely that noise levels will exceed the relevant NMLs at times during the proposed construction activities. Table 6-115 outlines noise and vibration mitigation and management measures to be adopted during construction works.

No mitigation measures are proposed during operation.

Table 6-115 Construction mitigation measures

Reference	Impact	Mitigation measure	Responsibility	Timeframe
NV1	General	A noise and vibration management plan is to be prepared and implemented that includes the identification of sensitive receivers and management measures documented in the EIS and conditions of approval	Construction contractor	Pre-construction
NV2	Notification	• Notify landholders, and sensitive receivers likely to be affected by noise, and address concerns prior to commencement of construction work. • All potentially noise affected residents would be notified of the construction details of the proposal (types of activities, hours of construction etc.) at least two weeks prior to construction commencement. Potentially noise affected residents are all those within the minimum working distance of the work-site. • Contact details for complaints and information would be provided. • In the event that a noise or vibration complaint is received, it would be responded to within 24 hours. • Complaints and associated responses would be documented and kept for future reference.	Construction contractor	Pre-construction, construction
NV3	Induction	All employees, contractors and subcontractors are to receive an environmental induction. The induction would include: • all relevant proposal-specific and standard noise and vibration mitigation measures • permissible hours of work • map of nearest sensitive receivers to work site, noting more densely populated areas around the construction disturbance footprint. • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries).	Construction contractor	Pre-construction, construction
NV4	Noise respite	• In accordance with the ICNG, where high levels of construction noise are required for periods of 4 hours or more in areas adjacent to residential sensitive receivers, 1 hour of noise respite would be provided for every 4-hour period.	Construction contractor	Construction
NV5	Noise and vibration risk assessment	• The construction contractor would complete a risk assessment to determine if construction equipment and blasting has the potential to cause vibration impacts on adjoining residential properties, infrastructure or heritage items, including the scar tree near the spillway. • The assessment would determine the appropriate size of construction equipment to be used, and if other management measures are required to minimise the potential for cosmetic damage and human comfort impacts based on the distances detailed in the EIS.	Construction contractor	Pre-construction, construction

Reference	Impact	Mitigation measure	Responsibility	Timeframe
NV6	Vibration	• Where vibration causing works are to take place within the relevant safe working distances, the construction contractor would contact the occupants prior to works commencing to give adequate notice of the duration of works.	Construction contractor	Pre-construction, construction
NV7	Equipment sound power	• Ensure relevant sound power levels can be achieved through acoustic design of the proposed equipment and enclosures.	Construction contractor	Pre-construction, construction
NV8	Traffic	• Deliver materials, plant and equipment, and dispose of material from the site, during the specified times for construction activities.	Construction contractor	Pre-construction, construction
NV9	Equipment	• Position equipment to minimise impacts on neighbours.	Construction contractor	Pre-construction, construction
NV10	Sundays and public holidays	• Only works that generate low noise and low traffic should be permitted on Sundays or public holidays	Construction contractor	Pre-construction, construction
NV11	Plant items	• Minimise the number of plant items operating concurrently when in proximity to receivers	Construction contractor	Pre-construction, construction
NV12	General	Adopt strategies set out in the AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Maintenance and Demolition sites* for: • universal work practices • plant and equipment • work scheduling • relative effectiveness of noise controls.	Construction contractor	Pre-construction, construction
NV13	Additional noise mitigation measures	Apply mitigation measures outlined in the Construction Noise and Vibration Guideline (RMS 2016) where exceedances are expected to occur.	Construction contractor	Pre-construction, construction



CHAPTER 6

Section 6.13 Health and Safety

6.13 HEALTH AND SAFETY

This section provides a summary of the health and safety impacts and mitigation measures associated with the Proposal during construction and operation. The assessment of health and safety impacts includes, but is not limited to, dam safety, bushfire risk, public safety, air quality, construction risks, flooding and emergency management. Detailed assessments of bushfire risk, air quality and flooding are provided in Appendix R, Appendix Q and Appendix F respectively.

The relevant SEARs are shown in Table 6-116.

Table 6-116 Relevant SEARs – health and safety

Relevant key issue requirement/s	Where addressed
The Proponent must demonstrate that the proposed works would comply with Dams Safety NSW and Dams Safety NSW Board advice, and the statutory requirements of the Dams Safety Act 2015, Dams Safety Regulation 2019.	Section 6.13.3
The Proponent must assess the potential health impacts of the proposal, in accordance with the current guidelines.	Section 6.13.3 Appendix F (Flooding) Appendix Q (Air Quality) Appendix R(Bushfire Risk)
Preparation of a bush fire assessment report that identifies the extent to which the proposed development conforms with or deviates from provisions of the Planning for Bush Fire Protection 2019 (RFS 2019).	Appendix R and summarised in section 6.13
The Proponent must assess the likely risks of the proposal to public safety, paying particular attention to visitor safety and access, bushfire risks and the handling and use of dangerous goods.	Section 6.13.3 Appendix R
The Proponent must identify potential ignition sources during construction, and detail proposed bush fire protection measures for the development, including fire suppression capabilities.	Section 6.13.3 Appendix R
The Proponent must address proposed emergency management, evacuation and access, and contingency measures, and whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES.	Section 6.1 Section 6.13.3 Section 6.13.4

6.13.1 Assessment methodology

The methodologies of the assessments that inform the content detailed in this section are provided below. This includes dam safety, health, bushfire risk, flooding, public safety and emergency management in relation to construction and operation of the Proposal.

Dam safety and emergency management

The following methodology was used to demonstrate that the Proposal would comply with the relevant legislation and other requirements:

- A review was undertaken of the concept design for compliance with the relevant standards including:
  - ANCOLD, Guidelines on Concrete Faced Rockfill Dams
  - NSW Dams Safety Committee, DSC3A, Consequence Categories for Dams
  - NSW Dams Safety Committee, DSC3B, Acceptable Flood Capacity for Dams
  - NSW Dams Safety Committee, DSC3C, Acceptable Earthquake Capacity for Dams.

A hydrology and consequence assessment will be conducted during detailed design.

- The following documents were reviewed:
  - Clarrie Hall Dam Safety Standards Annual Report
  - Dam Safety Emergency Plan for Clarrie Hall Dam (TSC 2024g)
  - Clarrie Hall Dam Operation and Maintenance Manual.

Health

Health impacts were assessed for the construction and operation phases of the Proposal by:

- reviewing the construction methodology to identify health and safety hazards to workers and the public, use and handling of dangerous goods, ignition sources, relevant guidelines, and emergency management measures
- identifying expected changes to the operational area and how they may impact health, safety, access for the public and stakeholders.

Both construction personnel and the public were considered in this assessment. The assessment of potential health impacts was assessed across various specialist reports to consider potential changes in air quality, noise and vibration, water quality, soil, bushfire and traffic due to the Proposal.

Air quality and bushfire have been assessed using current guidelines as discussed in this section (sections 6.13.1, 6.13.2 and 6.13.3).

The remaining potential health impacts have been assessed using current guidelines as discussed in the relevant sections of the EIS:

- noise and vibration – section 6.12
- water quality and flooding – section 6.1
- contamination – section 6.8
- traffic – section 6.14.

Air quality assessment

An Air Quality Impact Assessment (AQIA) (see Appendix Q) was prepared for the Proposal to determine the extent of air quality impacts as a result of construction and operation of the Proposal. The AQIA was prepared in line with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* ('Approved Methods for Modelling') (NSW Environment Protection Authority (EPA) 2022).

The AQIA aimed to:

- describe the existing environment including meteorology, climate and existing air quality environment
- detail the pollutants relevant to the assessment, and the applicable impact assessment criteria
- complete an air pollutant emission inventory for the Proposal
- complete atmospheric dispersion modelling for the quantified emissions, including an analysis of Proposal-only impacts and cumulative impacts that take into account baseline air quality
- provide an overview of mitigation measures proposed to be employed during the construction of the Proposal.

The nearest sensitive locations to the Proposal area have been identified for the purpose of assessing potential air quality impacts. These are referred to as assessment locations. The 45 assessment locations include a mix of private residences, recreational facilities and Proposal accommodation.

The AQIA considered 2 locations for the concrete batching plant (CBP) which are being considered for the Proposal. If CBP option 1 is chosen, assessment location R43 will not exist. Inversely, where CBP option 2 is chosen, assessment location R44 will not exist.

Details of the assessment locations are provided in Table 3.1 of Appendix Q and Figure 6-85.

As the air quality impacts of the operational phase of the Proposal would be similar to the current operation of the dam infrastructure, operational air quality impacts were not assessed in detail.

Analysis of greenhouse gas emissions are discussed in section 6.10.

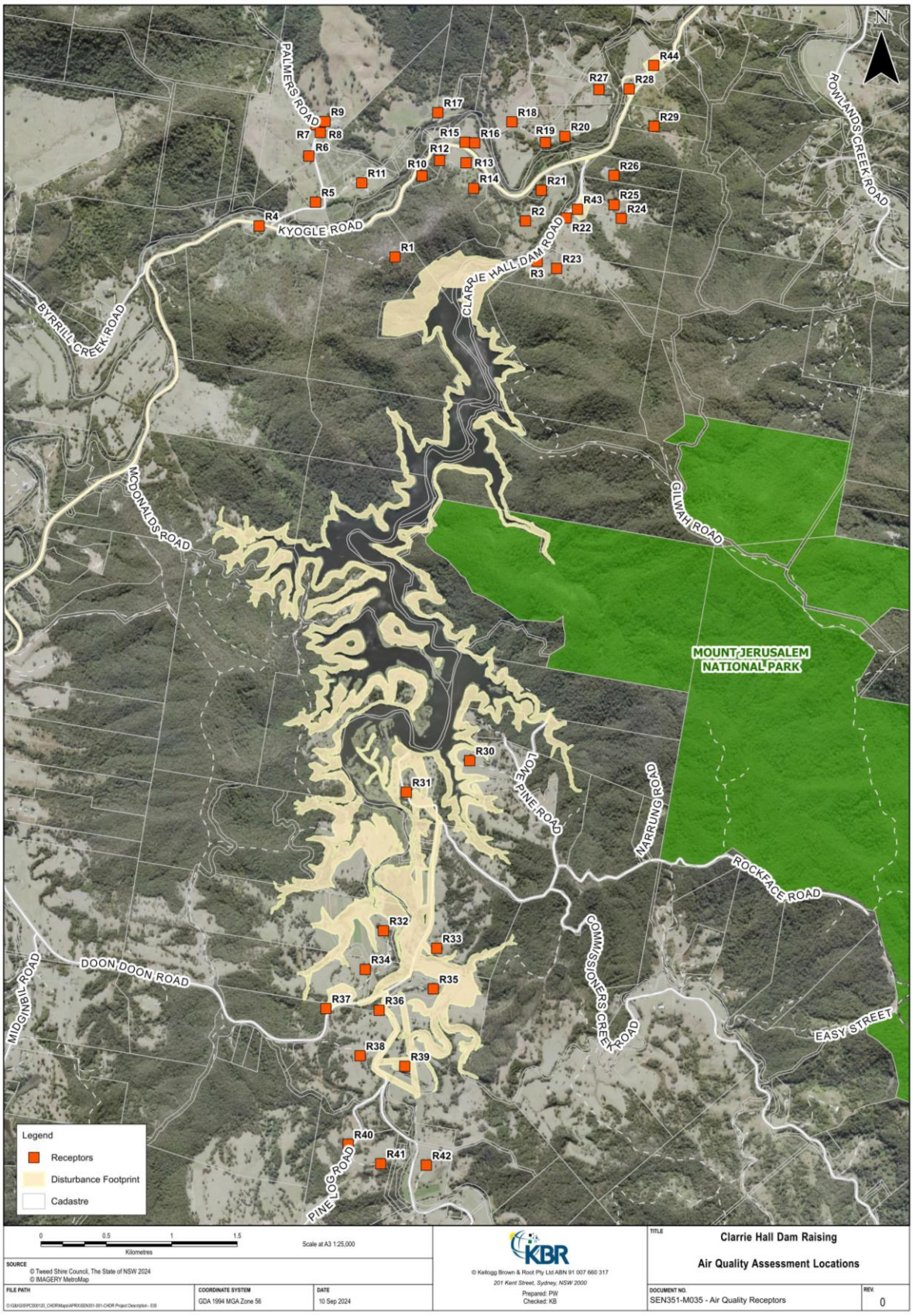


Figure 6-85 Air quality assessment locations

Source Appendix P

Assessment criteria

The air quality criteria that apply to the Proposal are stated in the Approved Methods for Modelling (NSW EPA 2022) and are displayed in Table 6-117 in relation to cumulative impacts for particulate matter. The air quality criteria relating to dust deposition are also displayed in Table 6-117, noting that the impacts are derived from total suspended particulates (TSP) emission rates and particle deposition calculations from the dispersion modelling process.

Table 6-117 Impact assessment criteria for airborne particular matter

Metric	Averaging period	Impact assessment criterion
TSP	Annual	90 µg/m^3
PM_{10}	24 hours	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24 hours	25 µg/m^3
	Annual	8 µg/m^3
Dust deposition	Annual	2 g/m^2/month (Proposal increment only)
		4 g/m^2/month (cumulative)

Characterisation of the existing scenario

There are no meteorological stations in the vicinity of the Proposal. Meteorological data recorded by the BoM Canungra (Defence) AWS from March 2018 to December 2022 were analysed for the purposes of selecting a representative year for dispersion modelling.

There are no air quality monitoring stations in the vicinity of the Proposal. The closest AQMSs to the Proposal are in Queensland and are operated by the Queensland Government Department of Environment, Science and Innovation. Air quality monitoring data from the closest stations (North Maclean, Flinders View and Mutdapilly) were considered for the purposes of defining a background dataset to be used in the cumulative assessment.

Emissions estimation

Emissions from fugitive dust sources associated with the construction emission scenario were quantified through the application of USEPA AP-42 emission factor equations. Particulate matter emissions were quantified for the 3 size fractions TSP, PM_{10} and $PM_{2.5}$.

Meteorological modelling and dispersion modelling

The dispersion modelling for this assessment involved the use of The Air Pollution Model (TAPM) and CALMET/CALPUFF.

Upper air profiles were generated by the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) TAPM meteorological model. CALMET was used as the meteorological pre-processor for the dispersion model CALPUFF.

TAPM was used to generate required parameters that are not routinely measured, specifically mixing height and vertical wind/temperature profile.

Each emission source was represented in CALPUFF as a line-volume or volume source, located according to the layout of the Proposal's main construction areas.

In addition to the 45 individual assessment locations, pollutant concentrations were predicted over a 10 km (x-axis) by 14 km (y-axis) domain with 200 m resolution.

Simulations were undertaken for the 12-month period of 2021.

Bushfire risk assessment

A Strategic Bushfire Study (Appendix R) was prepared to identify the relevant provisions of *Planning for Bushfire Protection 2019* ('PBP 2019') (NSW RFS 2019) that apply to the Proposal. The assessment aimed to prepare for the long-term and ongoing planning for the Proposal including detailed design, construction and operation.

The bushfire risk assessment included a review of the Proposal against the following guidelines, legislation and regional information:

- *NSW Rural Fires Act 1997* (RF Act)
- *NSW RFS Planning for Bushfire Protection 2019* (NSW RFS 2019)
- Australian Standard (AS) 3959-2018 – *Construction of buildings in bushfire-prone areas*
- Bushfire Risk Management plans (BFRMP) for the local government area (LGA)
- Bushfire history (SEED geomapping).

In addition to satisfying the aims and objectives of the PBP 2019, the Proposal required that the following requirements and recommendations listed in the PBP 2019 be considered:

- State significant development and infrastructure (section 2.4.2)
- Other development (Chapter 8)
- increased residential density (section 8.2.12).

Bushfire protection measures that satisfy the relevant performance criteria were identified.

The bushfire assessment included the proposed construction and operational areas, structures and ancillary facilities (non-habitable infrastructure) separate to the 2 options for locations of workers accommodation facilities (habitable structures).

The bushfire assessment included:

- obtaining an understanding of the potential bushfire risk to the primary asset, including the life and safety of the infrastructure and environment
- identification of potential ignition sources during construction.
- Detailing bushfire protection measures and fire suppression capabilities that can be implemented to reduce bushfire risk within the Proposal area.

Non-habitable infrastructure

The construction and operational areas for all non-habitable infrastructure were assessed under Chapter 8 (Other Development) of PBP 2019. Buildings of Class 5 to 8 (as per National Construction Code 2022), which includes all demountable offices, the concrete batching plant, were assessed under section 8.3.1 of PBP 2019. All Class 10 structures which includes storage sheds and containers, amenities facilities, and public shelters, were assessed under section 8.3.2 of PBP 2019. The assessment included a nominal buffer of 140 m around all construction impact areas to appropriately assess the bushfire threat, consistent with PBP 2019.

Compliance with Australian Standard 3959 *Construction of building in bushfire prone* areas and the National Australian Steel Housing Standard was considered when meeting the aims and objectives of PBP 2019 with regard to the temporary workers accommodation facilities.

Assessment of access, water supply and services, and emergency and evacuation was undertaken with the following aims:

- to provide safe access to/from the public road system for firefighters providing property protection during a bushfire and for occupant egress for evacuation
- to provide suitable emergency and evacuation (and relocation) arrangements for workers
- to provide adequate services of water for the protection of buildings during and after the passage of bushfire
- to locate gas and electricity so as not to contribute to the risk of fire to a building; and to provide for the storage of hazardous materials away from the hazard wherever possible.

Habitable structures

The performance of the temporary workers accommodation facilities was assessed against the same principles and criteria of Chapter 5 (Residential and Rural Residential Subdivision, although not requiring an approval from the NSW RFS), acknowledging section 8.2.1 of PBP 2019.

The following documents were reviewed to support the further assessment of bushfire risk:

- Bushfire Risk Management Plans (BFRMP) for the LGA
- AS/NZS 31000:2009 Risk Management - Principles and Guidelines
- Australian Government's Climate Change Impacts and Risk Management - A Guide for Business.

Public safety

The potential risks of the Proposal to public safety were assessed in regard to visitor safety and access, bushfire risks and the handling and use of dangerous goods.

Emergency management is discussed under dam safety.

6.13.2 Existing environment

Dam safety and emergency management

Clarrie Hall Dam is designed for water storage for water supply in accordance with the Clarrie Hall Dam Water Release Policy. The dam has a storage capacity of 16,000 ML at FSL and a catchment area of 60.2 km^2. The spillway discharge capacity of the dam at zero freeboard is 1,355 m^3/s (117,072 ML/d), which is 7 times the capacity of the dam. The maximum capacity of the outlet works at FSL is 9.7 m^3/s (838 ML/d). The outlet works are designed to meet guidelines for lowering the water level of the dam in the rare event of a potential dam failure.

Clarrie Hall Dam's FSL is the crest level of the spillway.

Flooding and dam influence

Clarrie Hall Dam has an uncontrolled spillway, which is designed for the sole purpose of safely passing a PMF event without compromising the integrity of the dam or spillway structures.

The dam does not have the capability to regulate or change the flow through the spillway nor regulate or maintain a surcharge above the spillway level. A dam with an uncontrolled spillway will still inherently attenuate and pass water when water surcharges above the FSL and naturally store water up to the level of the spillway crest.

Flood mitigation is therefore not possible at Clarrie Hall Dam other than what naturally occurs with an uncontrolled spillway.

However, Clarrie Hall Dam, like all open, un-gated spillway dams, helps mitigate against flooding to some extent, by reducing the peak height of a flood. This occurs even when a dam is full and water is passing via the spillway.

During periods of intense rainfall, excess water flowing into Clarrie Hall Dam flows over the dam's open, un-gated spillway. Because the dam is wider than Doon Doon Creek, with a large surface area and a narrow outlet (the spillway), it slows the flow of water, providing a marginal reduction in flood afflux (see Appendix F). If the dam did not exist, these large flows would flow quickly into the Tweed River, resulting in higher river flow peaks downstream.

Figure 6-86 demonstrates how Clarrie Hall Dam reduces the peak of water flowing out of the dam compared to the peak of water flowing into it.

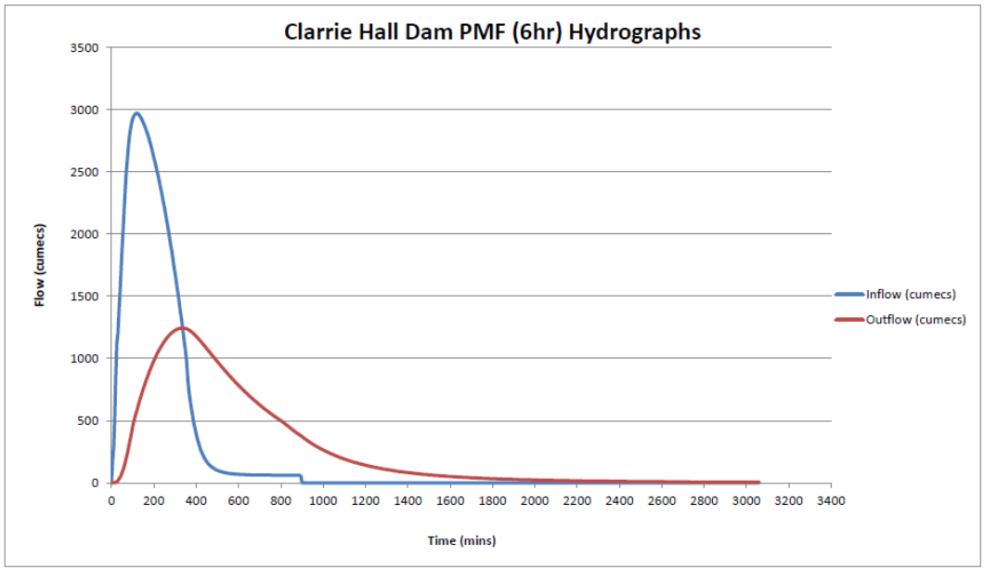


Figure 6-86 Clarrie Hall Dam reduction in peak outflow in comparison to peak inflow

Without the dam, the peak of outflow would be the same as the peak of inflow. With the dam, the peak of outflow is reduced, resulting in a reduction of peak impacts downstream. However, the overall duration of outflows is longer, compared to not having the dam.

Council manages releases from Clarrie Hall Dam for the following reasons:

- dam safety – Council undertakes controlled releases of water from Clarrie Hall Dam when it is deemed necessary for dam safety reasons.
- water supply – Council releases water to supplement flows in the Tweed River for extraction at Bray Park Weir for town water supply purposes. Council manages releases to balance the extraction needs at Bray Park Weir in accordance with the Tweed River Area Unregulated and Alluvial Water Sources Water Sharing Plan (WSP) 2023 (DCCEEW 2023a)
- environmental flow obligations in downstream waterways in accordance with the WSP
- water quality, including but not limited to managing algae blooms or saltwater intrusion at Bray Park Weir
- testing of dam operations or inspection of outlet works or spillway
- construction works related to the dam.

During a flood, Council continuously monitors the safety of Clarrie Hall Dam and provides information to relevant authorities consistent with Council's Dam Safety Emergency Plan.

Compliance

Dams are regulated by Dams Safety NSW, the NSW Government statutory authority under the *Dams Safety Act 2015* and Dams Safety Regulation 2019.

Council is the owner of Clarrie Hall Dam and therefore responsible for safety at Clarrie Hall Dam and reporting to Dams Safety NSW. Council regularly monitors and reports on the condition of the dam under these regulations.

Key data from the Annual Safety Standards Report dated 11 March 2024 is shown in Table 6-118 below.

Table 6-118 Key data from Clarrie Hall Dam Annual Safety Standards Report 2024

Dam Safety Report question	Data for Clarrie Hall Dam
Dam consequence category	High A
Date of the last consequence category assessment	28 February 2007
Date of next planned consequence category assessment	Currently being assessed
Has the number of people likely to be affected by a dam failure changed since the last consequence category review?	No
Is your dam above the safety threshold?	No
Do you know the date of your last risk report?	Yes
Date of last risk report	31 October 2008
Individual risk rating of the dam	$2.8x10^{-5}$ per annum which is below the regulated individual risk threshold of 1E-04 (0.0001) as required for an existing dam in accordance with clause 15(4c) of the *Dams Safety Regulation 2019 (2022 Reforms).*
Societal risk rating of the dam	$1.3x10^{-4}$ lives/year (which is lower than the societal acceptable risk threshold of 1E-03 (0.001) as required for an existing dam in accordance with clause 15(4)(a) of the *Dams Safety Regulation 2019 (2022 Reforms).*
Date of next planned risk report	Currently being assessed
Date of last dam safety management system review	28 February 2024
Date of last emergency plan review	7 March 2024
Date of last operations and maintenance plan review	28 February 2024

Council has a dam safety emergency plan in place for Clarrie Hall Dam. The plan is activated during floods when certain dam levels are reached, or immediately if other events such as an earthquake or other catastrophic events occur.

Dam safety inspections

Dam safety inspections are detailed by the owner provided in the dam safety management system. The inspections are required to meet Dam Safety Regulation 2019, ANCOLD guidelines, relevant standards and owners' requirements.

Consequence categories are used to determine the level and frequency of the required surveillance for the dam to ensure it can continue to operate safely. The consequence categories also define the extent and priority of any safety improvement measures if required and the design standards the dam must meet. Clarrie Hall Dam is classified as a high A consequence category dam.

The frequency of inspections for extreme and high A consequence category dams is shown below in Table 6-119.

Table 6-119 Frequency of inspections of local water utility dams

Consequence category	Comprehensive	Intermediate	Routine visual	Special
Extreme	On first filling, then 5-yearly	Annual	Daily	As required
High A, B, C	On first filling, then 5-yearly	Annual	Daily to three times per week	As required

Source: DPIE

Earthquake design

An updated seismic hazard study was carried out in 2017 by OZROCKS Geoservices Pty Ltd (OZROCKS, 2017). The maximum design earthquake for the dam is the 0.01% AEP (10,000 year) event (DSC3C).

Dam Safety Emergency Plan

Council has prepared a Dam Safety Emergency Plan (DSEP) for Clarrie Hall Dam (Tweed Shire Council, 2024) that covers flooding, earthquakes and other emergency situations.

Flood alert levels are key escalating and de-escalating action trigger points. The DSEP provides alert levels based on reservoir water level, as shown in Table 6-120.

As the existing spillway crest is equal to the FSL of the dam, all the alert levels in Table 6-120 are spill events and flood discharge via the spillway.

Table 6-120 Flooding alert levels

Alert level	Water level
Full supply level (no alert)	61.5 m AHD
Operational alarm	62.5 m AHD
White alert	64.5 m AHD
Amber alert	67.5 m AHD
Red alert	69.0 m AHD

It is noted that the top of the current wave wall is RL 70.4 m AHD. Therefore even 'red alert' is managed within the operating capacity of the spillway. The spillway is designed and was upgraded in 2014 to pass the to pass the then probable maximum discharge of 1,355 m^3/s associated with the PMF event (PWA 2018). The existing dam design can withstand a 600 mm depth of overtopping without major failure, in the event of a PMF event occurring. A PMF event would trigger a red alert.

The above alerts do not directly align to standard AEP event values.

Actions and emergency management for each alert level detailed within the DSEP are agreed with the State Emergency Service (SES) and communicated to other key stakeholders and affected parties.

The public warning system will be utilised by the SES when notified by Council. The first warning would be activated as the dam approaches amber alert and flooding is likely to continue.

Dam monitoring systems

Current dam monitoring systems assist with emergency management systems and controls. Table 6-121 shows the type of monitoring and instrumentation used to detect the development of emergency conditions.

Table 6-121 Dam instrumentation for monitoring

Type of instrumentation/monitoring		Locations	Normal monitoring frequency
27	Surface settlement points	Upstream	Two-yearly from 2014
11	Surface settlement points	Downstream	Two-yearly from 2014
1	Seepage weir	Toe of dam	Manually, minimum 3 days per week unless flooded
2	Seepage weirs; tunnel	L7R drain in dry tunnel	Continuously (telemetry)
1	Storage (ultrasonic)	At intake tower	Continuously (telemetry)
1	Rainfall	At intake tower	Daily/continuously (telemetry)
2	Left and right spillway seepage		Manually, minimum 3 days per week when spillway is **not** active

Dam monitoring, maintenance, serviceability and structural condition assessments, and inspections – in accordance with the dam safety management system – are ways to proactively manage the identification of hazards, assessment of risk and apply advanced controls to effectively control potential propagation events that could lead to failure including those from extreme seismic activity.

During an event that could be considered to escalate and lead to potential of dam failure, the public warning system will be utilised. SES is responsible for activating the system when notified by Council.

Failure due to flood levels overtopping the dam during PMF is not possible due to the spillway upgrade and wave wall raising in 2014 ensuring capacity for this design maximum event, as per the *Dam Safety Emergency Plan for Clarrie Hall Dam* (TSC 2024g).

Health – air quality

The existing air quality in the local airshed is influenced by:

- agricultural practices
- wind generated dust from exposed areas
- bushfires
- dust entrainment and exhaust emissions from vehicle movements along unsealed and sealed roads
- seasonal emissions from household wood heaters
- long-range transport of fine particles into the region.

More remote sources that contribute occasionally to suspended particulates in the region include dust storms and bushfires.

Meteorological data

There are no meteorological stations in the vicinity of the Proposal. The closest meteorological station is operated by BoM at Murwillumbah (Bray Park). This station, however, only records meteorological data at 9 am and 3 pm, which was not suitable for modelling use in the AQIA.

Although the data from Murwillumbah (Bray Park) monitoring station was not suitable for monitoring purposes, it can provide context for the existing environment. Murwillumbah experiences a mean annual 9 am wind speed of 8.2 km/h and mean annual 3 pm wind speed of 15.2 km/h). The 34-year average of wind direction at Murwillumbah demonstrates 9 am prevailing wind direction to be south-west, whereas the mean 3 pm prevailing wind direction is east (BOM, 2024). The annual mean 9am relative humidity is 76% at Murwillumbah and annual mean 3pm relative humidity is 59% (BOM, 2024). The mean maximum temperature is 25.8 °C at Murwillumbah and the mean minimum temperature is 14.5 °C (Bom 2024a).

North Maclean, Queensland, is the air quality monitoring station chosen to represent the baseline air quality conditions for the Proposal and the cumulative assessment portion of the AQIA. The summarised air quality data for North Maclean is presented in Table 6-122 for the period of 4 February 2021 to 31 December 2022.

Table 6-122 Statistics for PM_{10} and $PM_{2.5}$ concentrations – Department of Environment, Science and Innovation (DESI) – North Maclean, 2021 to 2022

Metric	Monitoring year	Maximum 24-hour average concentration (µg/m³)	Annual average concentration (µg/m³)	Number of days greater than 50*/25** µg/m³	Data recovery (%)
PM_{10}	2021	49.4	14.6	0	91
	2022	29.0	13.3	0	98
$PM^{2.5}$	2021	25.7	5.9	1	91
	2022	17.0	5.4	0	98

** for PM_{10}*

*** for $PM_{2.5}$*

Analysis of the 24-hour average particulate matter data for Maclean air quality monitoring station demonstrated the following for the period of 4 February 2021 to 31 December 2022:

- The maximum 24-hour average PM_{10} concentration was 49.4 µg/m^3 and the annual average concentration was 14.5 µg/m^3.
- The maximum 24-hour average $PM_{2.5}$ concentration was 21.6 µg/m^3 and the annual average concentration was 5.8 µg/m^3.
- The calculated TSP annual average background concentration was 36.3 µg/m^3.
- The assumed average dust deposition background value was assumed to be 2 g/m^2/month.

Modelling of existing conditions

CALMET (a diagnostic meteorological model) modelling for the Proposal locations diurnal profile shows that atmospheric instability increases during the daylight hours as the sun generates convective energy increases, whereas stable atmospheric conditions prevail during the night-time (Figure 6-87).

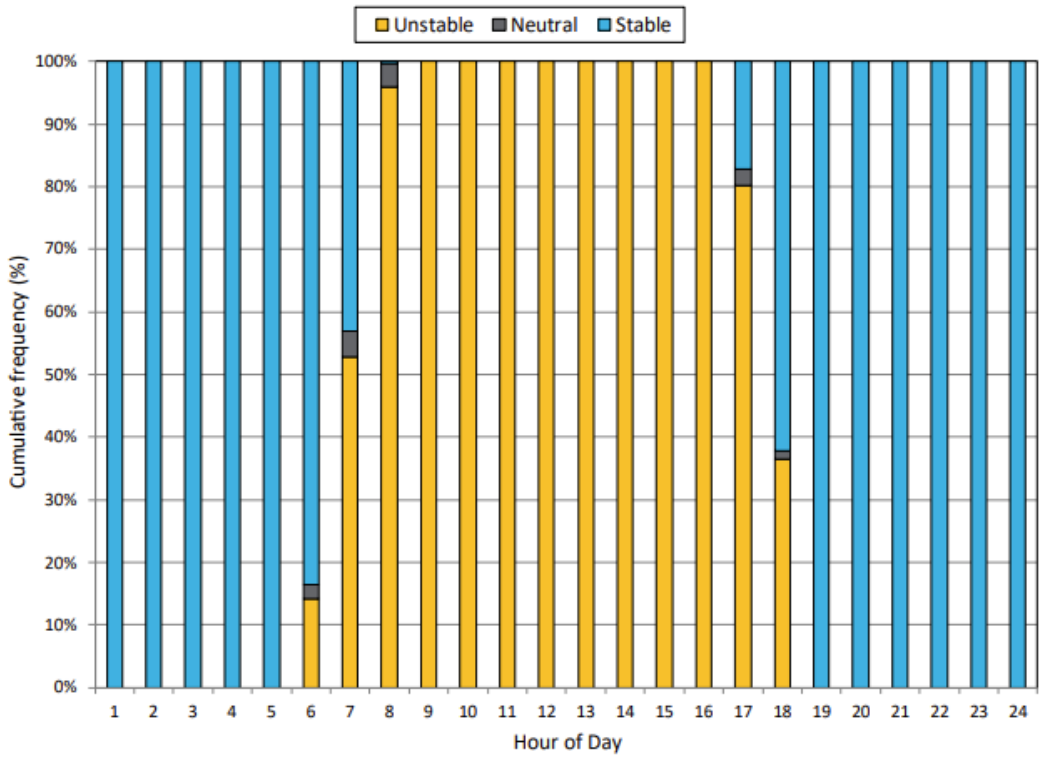


Figure 6-87 CALMET calculated diurnal variation in atmospheric stability ('no observations' mode)

Source: EMM Appendix Q

Mixing depth refers to the height of the atmosphere above ground level within which air pollution can be dispersed. The mixing depth of the atmosphere is influenced by mechanical (associated with wind speed) and thermal (associated with solar radiation) turbulence. CALMET modelling shows that higher daytime wind speeds and the onset of incoming solar radiation increase the amount of mechanical and convective turbulence in the atmosphere, where the boundary layer depth increases with turbulence.

Sensitive receivers

The sensitive locations (Figure 6-85) nearest to the Proposal were identified for the purpose of assessing potential air quality impacts. These sensitive receivers include a mix of private residences, recreational facilities and Proposal accommodation.

Bushfire risk

Clarrie Hall Dam is open for recreational uses such as bushwalking, nature appreciation (bird watching and nature photography), picnicking, recreational fishing, sailing, canoeing, kayaking and rowing, and electric powered boats, and special uses approved by council. Such activities introduce people to bushfire prone areas.

Weather

Clarrie Hall Dam is located within the Far North Coast region of NSW, where the climate is warm and subtropical.

The bushfire season within the locality generally runs from September to November; however, this statutorily extends to March most seasons due to hot summer temperatures and strong coastal winds. Prevailing winds associated with the bushfire peak season are north to north-westerly winds with high temperatures and low humidity. The worst seasons occur after prolonged periods of drought (NSW RFS 2017).

Site access

The existing dam embankment and proposed main construction area is accessed via Clarrie Hall Dam Road, which is a single entry and exit road accessed from Kyogle Road. The proposed upgrade of McCabes Bridge and realignment of Commissioners Creek Road would be accessed from Doon Doon Road. Access to Doon Doon Road and Commissioners Creek Road is via Kyogle Road only, with no alternative exit. The proposed temporary workers accommodation site options would be located on Tarcoola Lane (off Kyogle Road) (defined as WFA1) and Clarrie Hall Dam Road (defined as WFA2). Where temporary workers accommodation is located at WFA1, the proposed concrete batching plant would be located at WFA2, and vice versa.

Vegetation

Vegetation surrounding Clarrie Hall Dam is predominantly native forest characterised by wet sclerophyll forest and forested wetland formations (Keith, 2004), interspersed with pasture grasslands associated with agricultural practices (geo.seed.nsw.gov.au).

The proposed temporary workers accommodation facility WFA1 along Kyogle Road is located over grassland, with planted vegetation recorded along the roadside (Appendix R). Forested wetland occurs to the north and north-east of the Proposal area, associated with the Tweed River, and wet sclerophyll forest occurs upslope to the east and south-east on the other side of Kyogle Road.

Clarrie Hall Dam Road traverses Grassland to the east with wet sclerophyll forest present along the ridges extending down towards the road and WFA2, and forested wetlands to the west along Doon Doon Creek.

Further south around the proposed McCabes Bridge site compound and offices on Doon Doon Road, the vegetation is a mixture of grassland associated with historical clearing and agriculture, and wet sclerophyll forest associated with remnant bushland parcels, and riparian and road corridors. Elevated fuel loads are present within the road corridor, a result of unmanaged grasses and weeds, and edge effects.

Bushfire prone land

Bushfire prone land (BFPL) is land identified and mapped by Council and certified by the Commissioner of the NSW Rural Fire Service (RFS) that can support bushfire or is subject to bushfire attack. BFPL maps provide a trigger for development assessment provisions. Any land parcels affected must apply the legislative requirements for developing and building on BFPL.

The entire Proposal area lies within category 1, 2 or 3 BFPL or within a buffer area, shown in Figure 6-88. The defined buffer area for category 1 vegetation is 100 m, and for category 2 or 3 vegetation it is 30 m. The construction and operational areas for the dam raising are within category 1 BFPL or the buffer area. Category 1 vegetation is considered to be the highest risk for bushfire and is generally associated to forest, woodland, and heath vegetation (RFS 2015).

The grasslands at the southern end of the dam, and along Clarrie Hall Dam Road and Kyogle Road, are classified as category 3 BFPL. Category 3 is considered to be medium bushfire risk. The proposed temporary workers accommodation facilities and all site/construction compounds are situated in category 3 vegetation or within the buffer area.

The broader surrounding landscape is characterised by large tracts of category 1 vegetation on steep and elevated areas, with flatter low lying areas and valleys containing category 3 vegetation.

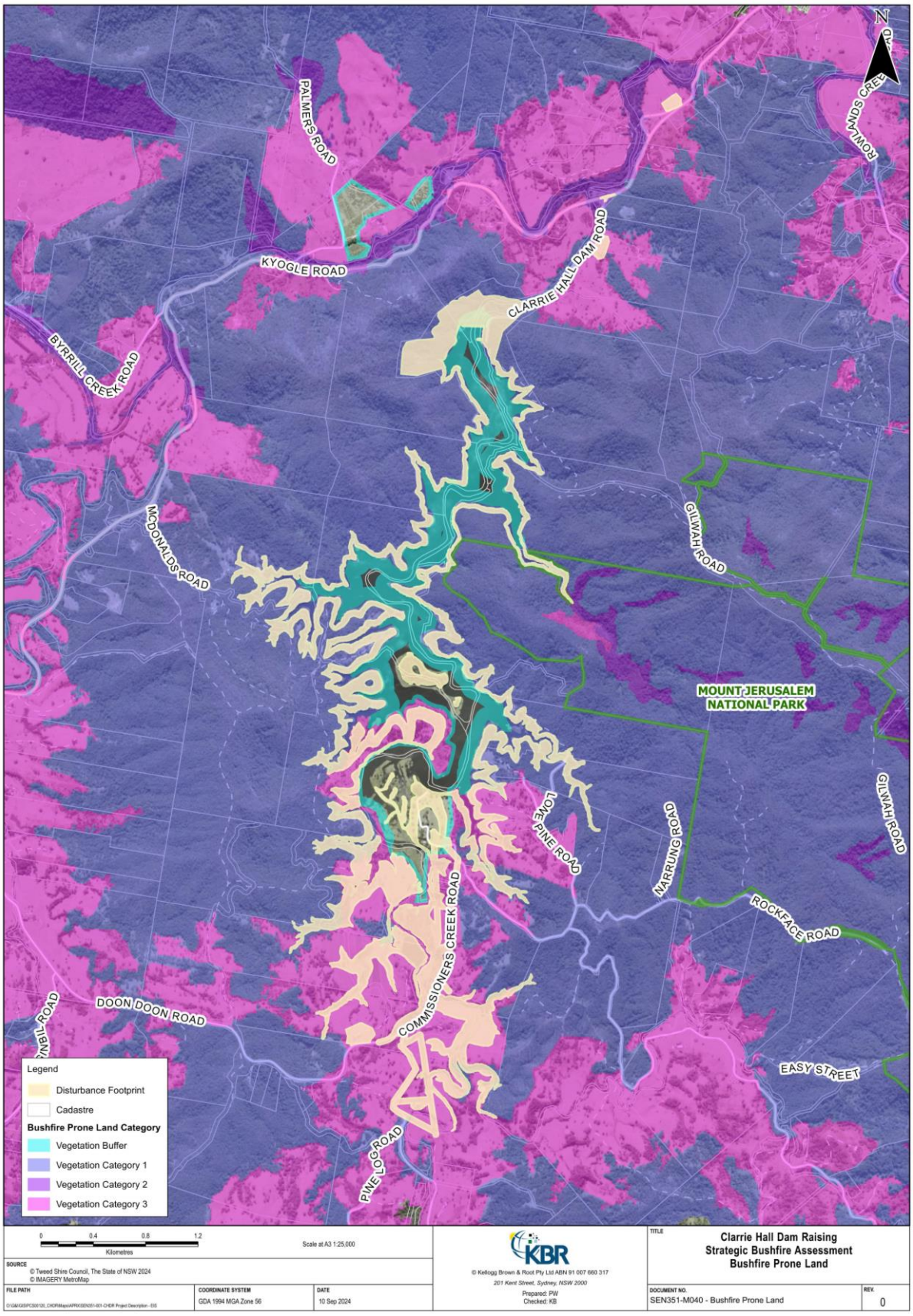


Figure 6-88 Bushfire prone land in the Proposal area

Topography

The northern portion of the Proposal area is characterised by mild to steep slopes between 5 degrees and 20 degrees. The slopes from the dam and embankment are upslope in all directions, with bushfire prone vegetation present upslope. Clarrie Hall Dam Road traverses through flatter terrain with mild undulation following Doon Doon Creek. Slopes are generally of a western aspect towards Doon Doon Creek and range between 0 to 5 degrees and 10 to 15 degrees.

The southern end of the dam is of a generally flatter topography, with undulation occurring between the various creek tributaries and slopes tending east and north progressing down Doon Doon Road towards the base of the dam.

Fire history and ignition

The main sources of ignition in the Far North Coast Bushfire Management Committee area are fire escape from legal or illegal fires (mainly prior to the introduction of the bushfire danger period), arson, and lightning strikes, resulting in, on average, 460 bushfires annually within the Committee area (Far North Coast BFRMP 2017).

Several large fires have impacted the locality and have burnt vegetation down to Clarrie Hall Dam Road and the current dam embankment (DPIE 2020h). The following fires have occurred within 1 km of the Proposal area:

- Kyogle Road Fire – burnt greater than 220ha of forest north and west of the dam, down to the water line in some areas including the Proposal area in 2019
- Gumboot Fire – burnt 607 ha of forest to the north and east of the dam down to the dam embankment in 2007– 08
- Wildfire – burnt 736 ha of forest to the edge of the eastern side of the dam in 1992– 93
- Wildfire – burnt 389 ha of forest across the Byrrill Ridge to the west of the dam in 1991– 92
- Wildfire – burnt 618 ha of forest and grassland south of the dam in 1980– 81
- Wildfire – burnt 13 ha of forest on the eastern edge of the dam within Mount Jerusalem National Park in 1974– 75
- Wildfire – burnt 153 ha of forest and grassland in the southeastern area of the dam in 1971– 72.

Public safety

Clarrie Hall Dam and the surrounding area has multiple existing public recreation areas, including:

- Clarrie Hall Dam recreation area (45 Clarrie Hall Dam Road, Uki NSW 2484) – which is open to the public year-round for day visits only. Access to the dam wall is via security gates on Clarrie Hall Dam Road, south-west of Uki, and the gates are open from 7.30 am to 5.30 pm (6.30 pm during daylight savings). Facilities at the dam wall include toilets, picnic areas and electric barbeques. No overnight camping is allowed
- Crams Farm recreation area (Commissioners Creek Road, Commissioners Creek NSW 2484) – which is open to the public from 7.30 am to 5.30 pm (6.30 pm during daylight savings). Access to Crams Farm is via security gates on Commissioners Creek Road. Crams Farm is the main recreational area for the dam, spanning 14 ha. Facilities include toilets, sheltered picnic areas and a boat ramp for launching watercraft. Swimming, overnight camping, livestock grazing, dogs or horses are prohibited in this area.
- 900 ha of Council-owned forested land that surrounds the dam
- Nearby Mount Jerusalem National Park.

6.13.3 Assessment of impacts

Potential impacts that may result from the construction and operation of the Proposal have been assessed.

Dam safety and emergency management

Dams Safety NSW regulates dam safety in NSW and is responsible for developing and implementing regulation of effective dam safety management to protect life, property and the environment from dam failures. The requirements of Dams Safety NSW are mandated under the *Dams Safety Act 2015*. Dams Safety NSW is responsible for examining the location, design, construction, operation and maintenance of prescribed dams, including any proposed changes.

Dams Safety NSW has produced a range of guidance sheets, as listed below, that are relevant to the Proposal:

- DSC2A: Dam safety management system
- DSC2B: Documentation and information flow over dam life cycle
- DSC2C: Surveillance reports for dams
- DSC2D: Demonstration of safety for dams
- DSC2F: Operation and maintenance for dams
- DSC2G: Emergency management for dams
- DSC2I: Community consultation and communication (CC&C)
- DSC3A: Consequence categories for dams
- DSC3B: Acceptable flood capacity for dams
- DSC3C: Acceptable earthquake capacity for dams
- DSC3D: Reliability of spillway flow control systems
- DSC3G: General dam safety considerations.

Design compliance

The Clarrie Hall Dam Raising Concept Design Report was prepared by NSW Public Works Advisory (Appendix B) in accordance with the requirements of the NSW Dams Safety Committee (DSC) and Australian National Committee on Large Dams (ANCOLD). According to the latest Dambreak Study (NSW Public Works, 2007), Clarrie Hall Dam is assigned a high A sunny day consequence category (SDCC) and a high A to 'extreme' flood consequence category (FCC).

The maximum design earthquake (MDE) from DSC3C (June 2010) for high A SDCC dams is assessed to be the 0.01% AEP (10,000 year) event. This was recently reviewed by OZROCKS Geoservices Pty Ltd (2017), who conducted an updated seismic hazard study and confirmed the maximum design earthquake for the dam is the 0.01% AEP (10,000 year) event (DSC3C).

The acceptable flood capacity (AFC) starting point, as outlined in NSW Dam Safety Committee Guidance Sheet DSC3B: Acceptable flood capacity for dams (June 2010) for extreme FCC dams, is the PMF. The PMF flood event has therefore been used as a basis for key design requirements.

The DSC was consulted regarding the determination of the consequence category used for Clarrie Hall Dam. The maximum FCC resulting from the Dambreak was high A to extreme. The extreme FCC was selected in discussion with the DSC and Council in order to allow for future development in the downstream catchment and potential increase to the Clarrie Hall Dam storage. It is noted

that, while the adoption of the extreme consequence category assigns the raised dam to withstand a high level of flood impact, it also provides long-term assurance of its integrity and safety.

The concept design as outlined in the Clarrie Hall Dam Raising Concept Design Report (Appendix B) not only satisfies Dams Safety NSW requirements but is also in accordance with all relevant ANCOLD guidelines, Australian Standards and current best practice, including:

- ANCOLD, Guidelines on Concrete Faced Rockfill Dams
- NSW Dams Safety Committee, DSC3A: Consequence categories for dams
- NSW Dams Safety Committee, DSC3B: Acceptable flood capacity for dams
- NSW Dams Safety Committee, DSC3C: Acceptable earthquake capacity for dams.

Throughout the detailed design process, there would be ongoing consultation and assessment with Dams Safety NSW and others as relevant to ensure that the design continues to meet legislative and other requirements.

Operation

The key risk to public safety during operation is a breach of the embankment of the raised dam. The modes of failure include flood failure and sunny day failure (which is failure not associated with flood and includes seismic event failure). The DSC3B and DSC3C prescribes the maximum flood and seismic events the design must pass without failure dependant on the assigned dam consequence category. Given the high consequences of dam safety risks, the design and construction of the dam would be completed to meet or exceed appropriate engineering standards and safety criteria as detailed above. The standards of design, construction and operation of the dam would reflect the level of potential adverse consequences from a dam failure.

Flood modelling of the raised dam has been undertaken and is summarised in section 6.1.3. The completion of the Proposal would result in a reduction of peak flows for all flood AEP events due to the upgraded spillway design. Modelling showed peak water levels were simulated to be lowered by up to 250 mm. Changes to flood extents downstream of the dam would be minimal, with sporadic reductions in flood levels. Upstream of the dam, increases in the flood water levels of up to 7.6 m would be attributed to raising the dam's spillway by 8.5 m. The main impacts of upstream flood impacts would be confined to the main waterway corridors and not require mitigation measures. It is noted that no buildings would be impacted by the increased flood extents and levels upstream of the dam. Only some properties situated within the vicinity of the additional storage area would experience encroachment from increased flood extents.

The outcomes of the flood assessment shows that there is a small increase in risk due to the proposed dam upgrade, upstream of the dam, which are mainly confined within the waterway corridors.

Following practical completion of the Proposal, the dam safety updates will incorporate new flood management trigger levels into the Operations and Maintenance Manual in accordance with Dams Safety NSW DSC2F Operation and Maintenance for Dams, which includes:

- proper operation and maintenance of the dam using trained personnel
- regular dam surveillance using trained personnel
- appropriate dam safety emergency plans to be in place for those dams whose failure could cause loss of life
- ongoing assessment of dam behaviour based on surveillance information
- periodic review of the dam's compliance with current Dams Safety NSW requirements

- review of all dam information and assessments by experienced personnel
- actions, in response to dam assessments, to ensure that their dams are maintained in a safe condition.

This will be conducted in consultation with the SES.

Societal and individual risk rating

The Proposal for the raised dam would be considered as a major augmentation to an existing dam. Due to this, the *Dams Safety Regulation 2019* requires the owner of a declared dam to set out in a report the societal and individual risk rating of the dam (or proposed dam) calculated in accordance with the methodology outlined in Government Gazette of the State of New South Wales Number 113. This would be conducted during detailed design, and the societal risk rating and Individual risk rating for the raised dam would be determined.

Health and safety of construction personnel

The *Work Health and Safety Act 2011* (WHS Act) is the principal legislation providing a nationally consistent framework to secure the health and safety of workers and workplaces. Section 26 of the WHS Act states the requirement of a proponent to ensure that they commission structures that are without risk to health and safety for workers throughout their lifecycle and consider the risk to those in and around the workplace.

Under the Work Health and Safety Regulation 2017, proponents have an obligation to consult with designers on how to eliminate or minimise risks to health and safety. Safety in design will be addressed during detailed design, in accordance with this requirement.

The construction of the raised dam wall and associated ancillary infrastructure would involve undertaking high-risk construction work, as defined under Chapter 6, Part 6.1, section 291 of the Work Health and Safety Regulation 2017. The high-risk work involves:

- clearing and grading
- rock stripping
- quarrying / rock processing / material movement and placing
- blasting
- concrete batching plants works
- rock and concrete processing creating silica dusts
- diesel-powered plant and power generation
- concreting
- rock drilling and anchoring
- hydro-demolition
- risk of a person falling more than 2 m
- demolition of an element of a structure that is load-bearing
- demolition of an element of a structure that is related to the physical integrity of the structure
- disturbing asbestos (or is likely to involve this)
- structural alteration or repair that requires temporary support to prevent collapse
- being carried out in or near a confined space

- being carried out in or near a shaft or trench deeper than 1.5 m or a tunnel
- the use of explosives
- being carried out on or near energised electrical installations or services
- tilt-up or precast concrete
- being carried out on, in or adjacent to a road, railway, shipping lane or other traffic corridor in use by traffic other than pedestrians
- being carried out in an area of a workplace where there is any movement of powered mobile plant
- being carried out in or near water or other liquid that involves a risk of drowning
- diving work.

Safe Work Method Statements will be prepared for all high-risk work as part of a Safety Management Plan for construction.

Flood risk during construction

Construction of the raised embankment requires access to the dam wall below the FSL. This would expose the dam wall construction area to dam spills and flooding resulting in potential impacts to worker safety, construction works and scheduling, plant and equipment, erosion and sedimentation, and water quality. Debris may potentially wash downstream causing environmental and safety impacts.

There is also potential for the integrity of the dam to be compromised during construction. This may be due to blasting and flooding. Blasting would be planned to ensure that ANZECC Guideline overpressure and ground vibration limits would be achieved, thus reducing the risk of critical infrastructure damage.

The following preliminary flood management measures for construction are proposed and these will be reviewed, refined and supplemented during detailed design.

- To ensure access for construction personnel and completion of the works, it is proposed to lower the FSL by up to 300 mm. Lowering the FSL would also reduce the risk of water quality impacts from possible spills and reduce the risk of construction flooding. However, rainfall within the catchment will increase the stored level and may lead to releases via the spillway. This will require regular monitoring of the weather and dam water level monitoring, and planning of construction works accordingly.
- Lowering the FSL of the storage by more than 300mm will be investigated during detailed design when the construction methodology and sequencing is confirmed. The dam should be lowered to provide capacity during a flood to protect construction works up to the 1 in 20 chance in a year rain event and allow sufficient time to move plant and equipment and secure the construction area. A similar level of flood mitigation would be provided to downstream flood prone areas.
- Coffer dams would be constructed upstream of the auxiliary spillway works and downstream of the dam wall works.
- Temporary spillway gates may be used during the construction of the new spillway.
- The alternative construction methodology provided in Chapter 3 allows the staging of the spillway works to ensure that one spillway is always able to pass floodwaters.

Detailed design and safety in design will include further investigation of the above options, and also include appropriate risk assessments to address the safety of construction personnel and the general public.

Consultation with the SES will be conducted throughout detailed design and construction to provide inputs to any changes, trigger levels, notifications and actions, including final flood alert levels and trigger points to the Emergency Management Plan for construction.

The design and construction would be undertaken in accordance with a flood management strategy, which would include the sequencing of construction events to ensure that the risk to public is not increased during construction.

Construction sequencing would be planned to ensure that flooding cannot cause dam overtopping and failure due to the need to reduce the spillway capacity at times during construction.

Existing downstream flows would be maintained by diverting water around the dam construction site.

Handling and use of dangerous goods

Storage and handling of the following dangerous goods will be required:

- **clearing and grading:** fuels, oils, lubricants, paints, chemicals, herbicides
- **rock stripping:** fuels, oils, lubricants, paints, chemicals, production of silica dusts
- **quarrying / rock processing / material movement and placing**: fuels, oils, lubricants, paints, chemicals, production of silica dusts
- **rock blasting, cutting and splitting:** fuels, oils, lubricants, paints, chemicals, explosives, production of silica dusts
- **concrete batching plants:** fuels, oils, lubricants, paints, chemicals, silica dusts
- **diesel powered plant and power generation:** fuels, oils, lubricants, paints, chemicals
- **work sections – embankment, spillway, quarry, material processing, intake tower, McCabes Bridge:** fuels, oils, lubricants, paints, chemicals, asbestos, production of silica dusts.

Schedule 11 of the Work Health and Safety Regulation 2017 identifies the quantities of hazardous chemicals (dangerous goods) at which notification, placards and manifests are required. Storage, handling or processing of Schedule 11 hazardous chemicals that exceed the quantities specified requires:

- notifying SafeWork NSW
- preparing an emergency plan and providing a copy to Fire and Rescue NSW.

Hazardous chemicals can cause fires, explosion, injure or poison people, or damage property if they are not stored correctly. Some hazardous chemicals are not compatible –incompatible chemicals will be identified and stored away from each other to minimise the risk of adverse reactions occurring.

Storage and handling of hazardous chemicals would be conducted in accordance with the Work Health and Safety Regulations 2017 and other requirements.

Mitigation measures for the transport and handling of hazardous chemicals are provided in section 6.13.4.

Emergency management

Emergency management during construction has considered the following:

- **Evacuation and access:** Due to the rural location of the construction sites, Clarrie Hall Dam and McCabes Bridge have generally restricted access due to single primary access points being Clarrie Hall Dam Road and Doon Doon Road respectively. This requires a risk assessment and controls to be developed and included in an Emergency Management Plan with back-up notification systems to ensure communication, should risks such as bushfires be identified.
- **Contingency measures:** The Emergency Management Plan would include contingency measures for communication and notification of evacuation. Contingency controls may include boat access in case land-based egress routes are restricted.
- **Measures to manage risk to life from flood:** Construction will allow continued serviceability of the dam and be undertaken to ensure structural integrity is not compromised. Detailed design will include construction staging that considers management of dam safety as follows.
  - Detailed design will be subject to independent review by a panel of dam experts; construction staging is an important element of such a review. Contractor involvement and methodology development is also important.
  - Maintenance or provision of an operational spillway is required in accordance with dam safety and construction safety requirements as discussed previously.
  - Monitoring of weather, dam storage levels and incoming flows will be required during construction. Construction methods for spillway works (existing and new) will be developed with consideration of flood spill events with various trigger levels including full demobilisation from the area effected.
  - Monitoring data, trigger levels and alert systems will be developed, tested and communicated as part of the Emergency Management Plan.
  - Existing flood alert levels will be reviewed and updated if required, to match construction staging. Existing storage and river gauging locations will also be reviewed to ensure data integrity and continuity.
- **Consultation with the SES:** Consultation with the SES will be required throughout detailed design and construction to provide inputs to any changes, trigger levels, notifications and actions, including final flood alert levels and trigger points. Consultation with the SES during preparation of this EIS is detailed in Chapter 5.

Health

Construction

Impacts to the health of the public during construction may occur as a result of:

- contamination of water supply due to erosion and sedimentation, chemical spill or restriction in operation of selective take-off from the intake tower
- noise/dust/vibration from:
  - increased traffic and heavy vehicle movements and out-of-hours transportation
  - general construction activities including clearing and grading, quarrying and blasting, operation of the concrete batch plant and operation of plant and equipment
- traffic flow / travel delay / road safety
- integrity of the dam to be compromised due to blasting and flooding

- stress due to the aforementioned impacts.

The potential health impacts listed above to the surrounding community have been assessed in the various specialist assessments included in this EIS.

The construction and operation of the Proposal are not expected to change water quality in a manner that would impact public health (see section 6.1).

The noise and vibration impacts associated with the construction of the Proposal identified likely occurrences of noise exceeding the current noise disturbance guidelines. However, this would not be harmful to public health and safety (see section 6.12) and appropriate mitigation measures would be applied where exceedances may occur (section 6.12.4).

The construction of the Proposal would involve the removal of potential asbestos containing material, this would be handled in accordance with the Protection of the Environment Operations (Waste) Regulation 2014, *WHS Act* and WHS Regulations to avoid public health impacts (see section 6.8).

Management of traffic during construction of the Proposal would mitigate risks to public health (see section 6.14).

Implementation of management measures associated with reducing bushfire risk during the construction and operation of the Proposal would reduce bushfire risk and therefore benefit public health and safety (see section 6.13.4).

Measures to reduce downstream flood risk and blasting risks during construction are discussed previously and provided in section 6.13.4.

Air quality is discussed below.

Operation

Water quality monitoring would be required as the storage raises to its new FSL. The initial wetting of the inundation area and disturbed lands from the construction works may alter taste, turbidity and chemical composition of the stored water. Due to the release of flows to Doon Doon Creek and Bray Park Weir, before extraction and treatment, natural balance may be re-established without additional treatment. No health issues are anticipated from such events and treatment processes will continue to ensure safe water; however, some taste change may be noticed by customers.

Air quality

Construction

Construction of the Proposal would generate emissions of:

- particulate matter, specifically:
  - total suspended particulate matter (TSP)
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10})
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$)
- deposited dust
- gaseous pollutants, specifically:
  - oxides of nitrogen (NO_x), including nitrogen dioxide (NO_2)
  - sulfur dioxide (SO_2)
  - carbon monoxide (CO)

- volatile organic compounds (VOCs).

Construction will involve the handling, transfer and emplacement of soil and rock, resulting in most impacts during construction being from fugitive emissions sources. In comparison to operational impacts, the construction phase represents the most significant period of the dam for potential air quality impacts.

The main emissions associated with construction of the Proposal are PM_{10}, $PM_{2.5}$ and TSP. Particles less than 10 µm and 2.5 µm in diameter are small enough to enter the human respiratory system and can lead to adverse health impacts. TSP, which relates to airborne particles less than around 30 µm in diameter, is used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of buildings and surfaces) rather than health impacts (NSW EPA 2013).

The remainder of emissions would be emissions of gaseous pollutants (e.g. NO_x, SO_2, CO and VOCs) from mobile and stationery diesel equipment during construction.

The most significant areas of dust generation are at the quarry, spillway, embankment and concrete batching plant. Therefore, the emissions inventory includes specific activities related to these areas. The main dust-generating sources included in the inventory are:

- stripping soil and overburden
- loading and unloading soil, overburden and rock
- drilling and blasting
- excavating rock
- crushing and screening rock
- hauling materials on unpaved roads
- hauling concrete on paved roads
- concrete batching plant operations
- wind erosion from exposed areas
- diesel combustion from plant equipment and trucks.

The realignment of Commissioners Creek Road and the replacement of McCabes Bridge would involve the following dust or air impacts:

- trucks hauling materials to and from the area
- wind erosion from stockpiles
- diesel combustion from trucks.

It is noted that the haul routes to and from the Commissioners Creek Road/McCabes Bridge construction area is paved, and stockpile areas prone to wind erosion are likely to be small in comparison to the main works at the spillway and embankment area. The residences closest to McCabes Bridge works are approximately 200 m away and are predominantly separated by large trees. Impacts to these areas would be considered relatively minor in comparison to the main works (i.e. the spillway and embankment).

It is noted that predicted impacts at assessment locations surrounding the main construction works were well below the assessment criteria (Table 6-117). Therefore, residences surrounding the ancillary works are also likely to be well below assessment criteria. Dust mitigation measures would be applied in these areas to manage any potential air quality impacts at surrounding residences.

CALMET diurnal profile modelling of the Proposal (Figure 6-87) indicates that the potential for effective atmospheric dispersion of emissions will be greatest during daytime hours and lowest during the evening through to early morning hours.

Similarly to the CALMET diurnal profile (Figure 6-87), high turbulence experienced during daytime hours (peaking in mid to late afternoon) would lead to an increase in depth of the boundary layer, generally contributing to higher mixing depths and greater potential for the atmospheric dispersion of pollutants.

Modelling of annual TSP, PM_{10} and $PM_{2.5}$ emissions for the duration of the Proposal for each emission source was undertaken, and the results are shown in Table 6-123. The modelling considers 2 scenarios for the CBP, where option 1 is located along Kyogle Road and option 2 is located along Clarrie Hall Dam Road, closer to the main works of the Proposal. From the data in Table 6-123, the most significant source of particulate matter emissions from the Proposal's construction activities were hauling materials on unpaved and paved roads, diesel combustion, and material handling. Details of annual emissions per activity are provided in Appendix Q.

Table 6-123 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions

Emission source	Calculated annual emissions (kg/year) by source		
	TSP	PM_{10}	$PM_{2.5}$
Rock quarrying	11,072	3,236	304
Spillway construction	2,777	785	78
Embankment construction	707	227	28
All wind erosion (excluding CBPs)	3,010	1,505	226
Other	10,878	10,878	9,972
CBP – option 1	3,824	1,017	291
CBP – option 2	7,247	1,628	446
Total kg/y with CBP option 1	**32,268**	**17,468**	**10,898**
Total kg/y with CBP option 2	**35,691**	**18,259**	**10,053**

Dispersion modelling was undertaken for predicted incremental TSP, PM_{10}, $PM_{2.5}$ and dust deposition levels during construction for each of the 45 assessment locations. Scenarios of both CBP option 1 and CPB option 2 were considered in this assessment. The predicted concentrations and deposition rates for all pollutants and averaging periods are below the applicable NSW EPA assessment criterion at all assessment locations for both modelled scenarios. Therefore, the predicted contribution of air quality sources at the CBP was minor when compared to the total concentrations and the impact assessment criteria. For example, for 24-hour PM10 concentrations, the maximum predicted contribution from the CBP was 0.79 µg/m^3 at R22 (the closest to CBP option 1) or 0.87 µg/m^3 at R28 (the closes to CBP option 2). This represents 1.6% and 1.7% of the impact assessment criterion of 50 µg/m^3, respectively.

Cumulative impacts (i.e. the dam works, CBP and background) at each assessment location was also modelled to 'demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity' (NSW EPA 2022). The predicted concentrations and deposition rates for cumulative TSP, PM_{10}, $PM_{2.5}$ and dust deposition did not exceed the applicable impact assessment criteria at any of the assessment locations for both modelled scenarios. A cumulative maximum 24-hour average PM10 concentration of 50 µg/m^3 was predicted to occur on one day at assessment locations R3 and R23. This result was due to an existing background concentration of 49.4 µg/m^3 which was the result of a regional scale dust event which caused

elevated concentrations across large parts of south-east Queensland. On this day, the predicted contribution from the Proposal was 0.6 µg/m^3 at both R3 and R23.

It is noted that the CBP option 2 location produced slightly higher predictions. However, as above, modelling results for both options did not exceed the impact assessment criterion.

A range of mitigation measures would be implemented during the Proposal's construction phase. These measures were incorporated into the emissions calculations and dispersion modelling in the AQIA wherever an appropriate emission control factor (or reduction factor) was available. Appropriate mitigation measures for air quality impacts are detailed in section 6.13.4.

Changes in air quality due to construction of the Proposal do not exceed EPA guidelines and therefore would not pose impact to public health.

Operation

Operational phase emissions would principally consist of emissions from:

- wheel-generated dust emissions from the movement of vehicles along traffic routes between dam infrastructure on sealed roads
- fuel combustion (petrol, diesel) from vehicles travelling between dam infrastructure.

The volume of traffic and fuel combustion associated with the operation of the dam is likely to be significantly lower than the construction phase and no change to current operations. Consequently, air pollution emissions from the operations phase of the dam will be negligible relative to the construction phase.

Bushfire

Construction

The majority of changes to bushfire risk would occur during the construction phase of the Proposal, where high risk activities could result in an increased risk of ignition. High risk activities associated with bushfire include, but are not limited to, hot works (e.g. grinding and welding), vegetation slashing and vehicles traversing long grass. Ignition sources during construction include:

- fires
- smoking
- battery charging
- combustion engines (hot exhausts)
- chemical reactions
- explosive charge
- sparking from tools and rock breaking.

Management of ignition sources are provided in section 6.13.4.

In the southern portion of the Proposal, the electrical and telecommunications infrastructure would be realigned. The bushfire risk associated with this ancillary site would be assessed and managed by the utility company performing these services.

Appropriate vegetation setbacks, known as asset protection zones (APZs), will be required before construction starts, to assist in protection of assets. Additionally, the increased level of site observation may also aid in early detection of ignition.

Risk of arson would be unlikely to increase as a result of construction activities due to increased personnel on site.

Management of bushfire risk during construction

Management of bushfire risk during construction of the Proposal is discussed below.

APZ and easement landscape management actions (including, but not limited to slashing, mowing, landscaping and garden maintenance and fire breaks) are required to protect assets and prevent the spread of fire as follows:

- Providing a fuel-reduced, physical separation between structures, assets and bushfire hazards would provide sufficient space and maintain reduced fuel loads to ensure radiant heat level exposure is below critical limits and prevent direct flame contact to any Project-related structure.
- An APZ would also allow emergency services access and provides a safer area for firefighters to defend assets and mitigate intense radiant heat and direct flame zone.
- APZs around construction and operational areas are specific to buildings, and significant infrastructure as deemed appropriate by Council to the risk of loss.
- APZ are not necessary for open areas of construction such as quarries, earthworks, haul roads.
- Recommended APZ for construction and operation areas are provided in Table 6-124, noting that APZs may be constrained by environmental values including the clearing of native vegetation. Where the APZ is constrained, tolerable risk would be assessed.
- APZs for temporary workers accommodation facilities were determined using method 1 of AS 3959 *Construction of building in bushfire prone areas*. The prescribed APZs would ensure radiant heat exposure to the perimeter of the accommodation structures would not exceed 29 kW/m^2, based on existing vegetation and slope. APZs for WFA1 and WFA2 are shown in Figure 6-89 and Figure 6-90 respectively.

Table 6-124 Asset protection zones – construction and operational areas

Area / Structure	Asset protection zone
Class 5–8 buildings: including all offices and the concrete batching plant, and significant infrastructure including the dam embankment	A 15 m APZ where possible is recommended for such buildings and infrastructure due to the proximity and distribution of bushfire prone vegetation around the construction footprint. The APZ must be wholly within the boundaries of the development footprint and can include areas cleared for construction works such as lay-down areas. It must be maintained for the duration of construction and for the life of the dam.
Class 10 structures: including all sheds, containers, other storage spaces, amenities facilities, public shelters, and fences	A minimum 15 m APZ is recommended around these structures. The APZ must be wholly within the boundaries of the development footprint be maintained for the duration of the construction activity, and for the life of the dam for any operational facilities. Where the opportunity to increase this distance arises, due to disturbance or clearing associated to the Proposal, this option should be considered to reduce the risk of loss during a bushfire event.
Workers accommodation option 1: located on Tarcoola Lane off Kyogle Road (see Figure 6-89)	• North-east (downslope): 10 m APZ • South-east (upslope): 20 m APZ • South-west (upslope): 10 m APZ • North-west (downslope): 11 m APZ
Workers accommodation option 2: located on Clarrie Hall Dam Road (see Figure 6-90)	• North-east (upslope): 20 m APZ • South-east (upslope): 20 m APZ • South-west (downslope): 10 m APZ • North-west (downslope): 17 m APZ



Figure 6-89 Asset protection zone for WFA1



Figure 6-90 Asset protection zone for WFA2

The Proposal would require vegetation clearing within the construction footprint. Where vegetation is retained or reinstated (revegetation), it would require appropriate landscape management, as summarised below and included in section 6.13.4.

Electricity and gas provisions to the temporary workers accommodation facility would be installed to the relevant standards, thereby limiting the possibility of ignition of surrounding bushland or the fabric of buildings or structures.

Section 6.13.4 details bushfire protection measures recommended for the Proposal and fire suppression capabilities.

Management of bushfire risk during operation

The bushfire risk profile of the existing Clarrie Hall Dam is unlikely to be significantly altered by the raising of the dam embankment.

Upgrades to civil infrastructure would support access requirements for emergency services that may be required to attend a bushfire event at the dam or in the area, and water resources established for bushfire protection during construction should remain if appropriate.

Over the expected lifespan of the Proposal, the climate is projected to change, potentially resulting in more days of higher fire danger than previously experienced, and projected fire danger rating (FDR) exceeding current levels (Douglas 2017). Planning for long-term infrastructure should include consideration of the potential for increased fire danger and potentially higher fire frequencies.

Risk of arson would be unlikely to increase as a result of operational activities. Security measures would be incorporated as deemed appropriate by Council.

Landscaping of APZ areas during construction and operation would be managed to the prescribed standards for an inner protection area (IPA) as detailed in PBP 2019 Appendix 4, and the following:

- Trees:
  - Tree canopy cover should be less than 15% at maturity.
  - Trees at maturity should not touch or overhang the building.
  - Lower limbs should be removed up to a height of 2 m above the ground.
  - Tree canopies should be separated by 2 to 5 m.
  - Preference should be given to smooth barked and evergreen trees.
- Shrubs:
  - Large breaks or gaps in the vegetation to slow down or break the progress of fire towards buildings should be provided.
  - Shrubs should not be located under trees.
  - Shrubs should not form more than 10% ground cover.
  - Clumps of shrubs should be separated from exposed windows and doors by a distance of at least twice the height of the vegetation.
- Grass:
  - Grass should be kept mown (as a guide grass should be kept to no more than 100 mm in height).
  - Leaves and vegetation debris should be removed.

Landscaping requirements would be incorporated into a vegetation management plan.

Emergency access and management

Access measures must be maintained to provide safe operational access to infrastructure and water supply for emergency services, while residents are seeking to evacuate from an area. The current access roads that will be used for the Proposal area are:

- Kyogle Road – Kyogle Road runs across the north and down the west side of the Proposal Area, connecting Uki to Kunghur. It is an all-weather sealed through road, approximately 8m in width. Notably, there are Rural Fire Service brigades at both Uki and Kunghur. The proposed WFA1 is located on Kyogle Road.
- Clarrie Hall Dam Road – Access to the dam embankment construction and operational area, and proposed WFA2, will be provided from Clarrie Hall Dam Road that runs northeast from the dam, joining to Kyogle Road. Clarrie Hall Dam Road which is an all-weather sealed road approximately 7m in width. It is a no through road terminating at the Clarrie Hall Dam. A lockable gate is present at the entry to Clarrie Hall Dam Road.
- Doon Doon Road and Commissioners Creek Road – The McCabes Bridge construction area and site compound is accessed via Doon Doon Road, which also joins on to Kyogle Road. Doon Doon Road is an all-weather sealed road approximately 7m in width. It links on to Commissioners Creek Road for access to McCabes Bridge and the site compound. Doon Doon Road is a no through road.

These access roads are all public roads and will provide an all-weather carriageway of more than 4 m wide for the life of the Proposal. These roads would additionally be utilised to support access for heavy vehicles transporting and storing dam infrastructure associated with the Proposal. All access roads would be capable of supporting Cat-1 fire vehicle access, consistent with the NSW RFS Fire Trail Standards (NSW RFS 2019).

The proposed temporary workers accommodation facility WFA2 is proposed on a no-through-road, and primary access is achieved through forest, increasing the risk if evacuation is required. If WFA2 were to be progressed, the access roads to WFA2 are to provide a minimum trafficable width of 6 m (in accordance with Table 7.4a, PBP 2019). Where this cannot be achieved, turning-points and passing bays would be established in accordance with the NSW RFS Fire Trail Standards (NSW RFS 2019).

A higher reliance on the emergency management and evacuation planning would be necessary during the construction phase, in particular evacuation triggers, as well as passive fire protection such as APZs.

The Proposal will provide adequate services of water for the protection of structures and suppression of bushfire and will locate gas and electricity so as not to contribute to the risk of fire. Although the dam can provide sufficient volumes of water, appropriate access and connection would be necessary for attending fire services if this was to be considered an option. To support fire suppression around the facilities, a 20,000 L water tank (static water supply) constructed of non-combustible material (steel or concrete) is recommended for construction operations and the temporary workers accommodation facility. An additional 20,000 L water tank is recommended to be established at the site compound at the southern portion of the Proposal. Further details of this mitigation measure are provided in section 6.13.4.

Public safety

Dam Safety and emergency management and Construction flooding provides information regarding public safety related to flooding.

Construction

During construction, the Clarrie Hall Dam recreational area is expected to be closed to the public for the full duration of the works. Partial or short-term closure, or isolation from public access, of the Crams Farm recreational area may also be required to allow construction of the McCabes Bridge works.

Operation

Public areas would be returned and reopened once works and inspections are complete. Visitor safety will be similar to currently.

6.13.4 Mitigation measures

Table 6-125 identifies the measures that would be implemented during construction and operation of the Proposal to mitigate health and safety impacts.

Table 6-125 Dam safety, health and safety, bushfire risk and air quality mitigation measures

Reference	Impact	Mitigation measures	Responsibility	Timeframe
Dam safety				
DS1	Dam break and risk rating	A Dam Break study would be undertaken during the detailed design phase to determine the Proposal's flood consequence category (FCC) and sunny day consequence category (SDCC). Dams Safety Regulation 2019 requires the owner of a declared dam to set out in a report the societal and individual risk rating of the dam (or proposed dam) calculated in accordance with the methodology outlined in Government Gazette of the State of New South Wales Number 113.	Design Contractor	Detailed design
DS2	Water supply level	To allow the construction of the embankment and spillway, the dam water supply level would be lowered by 300 mm to allow construction personnel adequate access to complete the works. The lowering of the water supply level would additionally contribute to lowering construction flood risk associated with the works.	Construction contractor, Council	Construction
DS3	Emergency management	During flood conditions, Council would continuously monitor the safety of Clarrie Hall Dam and provide information to relevant authorities consistent with the Council's Dam Safety Emergency Plan.	Council	Pre-construction, construction and operation
DS4	Dam safety inspections	Dam Safety inspections are detailed by the owner in the dam safety management system to meet *Dams Safety Regulation 2019*, ANCOLD guidelines, relevant standards and owners' requirements. Clarrie Hall Dam is owned by Council, and inspections would be undertaken at the appropriate frequency relative to the dam consequence category.	Council	Pre-construction, construction and operation
DS5	Dam design	The detailed design would meet NSW Dams Safety Committee (DSC) requirements, Australian National Committee on Large Dams (ANCOLD) guidelines and all legislative and other requirements.	Design Contractor	Detailed design
DS6	Emergency management	The *Tweed Shire Council Dam Safety Emergency Plan for Clarrie Hall Dam* (December 2021) would be reviewed and updated to reflect the raised dam wall height, the appropriate flooding alert levels and any other updates required.	Council	Construction, operation
Health and safety				
HS1	Recreation facilities	Public access to the Clarrie Hall Dam recreation facilities at the dam wall and Crams Farm would be restricted.	Construction contractor	Construction

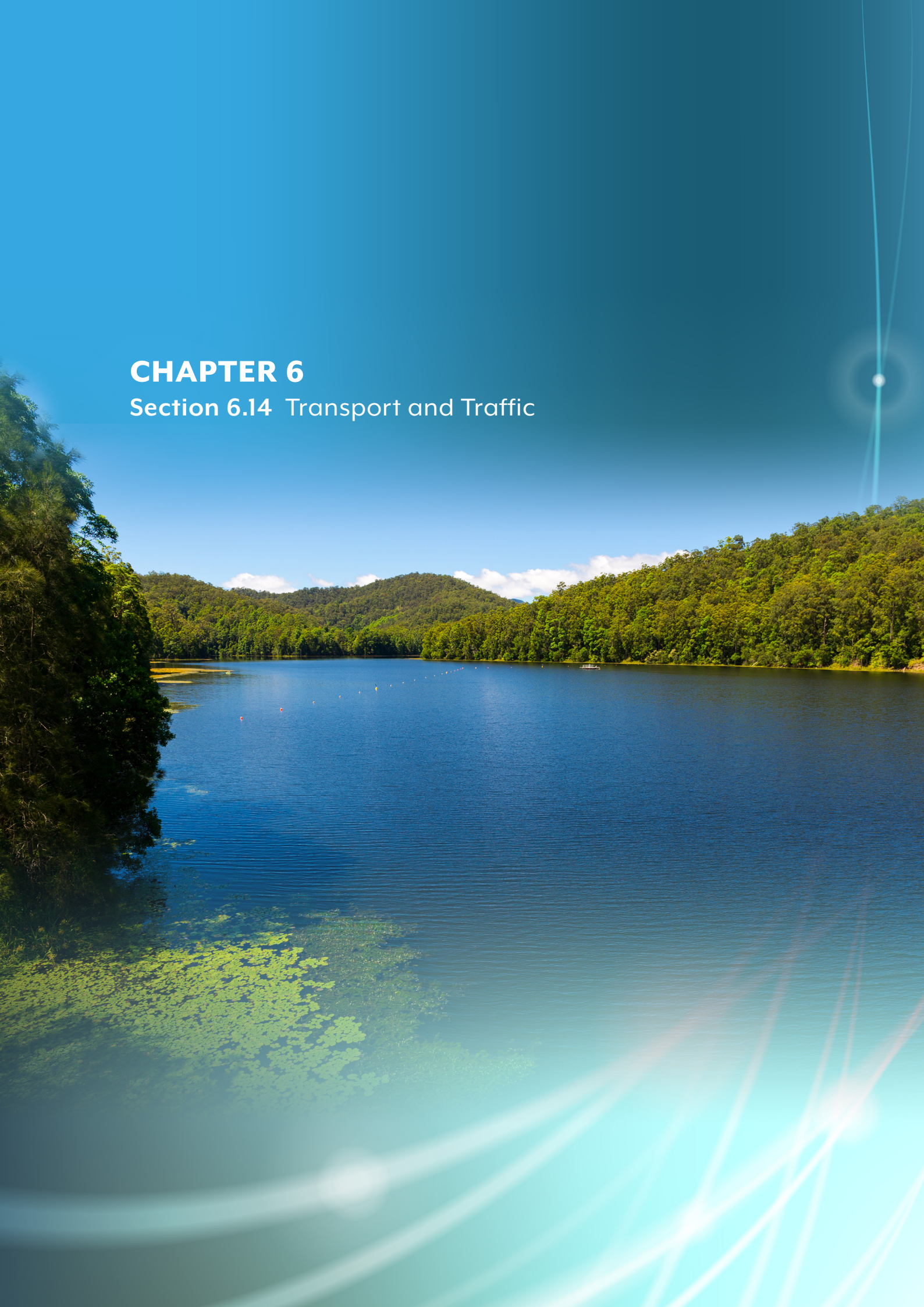
Reference	Impact	Mitigation measures	Responsibility	Timeframe
HS2	Safety	A Safety Management Plan (SMP) will be prepared and implemented for construction. The SMP will include, but not be limited to, the following: • procedures for high-risk work in accordance with: – WHS Act (NSW) 2011 – WHS Regulations (NSW) 2017 – Codes of Practice (NSW) • storage and handling of dangerous goods in accordance with: – WHS Act (NSW) 2011 – WHS Regulations (NSW) 2017 – Dangerous Goods (Road and Rail Transport) Act 2008 – Dangerous Goods (Road and Rail Transport) Regulation 2022 • emergency management including consideration of: – evacuation and access – contingency measures – measures to manage risk to life from flood – measures to manage risk to life from bushfire.	Construction contractor	Pre-construction
HS3	Water quality	Increased frequency of water quality monitoring will be conducted as the dam storage rises to its new FSL.	Council	Post-construction
Bushfire Risk				
BR1	Ignition sources	Ignition sources would be identified and managed for high-risk activities through emergency management planning as part of the Construction Environmental Management Plan and Safety Management Plan. The Emergency Management Plan will include (but not be limited to) the following measures for reducing bushfire risk: • restrictions to activities on elevated FDR days and during total fire bans (TOBANs) (i.e. permitting requirements or a ban on specific activities) • designated smoking areas and cigarette disposal • appropriate refuelling locations • appropriate storage and signage of hazardous and flammable materials • testing of electrical equipment (test and tag).	Construction contractor	Pre-construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
BR2	Asset protection Zones (APZs)	APZs would be established and maintained around all buildings, significant infrastructure and other structures in accordance with Appendix 4 PBP 2019 for an inner protection area and the RFS Standards for Asset Protection Zones. Details of the APZs are provided in Table 6-124.	Construction contractor, Council	Construction, operation
BR2	Temporary workforce workers	Residential development (proposed temporary workers accommodation), assessed under Chapter 8 of PBP 2019, will also need to meet the requirements of Chapter 7 of PBP 2019. It is noted that the increase in residential density does not require separate approval. However, the same principles and criteria associated with subdivisions in bushfire prone areas apply.	Construction contractor	Pre-construction, construction
BR3	Temporary workers accommodation and site offices	Any temporary prefabricated demountable units associated with site offices and the temporary workers accommodation facility will be constructed to comply with sections 3 and 5-7 of AS 3959-2018, or NASH *Standard National Standard Steel Framed Construction in Bushfire Areas s– 2014* as appropriate, and Section 7.5 of PBP 2019.	Construction contractor	Pre-construction, construction
BR4	Emergency management	The Emergency Management Plan is to include the following: • detailed measures to identify, prevent, and mitigate fires igniting (ignition sources), for example.: – hot works permits for works which may result in the ignition of fire – hot works not to be carried on Extreme or catastrophic fire danger rating days or total fire ban days, or when local authorities or the site manager deems weather conditions too dangerous • roles, responsibilities, and 24-hour emergency contact details including alternative telephone contact • inductions for construction personnel on bushfire risk management and other fire-related risks that could present at the project site, the project bushfire contingency plan and emergency response procedures • availability of fire-suppression equipment, access and water including site infrastructure plans and site access and internal road plans • location of hazards (physical, chemical, electrical) that will impact on the firefighting operations and procedures to manage any identified hazards during firefighting • storage, maintenance and appropriate signage of fuels and other flammable materials • notification of the local NSW RFS Fire Control Centre for any works that have the potential to ignite surrounding vegetation, proposed to be carried out during a bushfire fire danger period to ensure weather conditions are appropriate • situational awareness and evacuation planning, including:	Construction contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
		– how situational awareness will be managed (bushfire alert levels, local fire weather information sources and details) – fire response and evacuation matrix – evacuation procedures, evacuation routes and neighbourhood safer places • additional matters as agreed and required by the NSW RFS District Office. The Emergency Management Plan is to be prepared in consultation with the Tweed Fire Control Centre and local RFS brigades (1st attending brigades – Uki and Kunghur).		
BR5	Fire suppression capabilities	Specific to the temporary workers accommodation facility, the static water and hydrant supply will be provided, and comply the following requirements of PBP 2019: • a minimum 20,000 L static water supply (above-ground storage steel or concrete tank) • connections suitable for firefighting purposes are located within the temporary workers accommodation facility, being 65 mm Storz outlets • any electrical water pumps feeding the tanks have a secondary alternative in the event of power failure (i.e. diesel pumps) • any installed fire hydrant, spacing, design and sizing comply with the relevant clauses of Australian Standard AS 2419.1:2005 • fire hydrant flows and pressures comply with the relevant clauses of AS 2419.1:2005 • a fire hose reel system is constructed at the temporary workers accommodation facility in accordance with AS/NZS 1221:1997 and installed in accordance with the relevant clauses of AS 2441:2005 • unobstructed access to water supply points at all times • all above-ground water service pipes are metal, including and up to any taps.	Construction contractor	Pre-construction, construction
BR6	Fire suppression capabilities	Establishment of a 20,000 L water tank (static water supply) constructed of non-combustible material (steel or concrete) is recommended for construction operations at the McCabes Bridge construction compound.	Construction contractor	Pre-construction, construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
BR7	Fire suppression capabilities	The following fire suppression capabilities are recommended to be available at the construction compounds associated with the Proposal: • water cart and spray pumps • water extraction points • fire extinguishers on plant and equipment and at key locations (offices, storage facilities etc.) • water / dust suppression.	Construction contractor	Pre-construction, construction
BF8	Bushfire risk reduction	Proposed bushfire protection measures for the development include: • chemical and fuels storage controls • controlled and ventilated battery charging locations • controlled explosive use • water/dust suppression • vegetation clearance and management buffer zones • fire extinguishers on plant and equipment and at key locations (offices, storage facilities, etc.).	Construction contractor	Pre-construction, construction
Air Quality				
AQ1	Particulate matter emissions	To reduce the impact of particulate matter emissions, it is proposed that: • dust from drilling would be controlled through water injection in drill holes • wind erosion from exposed areas and stockpiles at the CBP would be controlled through watering (50% control factor) • unpaved roads within rock movement areas would be watered using water carts (75% control factor) • water sprays or carts would be used to control dust on other exposed areas at worksites and on paved roads where required (e.g. where there is a prolonged instance of visible dust).	Construction contractor	Construction

Reference	Impact	Mitigation measures	Responsibility	Timeframe
AQ2	Diesel combustion emissions	To reduce the impact of diesel combustion emissions, it is proposed that: • where feasible, mobile and stationary equipment would be compliant with a more recent emission standard than USEPA Tier 2 would be sourced • unpaved roads would be routinely maintained to reduce truck tyre rolling resistance • all equipment would be routinely serviced to maintain manufacturers' emission specifications • idling of diesel equipment would be minimised wherever feasible.	Construction contractor	Construction
AQ3	General air quality	A CEMP would be prepared prior to commencement of construction activities. In relation to air quality, the CEMP will include: • air quality objectives, targets, and key performance indicators • relevant legislation and guidelines • sources of air quality emissions • mitigation measures • roles and responsibilities • complaints procedure.	Construction contractor	Pre-construction



CHAPTER 6

Section 6.14 Transport and Traffic

6.14 TRANSPORT AND TRAFFIC

This section provides a summary of potential transport and traffic impacts during construction and operation of the Proposal, as detailed in the Traffic Impact Assessment (TIA) provided in Appendix S.

The relevant SEARs and where they are addressed are included in Table 6-126.

Table 6-126 Relevant SEARs – transport and traffic

Relevant key issue requirement/s	Where addressed
1. The Proponent must prepare a Traffic Impact Assessment in accordance with the current guidelines. The Traffic Impact Assessment is to address, but not be limited to the following:	The Traffic Impact Assessment is provided in Appendix S and summarised in this section (section 6.14)
(a) intersection sight distances at key intersections along the primary haul route	Section 6.14.3 to 6.14.4 Appendix S (Section 5.4)
(b) turning paths for the largest vehicle at key intersections	Section 6.14.3 to 6.14.4 Appendix S (Section 5.5)
(c) details of any proposed improvements to affected intersections	Section 6.14.4 to 6.14.4 Appendix S (Chapter 6)
(d) existing and proposed site access standards	Section 6.14.1 to 6.14.4 Appendix S (Section 4.3 and Chapter 5)
(e) details of servicing and parking arrangements	Appendix S Section 5.11
(f) impact on public transport (public and school bus routes)	Section 6.14.3 to 6.14.4 Appendix S (Section 5.6)
(g) impacts of road traffic noise and dust generated along the primary haul route/s.	Section 6. 12 and 6.13 Appendix P Appendix Q

6.14.1 Methodology

The assessment of potential transport and traffic impacts for construction and operation of the Proposal has been undertaken through a combination of data capture, analysis and modelling. This has been completed in accordance with the requirements of the NSW Roads and Traffic Authority (RTA) (now Transport for NSW (TfNSW)) *Guide to Traffic Generating Developments* (2002).

The assessment included:

- a review of background traffic data
- a site inspection and traffic surveys
- a swept path intersection analysis (road area covered by the outermost and innermost points of the vehicle making a low-speed turn)
- SIDRA intersection analysis (a micro-analytical tool for assessing individual intersections and linked intersection-network modelling)
- an assessment of future road upgrade requirements and maintenance impacts
- analysis of the above.

Baseline traffic volumes have been determined using a 1% per annum linear growth rate applied to current baseline traffic volumes (2023). This has been completed up until the anticipated year of

construction (2026). A 1% per annum growth rate is considered conservative considering that no other major developments are planned nearby to the Proposal that may influence traffic.

The assessment focused mostly on construction phase impacts, as in operation the Proposal would generate minimal traffic volumes, and those are not expected to impact the existing road network.

6.14.2 Existing environment

The primary transport routes and road network that would be impacted by the Proposal consists of state and local government roads managed by Council. These are shown in Figure 6-91.

Key roads to be used by the Proposal would include:

- Kyogle Road – a sealed two-lane regional road that travels south-west from Murwillumbah to Kyogle carrying regional and local traffic
- Doon Doon Road – a sealed two-lane local road that travels south-east from Kunghur to Doon Doon carrying local traffic
- Commissioners Creek Road – a sealed two-lane local road that travels north-west from Doon Doon and then follows Commissioners Creek toward the south-east carrying local traffic. The existing McCabes Bridge is a single-lane bridge, so two-way vehicular movement is not possible
- Clarrie Hall Dam Road – a sealed two-lane local road that travels south from Kyogle Road to Clarrie Hall Dam
- Tarcoola Lane – a sealed two-lane local road that connects to Kyogle Road and ends in a cul-de-sac approximately 200 m away.

Details of the key roads and intersections are provided in section 3.1.1 of the TIA (Appendix S).

Tube-count traffic data collected along Kyogle Road indicates peak traffic to be less than 270 vehicles per hour, and peak traffic average to be 202 vehicles per hour across weekdays. The data indicates that approximately 90% of the vehicles are light vehicles and 10% are truck or other heavy vehicles (including semi-trailers).

The following three intersections were identified as the key intersections for the construction access and traffic impact assessment:

- Kyogle Road and the future accommodation village or batching plant access road (currently 'Tarcoola Lane') (intersection 1)
- Kyogle Road and Clarrie Hall Dam Road (intersection 2)
- Kyogle Road and Doon Doon Road (intersection 3).

Intersection surveys were undertaken by EMM on 14–16 February 2023. The respective network peak hours were determined to be:

- 8:00 am to 9:00 am
- 4:00 pm to 5:00 pm.

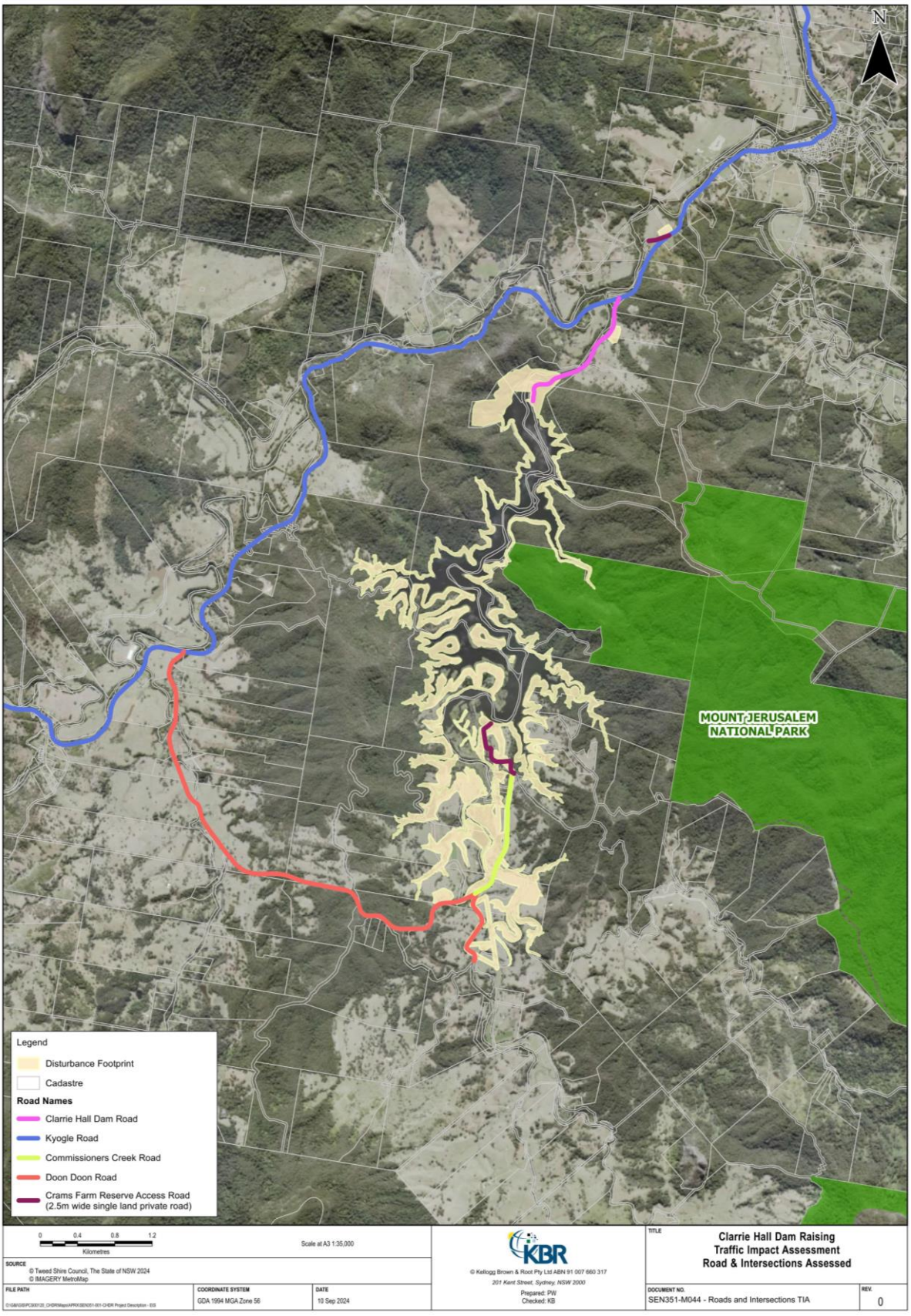


Figure 6-91 Road network

Crash history

Crash data from the Transport for NSW (TfNSW) Centre for Road Safety interactive history database between 2018 and 2022 was assessed along the main traffic routes (Kyogle Road, Doon Doon Road, Commissioners Creek Road, Clarrie Hall Dam Road and Tarcoola Lane).

The data shows 19 recorded crashes between 2018 and 2022, of which 17 occurred on Kyogle Road; 1 crash occurred on Clarrie Hall Dam Road; and 1 crash occurring on Doon Doon Road. One of the crashes on Kyogle Road was fatal, and of other crashes on Kyogle Road, 4 resulted in serious injuries, 6 in moderate injuries, 4 in minor/ other injuries and 2 in non-casualties. The 1 crash on Clarrie Hall Dam Road resulted in serious injuries, and the crash on Doon Doon Road resulted in moderate injuries.

In total, 37% of all crashes (7 in total) involved speeding. The fatal accident in 2018 involved speeding and a truck at a T-intersection. The majority of crashes involved a vehicle running off the road at a bend.

Overall, 19 crashes over a 5-year period are relatively minor. This number does not indicate any major road safety issues along this section of Kyogle Road.

Public transport and facilities

Public transport around the Proposal site is limited. Two bus operators provide regular public bus transportation between Murwillumbah and Uki along Kyogle Road:

- Murwillumbah Bus Company (route 625, once daily)
- Gosel's Bus Service (route 630, twice daily return bus service between Murwillumbah and Nimbin).

Additionally, Gosel's bus service provides a dedicated school bus service in the Tweed Shire, route 305, along Doon Doon / Commissioners Creek Road, and then to Uki and Murwillumbah along Kyogle Road. The Uki Public School and Aetaomah Steiner School, located between Uki and the Kyogle and Doon Doon Road intersection, are serviced by routes 625, 630 and 305.

During the site inspection, one or two recreational cyclists where observed, although no bicycle network reaches past Murwillumbah. Further, no pedestrian infrastructure is located within the vicinity of the site.

6.14.3 Impact assessment

Potential transport and traffic impacts have been assessed for the existing road network, new access roads and access road upgrades required to allow construction and operational access for the Proposal.

Construction

The communities near the site are linked by a network of regional roads and local government roads managed by Tweed Shire Council. Kyogle Road forms the most direct route from Murwillumbah to the site and would be the main transport route for material and people to Clarrie Hall Dam and McCabes Bridge construction sites.

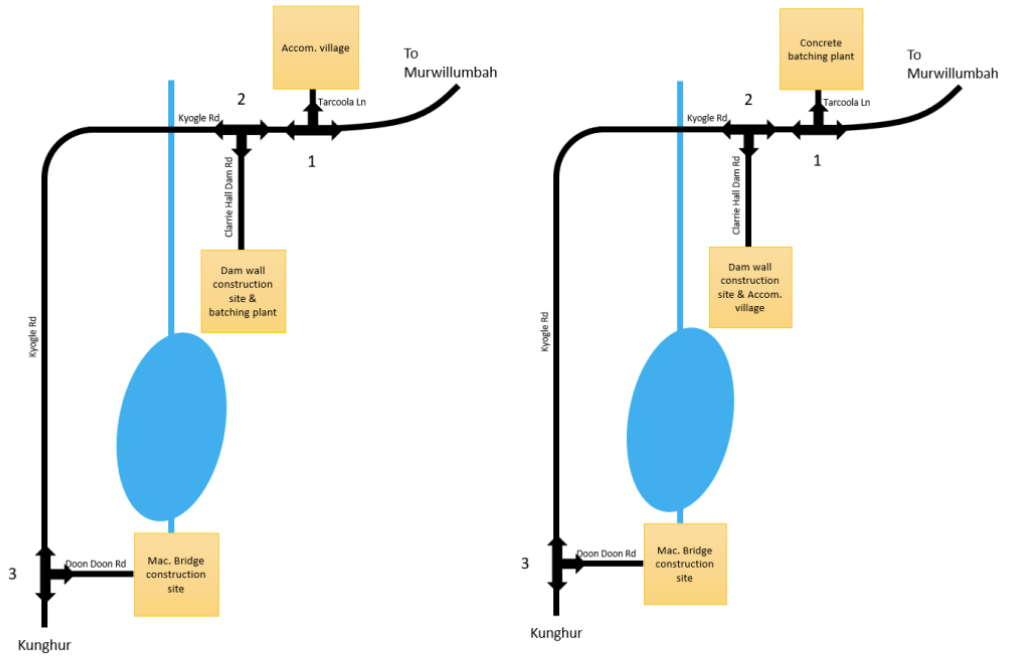
The roads that would be used by construction traffic for the dam wall, concrete batching plant, workers accommodation, and McCabes Bridge include:

- Kyogle Road
- Clarrie Hall Dam Road
- Doon Doon Road

- Commissioners Creek Road (red)
- Crams Farm Reserve Access Road (black): 2.5 m wide single lane private road.

The overall assessment of the Proposal considered construction impacts of 2 options for the location of the concrete batching plant and staff accommodation. These, shown in Figure 6-92, will be confirmed during detailed design:

- Option 1 consists of workers accommodation on Tarcoola Lane (off Kyogle Road) and a concrete batching plant on Clarrie Hall Dam Road.
- Option 2 consists of workers accommodation on Clarrie Hall Dam Road and a concrete batching plant on Tarcoola Lane (off Kyogle Road).



Option 1 – CBP located off Clarrie Hall Dam Road, just north of the main dam work site, and accommodation village located off Tarcoola Lane, to the northeast

Option 2 – Accommodation village located off Clarrie Hall Dam Road, just north of the main dam work site, and CBP located off Tarcoola Lane, to the northeast.

Figure 6-92 Transport routes schematic, showing the key project-related roads and intersections assessed for option 1 (left) and option 2 (right)

Source: EMM Appendix S

Although construction activities are likely to occur 7 days per week, the assessment was conducted for the hours of 7:00 am to 6:00 pm, six days per week. It was assumed that staff would arrive between 6:00 am and 7:00 am and leave the site between 6:00 pm and 7:00 pm, which is outside of local peak hours.

Construction traffic associated with the Proposal includes:

- heavy vehicle traffic associated with delivery of accommodation buildings, site offices, establishment of the concrete batching plant and the delivery of other plant, equipment and bulk materials, including spoil, to and from sites.
- heavy vehicle traffic associated with the supply of feed materials to the concrete batching plant, and delivery of concrete across the Proposal's construction sites

- heavy vehicles associated with service of the construction phase – for example, provision of fuel, waste collection services
- light vehicle traffic associated with external clients, visitors and representatives
- light vehicle traffic associated with the workforce commuting to site from external locations
- light vehicle traffic associated with the workers community from the accommodation village to the sites
- light vehicle traffic associated with ongoing dam operations and maintenance.

Almost all traffic (heavy and light) is expected to be travelling to the site from the east, via Uki. Little to no construction traffic is expected to come from the west (west of Kunghur via Kyogle Road). Sand and other suppliers are assumed to travel via costal arterial roads (M1) and the Tweed Valley Way.

Road traffic

Road traffic volumes were calculated using extrapolated data from traffic surveys conducted in 2023 and proposed construction traffic. A summary of road traffic associated with option 1 and option 2 is included in Table 6-127 and Table 6-128.

Table 6-127 Option 1 construction traffic volumes

Road	Traffic type	Volume (peak)	Heavy vehicle percentage
Kyogle Road (east of Tarcoola Lane)	Construction traffic volumes	138 (am) / 122 (pm)	27% (am) / 17% (pm)
	Total traffic volume	367 (am)/ 331 (pm)	12% (am) / 11% (pm)
Kyogle Road (between Clarrie Hall Dam Road and Tarcoola Lane)	Construction traffic volumes	199 (am) / 187 (pm)	16% (am) / 28% (pm)
	Total traffic volume	428 (am) / 396 (pm)	9% (am) / 1% (pm)
Kyogle Road (between Doon Doon Road and Clarrie Hall Dam Road)	Construction traffic volumes	80 (am) / 72 (pm)	35% (am) / 28% (pm)
	Construction and baseline traffic volume	310 (am) / 281 (pm)	12% (am) / 12% (pm)
Clarrie Hall Dam Road (between Kyogle Road and concrete batching plant)	Construction traffic volumes	135 (am) / 115 (pm)	15% (am) / 0% (pm)
	Construction and baseline traffic volume	145 (am) / 119 (pm)	14% (am) / 0% (pm)
Doon Doon Road (near Kyogle Road)	Construction traffic volumes	80 (am) / 72 (pm)	35% (am) / 28% (pm)
	Construction and baseline traffic volume	131 (am) / 109 (pm)	25% (am) / 23% (pm)
Tarcoola Lane	Construction traffic volumes	71 (am) / 67 (pm)	7% (am) / 1% (pm)
	Construction and baseline traffic volume	75 (am) / 71 (pm)	1% (am) / 0.1% (pm)

Table 6-128 Option 2 construction traffic volumes

Road	Traffic type	Volume (peak)	Heavy vehicle percentage
Kyogle Road (east of Tarcoola Lane)	Construction traffic volumes	138 (am) / 122 (pm)	27% (am) / 17% (pm)
	Construction and baseline traffic volume	367 (am) / 333 (pm)	12% (am) / 11% (pm)
	Construction traffic volumes	153 (am) / 141 (pm)	37% (am) / 32% (pm)

Road	Traffic type	Volume (peak)	Heavy vehicle percentage
Kyogle Road (between Clarrie Hall Dam Road and Tarcoola Lane)	Construction and baseline traffic volume	382 (am) / 350 pm)	17% (am) / 17% (pm)
Kyogle Road (between Doon Doon Road and Clarrie Hall Dam Road)	Construction traffic volumes	80 (am) / 72 (pm)	35% (am) / 28% (pm)
	Construction and baseline traffic volume	310 (am) / 281 (pm)	12% (am) / 12% (pm)
Clarrie Hall Dam Road (between Kyogle Road and accommodation village)	Construction traffic volumes	93 (am) / 89 (pm)	31% (am) / 28% (pm)
	Construction and baseline traffic volume	103 (am) / 93 (pm)	29% (am) / 27% (pm)
Doon Doon Road (near Kyogle Road)	Construction traffic volumes	80 (am) / 72 (pm)	35% (am) / 28% (pm)
	Construction and baseline traffic volume	131 (am) / 109 (pm)	25% (am) / 23% (pm)
Tarcoola Lane	Construction traffic volumes	49 (am) / 29 (pm)	90% (am) / 83% (pm)
	Construction and baseline traffic volume	53 (am) / 33 (pm)	83% (am) / 73% (pm)

Intersection performance

Peak construction traffic is determined to be in month 11 of 18. Anticipated traffic volumes from this month have been used as a basis for modelling intersection performance.

Intersection modelling showed estimates of traffic volumes at key intersections will be within level of service A - (average delay of <14 seconds per vehicle). This is summarised in Table 6-129.

Table 6-129 Traffic volumes at each of the intersections

Intersection	Scenario	Volume	Level of service
Kyogle Road and Tarcoola Lane	Baseline	243 (am) / 222 (pm)	A (am) / A (pm)
	Baseline + option 1	458 (am) / 420 (pm)	A (am) / A (pm)
	Baseline + option 2	422 (am) / 376 (pm)	A (am) / A (pm)
Kyogle Road and Clarrie Hall Dam Road	Baseline	249 (am) / 224 (pm)	A (am) / A (pm)
	Baseline + option 1	467 (am) /420 (pm)	A (am) / A (pm)
	Baseline + option 2	421 (am) / 381 (pm)	A (am) / A (pm)
Kyogle Road and Doon Doon Road	Baseline	209 (am) / 186 (pm)	A (am) / A (pm)
	Baseline + option 1	294 (am) / 262 (pm)	A (am) / A (pm)
	Baseline + option 2	294 (am) / 262 (pm)	A (am) / A (pm)

In the highest traffic scenario, the Kyogle Road and Tarcoola Lane intersection and Kyogle Road and Clarrie Hall Dam Road intersection would still have approximately 80% additional capacity after accommodating additional traffic generated during construction of the Proposal. The intersection between Kyogle Road and Doon Doon Road will have approximately 90% additional capacity.

Overall, the intersections analysed demonstrate no significant differences between the volume of construction traffic, whether generated by option 1 or option 2. In both options, the intersections can support Proposal-related traffic without significant queuing or delays.

Intersection turning lanes

The existing design of the Kyogle Road and Tarcoola Lane intersection has basic left and right turn treatments to cater for left and right turning movements. The addition of the Proposal's construction traffic will require no further changes to the existing design regardless of whether option 1 or option 2 is adopted.

The existing design of the Kyogle Road and Clarrie Hall Dam Road intersection has a large geometry which will easily facilitate heavy vehicle movements. The intersection includes a left turn lane but has no dedicated treatment to facilitate a right turn movement.

The existing design of the Kyogle Road and Doon Doon Road intersection has basic left turn treatments to cater for left turning movements. The addition of the Proposal's construction traffic will require no changes to the existing design, regardless of whether option 1 or option 2 is adopted.

Road safety

At the Kyogle Road and Clarrie Hall Dam Road intersection and the Kyogle Road and Doon Doon Road intersection, vegetation is proposed to be trimmed to meet line of sight distances in accordance with the *Austroads Guide to Road Desing Part 4A (Unsigned and Signalised Intersections (Austroads, 2017).* Line of sight distances along the Kyogle Road and Tarcoola Lane intersection have been estimated to meet minimum requirements.

Traffic treatment at the Kyogle Road and Clarrie Hall Dam Road intersection will be reviewed during detailed design. It is anticipated that temporary mitigation measures, if required, will be implemented during the construction stage only.

Impacts on public transport, pedestrians and cyclists

The Proposal is unlikely to have any significant impact on public transport, considering the low frequency of public transport in the area. Additionally, the limited number of pedestrian activities and lack of bicycle infrastructure mean the Proposal is unlikely to have any significant impact on pedestrians or cyclists.

To minimise any interaction, heavy vehicle operation along Kyogle Road to and from the site during school terms in NSW will be avoided between 8:00 am and 9:30 am, and between 2:30 pm and 4:00 pm.

Transportation of dangerous goods

The transport of any dangerous goods requires approval from the National Heavy Vehicle register. The approval process will be completed as per State Environmental Planning Policy No. 33 – *Hazardous and Offensive Development* and apply the relevant mitigation and management measures.

Operation

The Proposal will generate minimal operational traffic on a regular basis. Traffic will mainly consist of operational and maintenance crews.

The dam also attracts regular visitors, likely during weekends and school holidays when traffic volumes on the road network are lower than usual. This is not expected to increase significantly once construction is complete. As such, any additional traffic generated by operation of the Proposal is minimal and will be absorbed in the daily fluctuation of traffic and not be noticeable. Therefore, no mitigation measures are proposed for the operational phase of the Proposal.

Summary

The TIA found that transport and traffic impacts would only occur during construction and that there would be no potential impacts to public transport, pedestrian and cyclist movements.

Overall traffic impacts of the project are expected to be minimal and can be managed with the implementation of suitable management and mitigation measures.

6.14.4 Mitigation measures

Mitigation measures for the construction phase of the Proposal are outlined in Table 6-130.

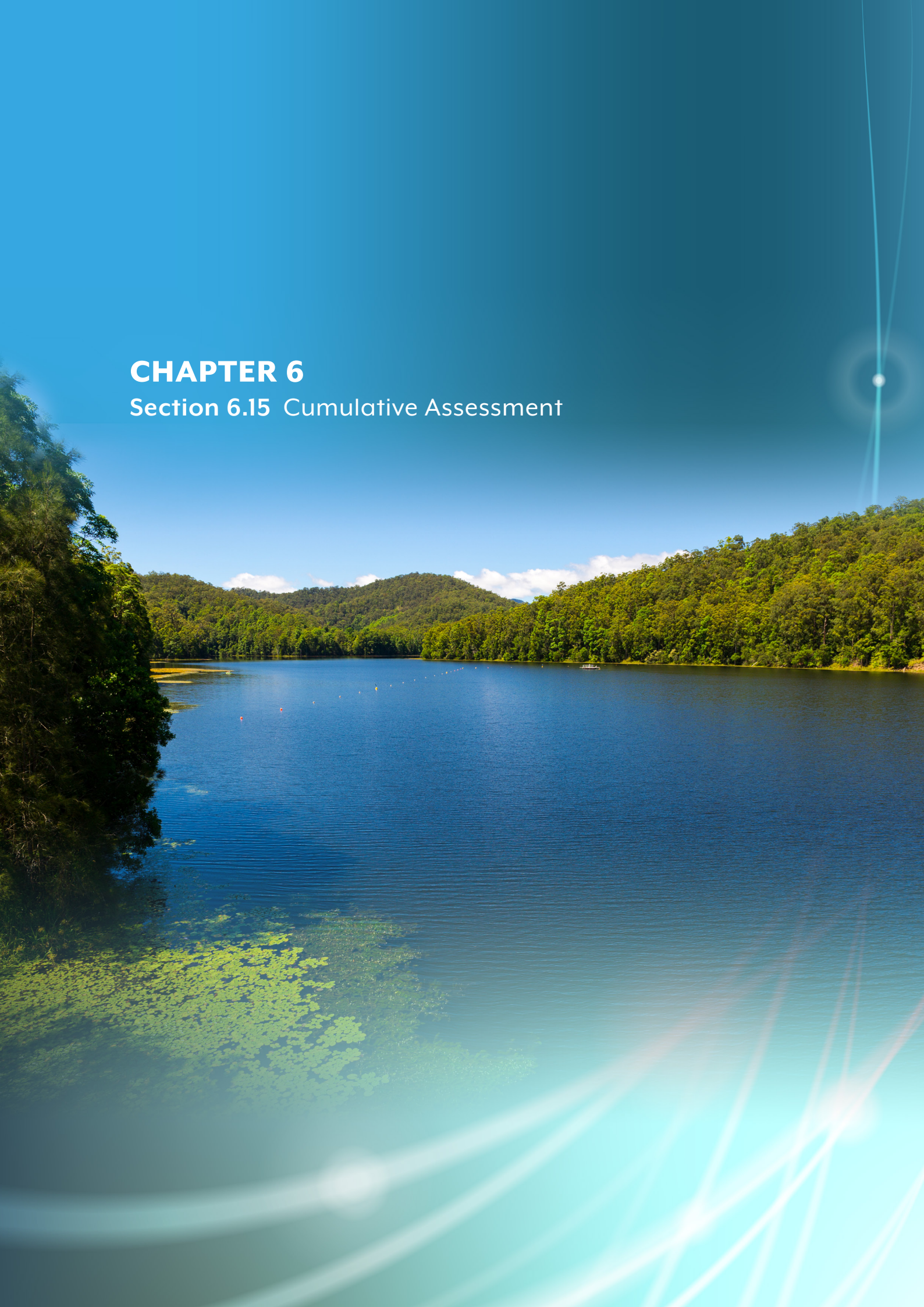
Because of the minor volumes of traffic generation, no mitigation measures are proposed for the operation stage of the Proposal.

Table 6-130 Construction phase mitigation measures

Reference	Impact	Mitigation measure	Responsibility	Timeframe
TT01	General	A Traffic Management Plan (TMP) would be prepared in consultation with Tweed Shire Council, prior to the commencement of road upgrades and construction of the Proposal and implemented as part of the CEMP. The TMP would include measures to minimise traffic impacts, ensure public safety and would be prepared in accordance with: • the RTA's manual, *Traffic Control at Work Sites*, issued December 2010 • the technical manual *Traffic control at work sites* by Transport for NSW (latest edition). The TMP would include details on access routes to the site and traffic and access management including: • information to drivers about the school bus routes along Kyogle Road • direction to avoid compression braking near residential receptors • direction to avoid heavy vehicle trips during school zone times (8.00 am–9.30 am and 2.30 pm–4.00 pm) • consultation with relevant councils and road authorities to install school bus signs at suitable locations along construction routes if necessary to warn heavy vehicle drivers of student drop-off and pick-up areas • responses to local climate conditions that may affect road safety such as fog, dust and wet weather. The TMP would be prepared in consultation with affected landowners.	Construction contractor	Pre-construction, construction
TT02	General	Traffic routes and access would be designed in accordance with the EIS and conditions of approval, local Council requirements and TfNSW requirements to provide safe movement of all road users and to minimise disruption to local residents. Traffic routes and access would be revised based on the construction staging and on traffic movements / numbers to and from the construction site.	Contractor	Detailed design, pre-construction, construction
TT03	Access points	The contractor would assess the visibility and safety of all designated egress and access points from the construction sites, construction compounds, concrete batching plant and accommodation site, and develop appropriate traffic controls in consultation with Council, as part of the TMP.	Contractor	Detailed design, pre-construction
TT04	Kyogle Road and Clarrie Hall Dam Road intersection	The requirement for a basic right turn treatment (BAR) on Kyogle Road west approach, and a shortened auxiliary left turn treatment on Kyogle Road east approach would be reviewed during detailed design and designed accordingly, if required. When the locations of the accommodation camp and concrete batching plant are confirmed during detailed design, if a lower order treatment is required at this intersection, a BAR and BAL treatment would be provided.	Contractor	Detailed design, pre-construction

Reference	Impact	Mitigation measure	Responsibility	Timeframe
TT05	Tarcoola Lane, Doon Doon Road and Commissioners Creek Road	The TMP would include: • Drivers are to pass opposing traffic on Tarcoola Lane, Doon Doon Road and Commissioners Creek Road where there is adequate road width. It is acknowledged that there are some narrower sections of road where drivers will need to take care when passing.	Contractor	Pre-construction, construction
TT06	General	Construction vehicles would only be allowed to enter, operate within, or exit from a traffic flow, in a manner which does not endanger the public and under suitably designed appropriate traffic control measures.	Construction contractor	Pre-construction, construction
TT07	General	Before works start, existing access tracks, road and culverts that would be used by heavy vehicles would be assessed for adequacy and upgraded where necessary. Appropriate drainage would be provided for any new roads such as Commissioners Creek Road and Clarrie Hall Dam Road during the works to ensure that vehicle movements do not cause erosion and sedimentation of nearby waterways.	Contractor	Detailed design, pre-construction
TT08	Permits and licences	The contractor would obtain from Council and/or TfNSW necessary permits for road openings or occupancy and comply with all conditions.	Construction contractor	Pre-construction, construction
TT09	Landowner notification	Prior notification (at least 2 weeks) would be provided to any landowner where access to their property may be temporarily impacted due to the Proposal.	Contractor	Pre-construction, construction
TT10	Community consultation	Any disturbance to adjacent landowners/residences as a result of vehicle movements and noise would be minimised, and all access gates would be in their original condition following completion of the works.	Contractor	Detailed design, pre-construction, construction
TT11	Site induction	The site induction would inform all site personnel including contractors, of the approved traffic routes and access. Approved traffic routes would be included in contracts with suppliers of materials or equipment to the site.	Construction contractor	Pre-construction, construction
TT12	General	The TMP would specify construction vehicle speed limits (signage) within work sites and along access routes. Consideration would be given to local road condition, road surfaces, traffic volumes and other relevant factors.	Contractor	Detailed design, pre-construction, construction

Reference	Impact	Mitigation measure	Responsibility	Timeframe
TT13	Signage	The following signage would be installed: • Site-specific traffic and safety signage would be installed that has been customised to the location, road conditions and construction methodology. • Signage for the entire construction duration would be maintained to inform both construction staff and the public (motorists and pedestrians) of the construction activities and plant movement.	Construction contractor	Pre-construction, construction
TT14	Community consultation	There would be consultation with neighbours and/or affected landholders and community in Uki regarding traffic volumes and timing of vehicle movement, to minimise any inconvenience that may arise.	Construction contractor	Pre-construction, construction
TT15	General	All reasonable and practical steps would be implemented to separate pedestrians and vehicles at the worksite, such as through the installation of fencing, flagging or plant exclusion zones.	Contractor	Pre-construction, construction
TT16	Line of sight	Vegetation on Kyogle Road at its intersections with Clarrie Hall Dam Road and Doon Doon Road would be trimmed to achieve the required sight distance.	Contractor	Pre-construction
TT17	Road maintenance	A road maintenance program will be developed in consultation with the relevant road authorities to be undertaken during construction. The program would include route inspections of all the affected local roads. Road pavements, would be restored to their pre-construction condition at the completion of construction.	Contractor	Pre-construction, construction
TT18	Restriction of heavy vehicle movement during school hours	Heavy vehicle travel through Kyogle Road, Doon Doon Road and Commissioners Creek Road from 8:00 am to 9:30 am and from 2:30 pm to 4:00 pm on school days would be avoided.	Contractor	Construction



CHAPTER 6

Section 6.15 Cumulative Assessment

6.15 CUMULATIVE IMPACTS

This section provides an assessment of the potential of the Proposal to generate cumulative impacts in the region. The assessment has been completed to address the SEARs, as shown in Table 6-131, and has been prepared in accordance with the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPE 2022b).

Table 6-131 SEARs for cumulative impact assessment

SEARs for cumulative impact assessment	Where addressed
Where relevant, the assessment of key issues below and any other significant issues identified in the risk assessment, must include: • consideration of the potential cumulative impacts due to other developments in the vicinity (completed, underway or proposed).	Section 6.15

6.15.1 Assessment methodology

The *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPE 2022b) lists two types of cumulative assessment approaches:

- Incremental approach: involves adding the incremental impacts of the project to the baseline condition of each relevant matter (e.g. hydrology, biodiversity, heritage, social impact, noise and vibration) and then combining the effect of different impacts of the project, normally on a sensitive area or receiver. Consideration of incremental impacts is standard practice and has been addressed within the technical reports appended to the EIS, within section 6.1 to 6.14 and Chapter 7.
- Cumulative approach: the cumulative impacts of the project on key matters are considered alongside other possible impacts from relevant future projects, or the combined effect of the different cumulative impacts of the project on key matters, sensitive receptors or important features are considered alongside other possible impacts from relevant future projects. The assessment of issue-specific cumulative impacts is presented in this section.

The cumulative impact assessment largely consists of qualitative analysis, due to a range of uncertainties such as the likelihood that any other projects identified in the vicinity will proceed, the level of detail available for these future projects, and the uncertainty of the timing of future projects.

The methodology included a search of the DPHI Planning Portal to gather information for consideration of current and future projects occurring within vicinity of the Proposal. Elements such as current land use of the predicted project area, scale of development, distance from the Proposal and probable environmental impacts from the operation of the Proposal were considered.

6.15.2 Screening of future projects

To screen for future projects that may be relevant to the cumulative impact assessment, the following sources were searched:

- NSW Department of Planning and Environment Planning Portal 'Major Projects' with the following filters, where 'All' was not selected:
  - local council area: Tweed Shire
  - assessment type: any
- NSW Department of Planning and Environment's Planning Portal 'Major Projects' map view (to search for projects outside the Tweed Shire LGA that are nearby)

- *Far North Coast Regional Water Strategy* (DPE 2023a).

The Proposal life is expected to extend to at least 2065 in relation to water security, and design life would be expected to continue beyond that. Screening for future projects considered the Tweed Shire LGA and nearby areas of Lismore LGA, Byron LGA, Ballina LGA and Rous County LGA.

The following State significant projects are currently planned, are being assessed or have been recently completed within the Tweed Shire LGA:

- Upgrades to Kingscliff High School (determined 2021, in progress)
- Tweed Valley Hospital (determined 2020, completed)
- Murwillumbah Education Campus (determined 2023, planning)
- Tweed Heads Affordable Housing, 25-27 Boyd Street (EIS being prepared)
- Hanson Tweed Sand Plant Expansion (assessment being prepared)
- Uniting Kingscliff Redevelopment, seniors housing (response to submissions)
- Kings Forest Town Centre Precinct, Cudgen (EIS being prepared)
- Tricare Hastings Point Seniors Living (EIS being prepared).
- Cobaki Residential Development (determined 2011, in progress)

Other potential projects near the Proposal but not located within the Tweed Shire LGA include:

- Lismore Battery Energy Storage System (EIS being prepared)
- Rous County Council Future Water Project 2060 actions for planning, design and approval of:
  - Stage 1: Upgrade of Marom Creek water treatment plant, accessing Alstonville and Woodburn groundwater
  - Stage 2: New groundwater source at Tyagarah.

No State significant projects were identified in the Byron LGA or Ballina LGA.

The majority of projects identified in the area surrounding the Proposal include developments for schools, hospitals, senior living and residential housing. Most of these developments are located along the Tweed coastline.

6.15.3 Assessment of cumulative impacts

The following section considers the combined effect of different cumulative impacts from the Proposal against current and future projects in the region. Impacts to hydrology, biodiversity, heritage, social, soils, climate change, noise and vibration, traffic and resources are considered.

Hydrology

The current or future projects identified are either located downstream of the Proposal or not within the Clarrie Hall Dam or Tweed River catchments.

The minimal changes to water quality, hydrology and streamflow associated with the Proposal would not contribute to cumulative impacts, as the current or future Projects would be unlikely to change the water quality, hydrology and streamflow of Doon Doon Creek or the Tweed River.

Marom Creek Water Treatment Plant is located approximately 45 km from the Proposal and is not connected to the river system of the Tweed River catchment. The Proposal would have negligible impact to groundwater within the region and would therefore not contribute to cumulative impacts to the groundwater Rous County would access.

Biodiversity

The Proposal would result in impacts to terrestrial and aquatic biodiversity, including the direct loss of approximately 246.11 ha of native vegetation and threatened species habitat and the direct loss of aquatic and riparian habitat due to the increased inundation area.

Approximately 1.91 ha of Mount Jerusalem National Park have been revoked. This revoked land is currently vested in the Minister administering the NPW Act, pending transfer to Tweed Shire Council upon subdivision, land title registration and the transfer of compensatory land. Council is currently negotiating with NPWS to transfer land that could be incorporated into Mount Jerusalem National Park or other nearby national parks, as compensation.

The proposed Kings Forest Town Centre Precinct is an 880 ha landholding located approximately 15 km south of Tweed Heads, close to the townships of Kingscliff, Bogangar, Cabarita Beach and Casuarina, in the Tweed Shire LGA. It is located within an area of outstanding biodiversity value and Coastal Wetlands area identified under *State Environmental Planning Policy (Resilience and Hazards) 2021*. Areas of the development have been set aside as environmental protection areas to be dedicated to Council or NSW National Parks and Wildlife Service. The cumulative impacts of the Proposal and Kings Forest Town Centre Precinct, if it proceeds, would contribute to the cumulative loss of biodiversity for the wider Tweed Shire region.

The proposed Cobaki Residential Development is located approximately 6 km west of Tweed Heads, in the Tweed Shire LGA. Following the initial Part 3A approvals (Concept Plan), two development applications have been approved by the Joint Regional Planning Panel (JRPP) for the Cobaki development. However, this was in 2011 and no work has commenced since then.

Should the project proceed, the main cumulative impacts relate to terrestrial and aquatic biodiversity. The site is located adjacent to a mapped Coastal Wetlands area under *State Environmental Planning Policy (Resilience and Hazards) 2021*. The proposed development site contains remnant bushland and is a mapped biodiversity values area. Areas of the development would be set aside for environmental protection areas to be dedicated to Council or NSW National Parks and Wildlife Service. Much of the land that the project is located on was previously cleared or used for agricultural purposes. The project is not considered to be likely to generate significant impacts to Matters of National Environmental Significance. The cumulative impacts of the Proposal and Cobaki Residential Development would contribute to the cumulative loss of biodiversity for the wider Tweed Shire region.

The Lismore Battery Energy Storage System would not have a significant impact to terrestrial biodiversity, and therefore would not contribute to significant cumulative biodiversity impacts to the wider region.

The remaining current and future projects would take place within or near previously disturbed land and therefore would not contribute significantly to cumulative biodiversity impacts.

Heritage

The Proposal would result in cumulative/intergenerational loss of Aboriginal cultural material. The impacts to Aboriginal heritage from current or future projects are uncertain. However, the studies that would be undertaken, where required, would contribute to a wider understanding of the cultural history of the region.

There are no historic heritage impacts of the Proposal that would contribute to cumulative historic heritage impacts to the wider region.

Social

The Proposal would largely result in social benefits upon its operation by ensuring secure water yield until at least 2065. Projects such as the Rous County LGA Marom Creek Water Treatment

Plant and access to groundwater would provide a cumulative benefit to the Far North Coast region. Both the Proposal and Rous County LGA projects are consistent with the *Far North Coast Regional Water Strategy* (DPE 2023a). Other projects such as hospitals, residential development and senior housing would also benefit from the Proposal and support growth of the region.

During the construction of the Proposal, local businesses and short-stay accommodation surrounding Uki and Murwillumbah would experience increased pressure during events due to construction personnel and visitors utilising the same areas. This cumulative impact would be short-term and would economically benefit local businesses. Discussions are under way with Council's Business Development Unit to identify other ways that the Proposal might benefit local businesses, for example, providing food or entertainment.

Soils

Construction of the Proposal involves soil disturbance, which would result in minor impacts such as erosion and sedimentation within the Tweed River catchment. Construction of the future Hanson Tweed Sand Plant would disturb soil near the Tweed River and would require management of impacts. Construction of Kings Forest Town Centre Precinct would also involve a large amount of soil disturbance. Any cumulative impacts would be short-term, as operation of the Proposal and future projects would result in minimal impacts to soil.

Climate change

The undertaking of the Proposal and any of the current and future projects would result in emission of greenhouse gases and consumption of natural resources, thus contributing to climate change. Greenhouse gas emissions during construction and operation of the Proposal have been estimated, and measures have been included to mitigate emissions. Cumulative impacts to climate change could result from the construction of the current and future projects.

The design of the Proposal incorporates considerations for climate change, to ensure safe and resilient operation of the Tweed Shire region's water supply.

Noise and vibration

All current and future projects are, or would be, located at a significant distance from the Proposal. Thus, cumulative noise and vibration impacts to the wider region would be negligible.

Traffic

Construction of the Proposal would involve impacts to traffic due to transport of materials and site staff. Cumulative impacts relating to the Proposal and future projects are uncertain due to unknown construction period overlaps. All current and future projects are, or would be, located at a significant distance from the Proposal. Thus, traffic impacts to the wider region would be negligible.

Resources

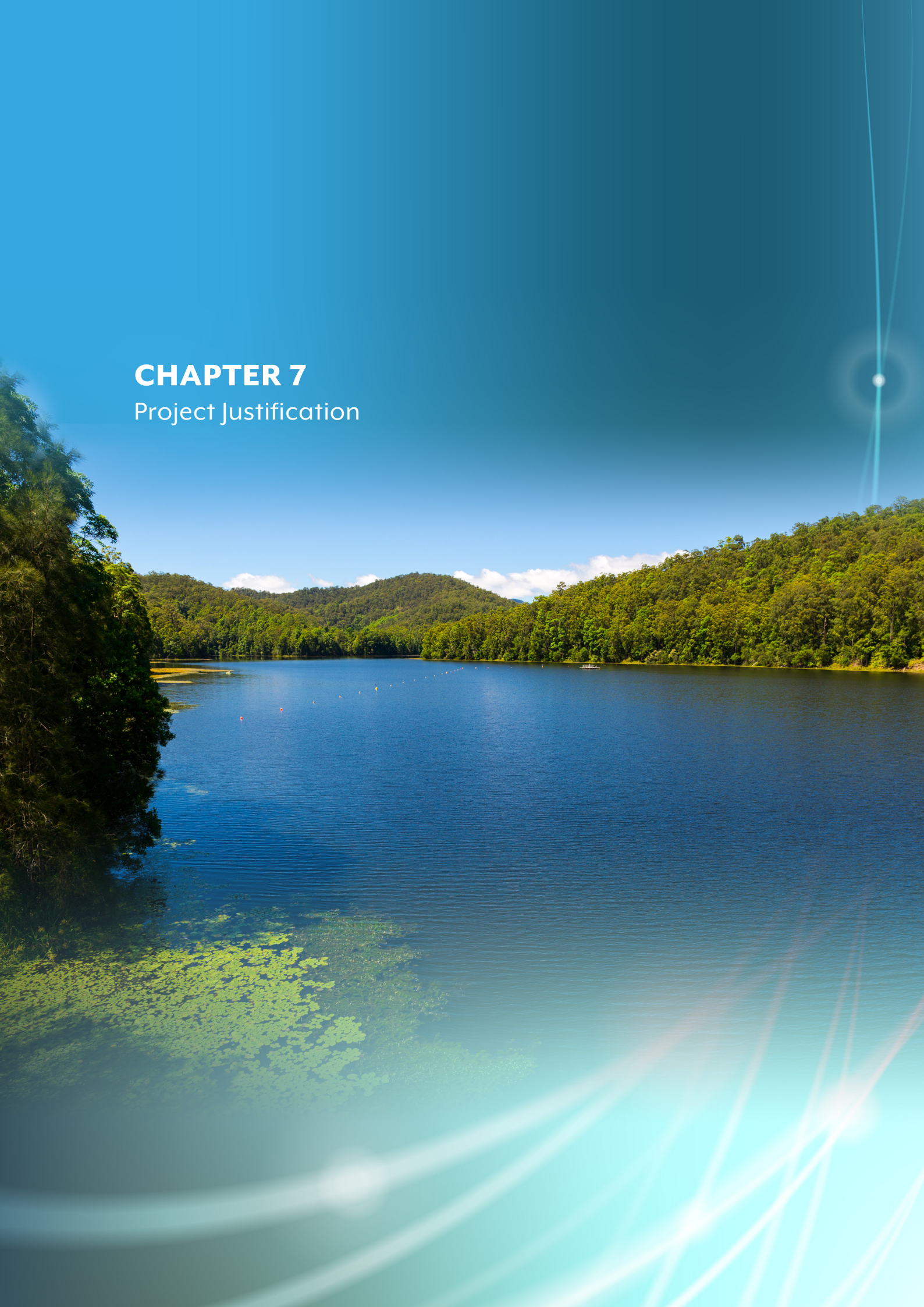
Construction of the Proposal would require a significant quantity of natural resources such as high-quality fill material, concrete, steel and asphalt. To reduce impacts to the supply chain and transport of materials, the Proposal would source all high-quality fill material from the recommissioned quarry adjacent to the existing dam and establish a concrete batching plant for on-site concrete production. Other future projects in the Tweed Shire region, such as Kings Forest Town Centre Precinct and Cobaki Residential Development would likely require significant quantities of natural resources such as fill material, concrete, steel and asphalt. Should construction of the Proposal occur in combination with these projects this would increase demand on resources and cause strain to local suppliers.

The operation of the Proposal would ensure secure water supply for the listed current and future residential development projects and support projected population growth. The Proposal would ultimately be a positive cumulative impact to the Tweed Shire Region's resources.

6.15.4 Conclusion

The cumulative impact assessment has identified current or future projects with potential to interact with the Proposal. The assessment has also reviewed available information to assess their environmental impacts. The key environmental aspects that would result in cumulative impacts are loss of biodiversity, Aboriginal heritage impacts and resource strain. The combined effect of these cumulative impacts is not considered to be significant. These impacts are able to be mitigated through the implementation of management measures for each key matter and as proposed by each individual project. Offset agreements would be established for significant impacts to threatened species, communities and key fish habitat and would provide for improved conservation outcomes within the region.

The Proposal would not significantly involve any material cumulative impacts in relation to other future projects in the region. No specific additional measures are required.



CHAPTER 7
Project Justification

7 EIS Synthesis

This chapter provides an evaluation, synthesis and justification of the Proposal as a whole, having regard to its economic, environmental and social impacts and the principles of ecologically sustainable development. A description of activities for which approval is being sought is summarised, and the findings of each section of this EIS are integrated in a consideration of the positive and negative impacts, unavoidable impacts, mitigation measures and an overall justification for the Proposal based upon the technical assessments in the EIS.

The relevant SEARs and where they are addressed in this EIS are shown in Table 7-1.

Table 7-1 SEARs for synthesis and justification of the proposal

SEARs for synthesis of the Proposal	Where addressed
F) A chapter that synthesises the environmental impact assessment and provides:	Chapter 7
i) A succinct but complete description of the project for which approval is sought.	Section 7.1
ii) A description of any uncertainties that still exist around design, construction and/or operational methodologies and how these will be resolved in the next stages of the project.	Section 7.1.1
iii) A compilation of the impacts of the project that have not been avoided.	Section 7.4
iv) A compilation of the proposed measures associated with each impact to avoid or minimise or offset these impacts	Appendix E
v) A compilation of the outcome(s) the proponent will achieve.	Section 7.7
vi) The reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts.	Sections 7.2, 7.3, and 7.5
vii) A consolidated summary of all the proposed environmental management and monitoring measures, identifying all the commitments in the EIS, including the anticipated level of performance in meeting required environmental standards and cleaner production principles.	Appendix E

7.1 DESCRIPTION OF THE PROJECT FOR WHICH APPROVAL IS SOUGHT

Tweed Shire Council proposes to raise the wall of Clarrie Hall Dam by 8.5 m, thereby increasing the capacity of the dam from 16,000 megalitres (ML) to approximately 42,300 ML. The raised dam would, as a result, provide adequate water supply to the Tweed Shire until at least 2065.

In 2018, a detailed concept design was prepared by NSW Public Works Advisory. The options assessment and concept design for the raised dam and its components were based on hydrological studies, geotechnical investigations, and seismic and structural assessments.

The concept design includes:

- constructing access roads to construction areas and establishing the construction site
- re-establishing the quarry used to construct the existing dam
- removing and storing parapet walls for reuse
- increasing the base width of the valley-side abutment and raising the crest of the concrete faced rockfill embankment to RL 70 m
- constructing a new concrete lined spillway higher on the west abutment

- extending the upstream concrete face to the new crest height
- raising the intake tower and access bridge
- constructing a new section of the Clarrie Hall Dam Road to provide access to the east abutment of the dam wall
- establishing new recreation and operational facilities including an amenities block, public shelters, viewing areas, interpretation signage, paths, car parks, landscaping, security fences, lighting, monitoring equipment and a boat ramp.

The operational footprint of the upgraded dam would increase the area of inundation to below the RL 70 m contour, which is the waterline boundary at full supply level (FSL).

In addition, construction activities would include:

- upgrading the Kyogle Road and Clarrie Hall Dam Road intersection
- replacing McCabes Bridge and realigning Commissioners Creek Road
- removing and/or reconstructing impacted infrastructure and facilities at Crams Farm
- relocating Telstra assets
- realigning powerline easements along Doon Doon Road and Commissioners Creek Road.

The Proposal also includes construction site compounds, workers accommodation, a concrete batching plant and site offices during construction.

A detailed description of the Proposal is provided in Chapter 3.

7.1.1 Uncertainties

The EIS has been prepared based on the detailed concept design completed by Public Works Advisory (Appendix B). Key uncertainties of the design or construction methodologies that may be subject to further refinement are summarised in Table 7-2.

Table 7-2 Uncertainties in concept design or construction methodologies

Stage	Details
Detailed concept design	The design of the spillway would be reviewed together with flood modelling that incorporates the latest climate change projections during detailed design.
Detailed design	Modelling to determine the dam consequence category would be conducted during detailed design in consultation with Dams Safety NSW and the SES.
Construction	The sequence of construction, including timing of ancillary works (such as McCabes Bridge construction), and the optimal level of dam water storage reduction during construction would be reviewed during detailed design.
Final locations of the concrete batching plant and workers accommodation sites	Two options for the locations of the concrete batching plant and temporary workers accommodation sites are provided in Chapter 3. The final locations of these would be determined during detailed design.
Final locations and layouts of the construction compound within the construction area	The final locations and layouts of construction compounds for the dam wall site and McCabes Bridge works would be determined during detailed design.
Location of the quarry haul roads	Two options for the quarry haul road are provided in Chapter 3. The final location of the quarry haul road would be determined during detailed design.

Stage	Details
Removal of vegetation within the raised FSL	The EIS considers the possibility of removing vegetation within the FSL inundation area to reduce impacts to water quality and aquatic ecology. This would also reduce greenhouse gas emissions. Locations for vegetation removal would be identified and would undergo risk assessment during the detailed design phase.
Alignment of plant community types (PCTs) for biodiversity offsetting	The vegetation to be impacted by the proposal has been described using the legacy PCTs, which were selected within the BAM-C case for the Proposal owing to the substantial amount of work progressed prior to June 2022, when revised PCTs were publicly released. Further consultation is required to match legacy PCTs with contemporary equivalent PCTs to ensure local offsets could be achieved using like-for-like vegetation on Council-owned land proposed for offsetting.
Source of embankment material	The Proposal would require large quantities of materials for the dam embankment and McCabes Bridge works. The source of these materials is expected to be from the quarry used for the construction of the current dam. Further geotechnical investigations are required to determine if further material would need to be sourced from elsewhere, and this would have to be confirmed by the construction contractor.
Spoil management	It is currently proposed that spoil unable to be beneficially reused onsite would be placed onsite or sent offsite for reuse or disposal. Spoil management options would be further developed during detailed design and prior to construction.
Dam site construction compound	Construction of the dam-site construction compound would require areas to be filled across Doon Doon Creek. The design of culverts and earthworks in this area would be developed during detailed design to meet the requirements of DPI-Fisheries, who has been consulted on this matter.

Mechanisms that could be used to ensure that uncertainties in the Proposal are assessed and mitigated include:

- construction and operational management plans
- terrestrial and biodiversity offsets
- project approval conditions, which may require further assessment
- a modification to the Project approval if a significant change to the Project was required after planning approval, such that it would not be consistent with the approval.

7.2 PROJECT OBJECTIVES AND NEED

7.2.1 Project objectives

Due to projected population growth and the increasing uncertainty of water supply yield associated with climate change, water demand in the Tweed Shire is expected to exceed secure yield by 2028. The Proposal aims to address this identified water security issue to ensure the Tweed Shire community continues to be provided with a safe and secure water supply beyond 2028.

The Proposal considers future population growth projections and predicted climate change impacts that would influence water security within the local region to therefore provide adequate water supply to the Tweed Shire until at least 2065. Increased water storage would allow for the continued growth of the region and ensure the resilience of the community, even in drought conditions, which are predicted to become more frequent and of longer duration due to climate change.

Section 1.3 of this EIS details the objectives of the Proposal in greater detail.

7.2.2 Consistency with strategic context

The Proposal is consistent with relevant local planning policies, strategies and plans, including:

- **The NSW Water Strategy** (DPE 2021): At a high level, the Proposal would address the long-term 'roadmap' by supporting the following priorities of the strategy:
  - Deliver increased resilience to changes in water availability.
  - Support resilient, prosperous and liveable cities and towns.
  - Support economic growth within a capped system.
- **The North Coast Regional Plan 2041** (DPE 2022a): The Proposal is consistent with the following objectives and strategies:
  - Objective 5: Manage and improve resilience to shocks and stresses, natural hazards and climate change
  - Objective 9: Sustainably manage and conserve water resources
  - Strategy 9.3: Encourage a whole of catchment approach to land use and water management across the region that considers climate change, water security, sustainable demand and growth, the natural environment and investigate options for water management through innovation.
- **The Far North Coast Regional Water Strategy** (DPE 2023a): The Proposal would assist Council to achieve the following objectives and opportunities, in addition to actions outlined in the strategy:
  - Deliver and manage water for local communities: improve water security, water quality and flood management for regional towns and communities.

    The Proposal would achieve these objectives with exception of flood management.
  - Improve the resilience of town water supplies by planning for the uncertainties of population growth and projected climate change.
  - Augmentation of the Clarrie Hall Dam: this EIS has been prepared as part of the application for approval. This would address the need to plan for emergency water supplies once Clarrie Hall Dam drops to approximately 97% capacity.
- **Community Strategic Plan 2022–2032** (TSC 2022a): The Proposal is consistent with Goal 2. 1, which is to 'provide safe, sustainable and affordable water supply and wastewater services as the foundations of a healthy community'.
- **Delivery Program 2022–2026 and Operational Plan 2023–2024** (TSC 2024a): In reference to Goal 2.1 of the Community Strategic Plan, this plan has identified the Proposal as a key project for the years 2022 to 2026.
- **Tweed Local Strategic Planning Statement** (TSC 2020a): The Proposal is consistent with the statement's Planning Priority 4 – 'reduce carbon emissions and sustainably manage energy, water, waste and development impacts'. The statement also refers to the Proposal to ensure long-term water security.
- **Integrated Water Cycle Management Strategy 2014** (Hydrosphere 2014): The Proposal is relevant to the following identified issues and provides a preferred outcome to them:
  - Issue 4: Uncertainty regarding the preferred Tweed district water supply augmentation option creates confusion regarding land use planning

  - Issue 13: Augmentation of the Tweed District Water Supply will be required in future due to population growth although the timing and additional supply required are unclear.

- **Water Supply Strategic Business Plan** (TSC 2019d): The Proposal is consistent with the following identified issues, and provides a preferred outcome to them:
  - Water availability: An increased water supply would be needed by 2028. Council has resolved to undertake the planning and land acquisition for the Proposal.
  - Emerging issues: It is anticipated that demand will exceed secure yield by 2028. Council has resolved to undertake the planning and land acquisition for the Proposal.
  - Corporate risk: A risk analysis was completed in 2013 that identified water source capacity failure and demand exceeding supply as key risks.

7.2.3 Consistency with statutory requirements

Council is responsible for ensuring adequate water supply during extreme events, such as drought, to meet critical human needs as a priority under section 60 of the *Water Management Act 2000*. The Proposal would aid in ensuring adequate water supply during extreme events, such as drought, by increasing storage and therefore allowing supply to last longer during dry periods.

Council is also required to ensure local water utilities' risks are managed effectively and strategically under Chapter 6 Division 2 of Part 3 of the *Local Government Act 1993*. The Proposal aligns with the strategic context outlined in section 7.1.2 and of the options assessed in 2009, 2015 and 2024. The Proposal would also allow for the frequency and duration of Council enforced water restrictions to be reduced.

Chapter 4 and Appendix A provide details of how the Proposal complies with statutory requirements.

7.2.4 Existing infrastructure risks and climate resilience

The existing Clarrie Hall Dam has limited water storage available, with roughly 12 to 18 months of water storage available for the major urban supplies in the Far North Coast (DPE 2023a). Currently, Council would need to plan for emergency supplies, such as temporary desalination, when the existing Clarrie Hall Dam drops to 97% capacity. This is impractical, as the lead times for emergency infrastructure such as this can be 1 to 2 years, requiring a decision on implementation very early on in a drought. Due to climate change and projected population growth, some models suggest that by 2030, Council would need to start planning emergency water supply when the existing Clarrie Hall Dam is completely full.

The Proposal aims to increase the water supply volume of Clarrie Hall Dam from 16,000 ML to 42,300 ML. This increase in water supply volume would result in greater water security, where Council would only have to begin planning an emergency water supply when Clarrie Hall Dam is at much less than 97% capacity. This would allow Council to have adequate time to establish an emergency water supply and reduce the risk of the Tweed Shire area running out of water before a suitable emergency supply could become operational.

The Proposal would increase the Tweed Shire LGA's resilience to drought and therefore satisfy resilience objectives stated previously.

The Proposal has assessed projected climate-change-related impacts across 2 different time horizons – the near future (2020 to 2039) and the far future (2060 to 2079). The main climate-related impacts assessed include increased average temperatures, increased time in drought, increased duration of extreme drought, increased intensity of rainfall events. The climate risks identified have been rated by severity, thus providing a prioritised list of climate risks that would be assessed against the design of the Proposal in the detailed design stage.

Further information regarding the assessed climate risks is provided in sections 6.1 and 6.10.

7.2.5 Community engagement

Consultation associated with the Proposal has been undertaken over the period of 2009 to 2024, largely facilitated by Council. In addition to community views obtained during options development for water supply augmentation, more thorough community consultation regarding the Proposal has been undertaken by Council since 2015, including updates on progress, community information sessions and consultation with individual landowners that would be directly impacted by the Proposal. Details of community and stakeholder engagement are provided in Chapter 5.

7.3 AVOIDANCE OF IMPACTS

7.3.1 Development of augmentation options for water supply

Potential social, environmental and economic impacts were considered during the development of options for water supply augmentation for the Tweed Shire that commenced in 2009.

The Proposal was selected as the preferred option to augment the water supply from the options study undertaken in 2009 for multiple reasons. When considering avoidance of impacts, the selection of the Proposal avoids the following impacts associated with alternative options:

- **new dam on Oxley River:** significant impacts to habitat for threatened flora and fauna; social impacts due to proximity to Tyalgum and potential flooding impacts to parts of the village and rural properties
- **desalination:** environmental impacts associated with the disposal of brine waste; issues associated with locating a suitable site and subsequent environmental impacts due to a coastal site location; and social and financial issues
- **direct or indirect potable reuse:** social issues regarding the acceptability of direct or indirect reuse of potable water
- **new dam on Byrrill Creek:** rainfall dependence resulting in further risk to the region's water supply; and environmental impacts from inundation of environmentally sensitive land, with associated agricultural land loss leading to impact on productivity and wellbeing of the community. This option was also prohibited by *Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2010* (DCCEEW 2023a)
- **Pipeline link to SEQ Water:** legislative difficulties due to interstate transfer of resources, these difficulties would persist even during periods of prolonged drought, when alternative supplies are needed most. The review of the strategic water supply options conducted by Stantec (2024) found that this option was ranked third out of the 3 options assessed, mainly due to the high cost.

7.3.2 Avoidance of impacts during preparation of concept design

During the concept design phase of the Proposal, several options were developed and assessed for the raising of Clarrie Hall Dam. The chosen option of single-stage construction to FSL at RL 70.0 m (AHD) is more economical and results in less environmental impacts when compared to raising the dam in stages. Additionally, raising the dam wall beyond 70.0 m (AHD) would have required the construction of saddle dams, resulting in further cost and environmental impacts.

Further information regarding the assessment of options is provided in section 2.4.1 and section 2.4.2.

The Proposal has been designed to avoid and minimise environmental impacts where reasonable and practicable. In doing so, the Proposal has been informed by the development of numerous

specialist studies and recommended mitigation measures to avoid impacts to the environment through design:

- The Project construction footprint would utilise previously established infrastructure such as the quarry to avoid cumulative environmental impacts and reduce offsite traffic generation for the transport of imported fill to site for raising of the embankment.
- Property acquisition within the proposed FSL has reduced social impacts to landowners that would result from land inundation.
- The proposed spillway and associated impact area were designed to avoid impacts to sites or places of Aboriginal cultural heritage significance. Additionally, the proposed spillway was designed to avoid significant changes in downstream flooding regimes.

Where impacts could not be fully avoided, they would be minimised. Further environmental impact mitigation measures and safeguards have been provided in Appendix E.

7.3.3 Avoidance of impacts assessed in the EIS

During the preparation of the EIS, the potential environmental impacts of both the construction and operation of the Proposal were assessed. These impacts would be considered and where possible, avoided during development of the detailed design and construction methodologies.

Chapter 6 provides mitigation measures for social and environmental impacts. These are collated in Appendix E, which provides a summary of mitigation measures and safeguards to be implemented across the detailed design, pre-construction, construction and operational phases.

7.4 UNAVOIDABLE IMPACTS

A summary of unavoidable impacts is provided below.

Biophysical impacts

Construction

Construction of the Proposal would result in disturbance of approximately 49.6 ha of land over a period of at least 70 weeks. This process would include land clearing, grubbing, stripping and construction of infrastructure activities. The key potential impacts to the biophysical environment from construction of the Proposal would include:

- direct loss of approximately 246.11 ha of native vegetation and threatened species habitat associated with the construction and operation footprint, including:
  - 222.69 ha of PCT 827 – Flooded Gum - Tallowwood – Brush Box moist open forest of the coastal ranges of the North Coast
  - 2.67 ha of PCT 1073 – Pink Bloodwood – Tallowwood moist open forest of the far northern ranges of the NSW North Coast Bioregion
  - 8.77 ha of PCT 1302 – White Booyong – Fig subtropical rainforest of the NSW North Coast Bioregion, which conforms to:
    - lowland rainforest in NSW North Coast and Sydney Basin bioregion, EEC listed under the BC Act
    - lowland rainforest of subtropical Australia, critically CEEC listed under the EPBC Act
- potential impacts to species listed under the *Biodiversity Conservation Act 2016* and *Environment Protection Biodiversity Conservation Act 1999* including:

- 12 Corokia (*Corokia whiteana*) individuals, listed as Endangered under the BC Act and EPBC Act
- 50 Rusty Rose Walnut (*Endiandra hayesii*) individuals, listed as Vulnerable under the BC Act and EPBC Act
- 457 Green-leaved Rose Walnut (*Endiandra muelleri subsp. bracteata*) individuals, listed as Endangered under the BC Act
- 4 Red Boppel Nut (*Hicksbeachia pinnatifolia*) individuals, listed as Vulnerable under the BC Act and EPBC Act
- 15 Fine-leaved Tuckeroo (*Lepiderema pulchella*) individuals, listed as Vulnerable under the BC Act
- 12 Rough-shelled Bush Nut (*Macadamia tetraphylla*) individuals, listed as Vulnerable under the BC Act and EPBC Act
- 709 Scrub Turpentine (*Rhodamnia rubescens*) individuals, listed as Critically Endangered under the BC and EPBC Act
- 105 Red Lilly Pilly (*Syzygium hodgkinsoniae*) individuals, listed as Vulnerable under the BC Act and EPBC Act
- 16 Durroby (*Szygium moorei*) individuals, listed as Vulnerable under the BC Act and EPBC Act
- 2.21 ha of habitat for Thorny Pea (*Desmodium acanthocladum*), listed as Vulnerable under the BC Act and EPBC Act
- 0.50 ha of habitat for Basket Fern (*Drynaria rigidula*), listed as Endangered under the BC Act
- 1.03 ha of habitat for Narrow-leaf Finger Fern (*Grammitis stenophylla*), listed as Endangered under the BC Act
- 78.96 ha of habitat for Slender Marsdenia (*Marsdenia longiloba*), listed as Endangered under the BC Act and Vulnerable under the EPBC Act
- 95.53 ha of habitat for Native Guava (*Rhodomyrtus psidioides*), listed as Critically Endangered under the BC and EPBC Act.

- The threatened fauna habitat to be lost as a result of construction and operation of the Proposal includes:
  - 165.61 ha of habitat for White-eared Monarch (*Carterornis leucotis*), listed as Vulnerable under the BC Act
  - 19.99 ha of habitat and one nest tree for White-bellied Sea-Eagle (*Haliaeetus leucogaster*), listed as Vulnerable under the BC Act
  - 14.49 ha of habitat for Albert's Lyrebird (*Menura alberti*), listed as Vulnerable under the BC Act
  - 32.16 ha of habitat for Pouched Frog (*Assa darlingtoni*), listed as Vulnerable under the BC Act and the EPBC Act
  - 6.09 ha of habitat for Giant Barred Frog (*Mixophyes iteratus*), listed as Vulnerable under the BC Act and EPBC Act
  - 0.16 ha of habitat for Loveridge's Frog (*Philoria loveridgei*), listed as Endangered under the BC Act

  - 136.92 ha of habitat for the Southern Myotis (*Myotis macropus*), listed as Vulnerable under the BC Act
  - 160.87 ha of habitat for Koala (*Phascolarctos cinereus*), listed as Endangered under the BC Act and EPBC Act
  - 0.10 ha of habitat for Southern Pink Underwing Moth (*Phyllodes imperialis smithersi*), listed as Endangered under the BC Act and EPBC Act
  - 2.20 ha of habitat for Mitchell's Rainforest Snail (*Thersites mitchellae*), listed as Endangered under the BC Act and Critically Endangered under the EPBC Act
  - 52.65 ha of habitat for Masked Owl (*Tyto novaehollandiae*), listed as Vulnerable under the BC Act
  - 52.65 ha of habitat for Sooty Owl (*Tyto tenebricosa*), listed as Vulnerable under the BC Act
  - 46 hollow bearing trees.
- soil erosion and sedimentation into waterways
- surface water impacts causing reduced water quality
- localised emissions of air pollutants due to dust generation and vegetation waste disposal
- generation of increased vehicle traffic
- noise and vibration impacts
- potential exposure of contaminated materials, such as asbestos
- Social impacts were found to be mainly positive (increased economic activity) and negative (potential stresses on social services due to the construction workforce).

These impacts can be managed with the mitigation measures provided in Appendix E. Loss of native vegetation and habitat for threatened species is a residual impact that cannot be further mitigated and would therefore be offset in accordance with the Biodiversity Offset Scheme.

Operation

Operational impacts associated with terrestrial biodiversity due to the raised FSL are included above.

The raising of Clarrie Hall Dam would result in the direct loss of aquatic and riparian habitat due to the increased inundation area. Offsets are required for the direct loss of key fish habitat as a result of the Proposal, which is discussed further in section 6.3.4 of the EIS.

Downstream hydrological impacts to Doon Doon Creek and the Tweed River have been modelled and assessed. These impacts included impacts to surface water, groundwater, and terrestrial and aquatic environments. The studies concluded that:

- changes to the Tweed River flow frequency are expected to remain negligible at Uki and imperceptible at Bray Park Weir
- there would be no changes to Australian Bass migration cues
- there would be reduced and/or more variable water quality during the first few years after commissioning of the raised dam due to how nutrients contained in the soils and vegetation would take some time to move into the water body following inundation
- during operation, potential water quality impacts could arise, including eutrophication; low oxygen content in parts of the dam leading to release of metals from sediments, which can

impact fish health are possible; however, these impacts are likely to be comparable to that from the existing dam

- operation of the Proposal, the risk of cold-water pollution to the downstream environment would decrease
- there would be a decrease in bed sheer for Doon Doon Creek, meaning that the rocky riverbed may be mobilised less frequently in floods
- groundwater pressure/level would increase in the Clarence Moreton Basin groundwater system up stream of the dam, and there would be no impacts to potential groundwater dependent ecosystems.

Changes to the Clarrie Hall Dam storage capacity and design of the spillway would result in changes to flood regimes both upstream and downstream of the Proposal during operation. The predicted changes suggest minor reduction in downstream flooding regimes and minor increase in upstream flooding which is confined to the main waterway corridors.

The long-term operation of the Proposal is expected to result in minimal other biophysical impacts, such as localised erosion and sedimentation from flows, and negligible air and greenhouse gas emissions.

7.4.1 Social

A number of social impacts and benefits have been considered in the EIS, where impacts would primarily occur within the construction phase of the Proposal, and benefits would be realised within the operation phase of the project. Overall, completion of the Proposal would provide a net social benefit to the Tweed Shire region due to an improvement in water security and greater resilience for the community.

Construction

Social impacts to the local community during the construction phase of the Proposal would include:

- visual and amenity impacts due to traffic generation and noise and dust from construction vehicles, though these are predicted to be temporary and minor in nature
- risks to public safety due to traffic generation and transport of dangerous goods
- increased demand for local housing, goods and services, placing pressure on local businesses and suppliers but also providing improved economic opportunities
- impacts to biosecurity.

These impacts can be managed with the mitigation measures provided in Appendix E.

Community consultation has been undertaken and has identified that most community members support the Proposal and are seeking further information regarding the impacts of the Proposal.

Operation

Operation of the Proposal would have minimal impacts to visual amenity, traffic, noise, air quality, biosecurity and demand for goods and services. Health and safety risks are not predicted to be significant, as the Proposal design would be subject to compliance with dam safety framework to ensure risk of dam failure due to flood or seismic events is minimised as far as practicable. Monitoring and maintenance of the Proposal would suitably manage risks during the operation phase. The raised embankment would only be visible from the recreation area at the dam wall, and the Proposed FSL would result in minor impacts to visual amenity for recreation users of Crams Farm and some residents located near Crams Farm. The permanent installation of powerlines,

while visible from rural residences and minor roads, would be consistent with existing views and infrastructure in the landscape.

The operation of the Proposal would result in loss of access to land and cultural sites of the Bundjalung traditional owners due to inundation at the FSL or risk of inundation during a flood event. The area at risk of inundation from flood spans from the FSL to the 1 in 10,000,000 year PMF event water level. These impacts are cumulative and would result in intergenerational loss of material culture. Archaeological mitigation and heritage interpretation to further inform our understanding of the past are proposed to offset some of these impacts.

Operational impacts to agricultural productivity would be insignificant because the footprint of the Proposal is located within areas that are either unable to be developed or are already excluded from agricultural practices due to their location being within the drinking water catchment.

The operation of the Proposal would provide improved water security and result in social and economic benefits. These benefits include greater community resilience during periods of drought, opportunities for agricultural sector and food production within the Tweed Shire region, and greater support for population growth.

7.4.2 Cultural

Aboriginal heritage

Aboriginal participation throughout the development of the EIS has been guided by NSW's *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DCCEEW 2010) as well as Proposal-specific communication strategies to promote transparent and frequent two-way dialogue between the Aboriginal community and the Proposal. Consultation activities, including cultural values mapping and further consideration of key rockshelter sites have been discussed within the ACHAR, with any feedback received discussed with RAPs and considered in the development of the ACHAR.

Through field surveys and cultural values mapping, 17 discrete Aboriginal sites and places were confirmed to be located within the Proposal footprint, including the PMF. Of the 17 discrete sites, 11 would be subject to direct impacts from inundation resulting in their complete or partial loss, 4 would be unaffected because they are outside of the FSL, and 2 are entirely within the inundation zone. Submerged soil profiles within dams experience limited modification, and as such, the sites and cultural deposits that would be inundated would be considered a conservation outcome.

Cultural values mapping identified Commissioners Creek and Byrrill Creek as 2 places of importance to the participants in the vicinity of the Proposal area. The Proposal would not adversely impact either of the identified places. Although Wollumbin is a place mentioned in a large number of Dreaming stories across the region, RAPs did not indicate the Proposal would result in an adverse impact to the place given the views towards Wollumbin would be unaffected by the Proposal.

The ACHAR has involved meaningful engagement with RAPs who have been involved in the comprehensive investigations of Aboriginal heritage values of the Proposal area. The investigations have contributed significantly to improve the archaeological and scientific understanding of a region with extremely limited cultural heritage investigations. While the Proposal would result in intergenerational/cumulative loss to material culture, there would be numerous cultural heritage benefits that could be realised in collaboration with RAPs, including heritage interpretation, mitigation of impacts to surface and/or subsurface stone artifactual material to provide further information on the past use of the region.

Impact mitigation measures for Aboriginal cultural heritage include the development of an Aboriginal Cultural Heritage Management Plan to provide a post-approval management framework for all future Aboriginal heritage requirements for the Proposal, conservation of overhangs, salvage

and recovery of objects and archival recording where appropriate. Further information is provided in section 6.5 and Appendix E.

Historical heritage

The EIS has also assessed places, sites and landscapes modified in the Australian historical period for purposes other than Aboriginal cultural traditions.

Much of the Proposal area has seen little change, since the modern development disturbances have been limited to areas that have been inundated following construction of Clarrie Hall Dam in 1983. Past historical activity within the Proposal area has not been intensive, and areas of high archaeological potential are limited to specific sites of post-1920 dairy farming activities and the former Doon Doon Sawmill Company.

Doon Doon Sawmill is subject to existing inundation impacts.

Crams Farm Reserve would not be impacted by the proposed increase of the FSL to 70 m AHD or the PMF to 77 m AHD. As a result, the raising of Clarrie Hall Dam is considered to pose no direct or indirect impacts to potentially significant archaeological resources.

The Bails and Dairy are 2 locally significant buildings that contribute to the historical setting of Crams Farm Reserve. The setting of Crams Farm Reserve also includes Doon Doon Hall and mature tree plantings. The historic heritage assessment (section 6.6) has determined that although the green space of Crams Farm Reserve will be reduced by the raising of Clarrie Hall Dam, no direct impacts are posed to the Bails and Dairy building by the proposed works, FSL or PMF. Indirect impacts include reduction in the surrounding lawn green space and former area of Crams Farm.

An assessment of impacts to natural heritage was also undertaken. The assessment found minimal changes in the outlook of some areas of the Wollumbin National Park would cause indirect impacts.

The Proposal operational footprint would extend into a portion of Mount Jerusalem National Park. As discussed in section 4.2.1, approximately 1.91 hectares of Mount Jerusalem National Park has been revoked through the National Parks and Wildlife Legislation Amendment (Reservations) Bill 2020. This was passed by the NSW Government on 25 November 2020. The revoked land is currently vested in the Minister administering the NPW Act, pending transfer to Tweed Shire Council upon subdivision, land title registration and the transfer of compensatory land. At the time of publishing this EIS, negotiations with NPWS were in progress.

An assessment of the potential indirect impacts to Mount Jerusalem National Park showed such impacts would be minimal. The measures proposed in the Biodiversity Development Assessment Report are suitable to manage the potential indirect impacts.

7.4.3 Economic impacts

The construction of the Proposal would result in increased pressure on goods and services. However, it would also create further economic opportunities for local businesses. Economic opportunities include direct and indirect local jobs, an increase in regional value and an increase in business turnover. Operation of the proposed dam would create local revenue to cover the cost of the Proposal and support potential upgrades to recreation facilities at the dam wall and Crams Farm.

Council will develop a management plan to address opportunities for recreation activities within the Clarrie Hall Dam area. Improvements to recreation opportunities within the local area would increase economic benefit for local businesses.

7.4.4 Cumulative impacts

Currently, the Proposal is unlikely to generate cumulative impacts with other potential future projects. A cumulative impact assessment has been conducted for the EIS (section 6.15) in accordance with the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPE 2022b).

Future projects within the Tweed Shire area mostly consist of housing developments on the coast. Several State Significant Development projects occurring within the Tweed Shire were screened and assessed for cumulative impacts. It was determined that none of these projects would contribute cumulative impacts to the Proposal due to their distance.

The operation of the Proposal would result in cumulative loss of Aboriginal cultural heritage for the local community. This would be managed by a heritage interpretation strategy, an Aboriginal Cultural Heritage Management Plan and ongoing consultation with the RAPs. Further detail is provided in section 6.5 and section 7.3.3.

7.5 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

The sustainability assessment (section 6.11) recommends that the Proposal be assessed by the IS v2.1 Rating accredited ESD assessment method. This assessment would be undertaken during the detailed design and construction phases of the Proposal and would embed sustainability into the Proposal design.

Table 7-3 summarises how the Proposal aligns with ESD principles. Further information on the Proposal's alignment with ESD principles is provided in section 6.11.

Table 7-3 Evaluation of the Proposal's alignment with ESD principles

Principle	Evaluation of the Proposal's alignment with principle
Precautionary principle / decision-making processes	Assessments have been undertaken to understand the potential environmental impacts during construction and operation of the Proposal. The Proposal has been designed to avoid environmental impacts where practicable, and mitigation measures are proposed to mitigate and manage the impacts where unavoidable. Any Proposal-related decisions would be guided by careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment and by assessment of the risk-weighted consequences of various options.
Intergenerational equity	This EIS has been prepared to meet the SEARs (Appendix A), which require that the EIS meet the minimum form and content requirements in section 190 and section 192 of the EP&A Regulation. Accordingly, assessments have been undertaken to understand the potential impacts that may occur during the construction and operational phases of the Proposal, as required by the SEARs. Matters assessed are included in Chapter 6. Appropriate mitigation measures to minimise environmental impacts during construction and operation are identified in Chapter 6. A summary of mitigation measures is provided in Chapter 7.
Conservation of biological diversity and ecological integrity	The BDAR (Appendix H) and Aquatic Ecology impact assessment (Appendix I) have been prepared in accordance with relevant legislation and aim to minimise significant impacts on any threatened species, endangered communities or their habitat as far as practical. Any significant residual impacts on biodiversity are proposed to be offset.
Improved valuation, pricing and incentive mechanisms	The Proposal has been designed to minimise adverse environmental impacts through an option selection process that includes the consideration of environmental factors and avoidance, mitigation or management of environmental impacts where impacts may potentially occur.

Principle	Evaluation of the Proposal's alignment with principle
	Any Proposal-related decisions would consider environmental factors in a cost-effective way and be guided by the whole-of-life costs of providing goods and services.

7.6 COMPLIANCE AND MONITORING PERFORMANCE

This EIS meets the requirements of the EP&A Regulation, the SEARs and has been prepared in accordance with *State significant infrastructure guidelines – preparing an environmental impact statement* (DPIE 2021b).

The specialist studies prepared for the EIS were completed in accordance with the technical requirements and guidelines informed by the SEARs and consultation with relevant government agencies and stakeholders. Statutory compliance of the EIS has been assessed in Chapter 4, Appendix A and Appendix C.

The environmental management framework for the Proposal comprises construction management and monitoring plans, and updates to operational plans, where appropriate. Where aspects have higher risk of impacts (i.e. biodiversity), specific monitoring plans would be developed. Appendix E provides a consolidated list of mitigation measures to ensure compliance of the Proposal and regular monitoring of the Proposal's environmental management and performance.

Monitoring programs for the Proposal would aim to:

- provide additional monitoring of baseline conditions
- identify and quantify any observed impacts
- assess the effectiveness of mitigation measures and safeguards
- ensure compliance with the relevant consent and licence conditions.

Council will be responsible for ensuring compliance with the approved project, liaising with DPHI and other regulators and communicating information to the community.

7.7 OUTCOMES AND CONCLUSION

The raising of Clarrie Hall Dam has been developed to ensure water security for the Tweed Shire region until at least 2065. As evidenced by recent droughts and secure yield modelling, the existing water supply system does not provide a secure water supply beyond 2028; therefore, augmentation of the Tweed Shire water supply by 2028 is required. The Proposal would result in the following key benefits:

- improved water security for the Tweed Shire region as water demand grows with projected population growth
- improved resilience to climate change for the Tweed Shire region as drought periods are expected to occur more often and for longer periods of time
- local procurement and business opportunities during construction of the Proposal, including opportunities for Aboriginal participation in construction
- Opportunities for Aboriginal participation during operation, including ongoing involvement in catchment management planning and community education.

The Proposal was developed following several iterations of detailed options analysis for water supply augmentation options, design, environmental assessment and stakeholder engagement. Where reasonable and practicable, the Proposal has aimed to avoid and minimise biophysical, social, cultural and economic impacts.

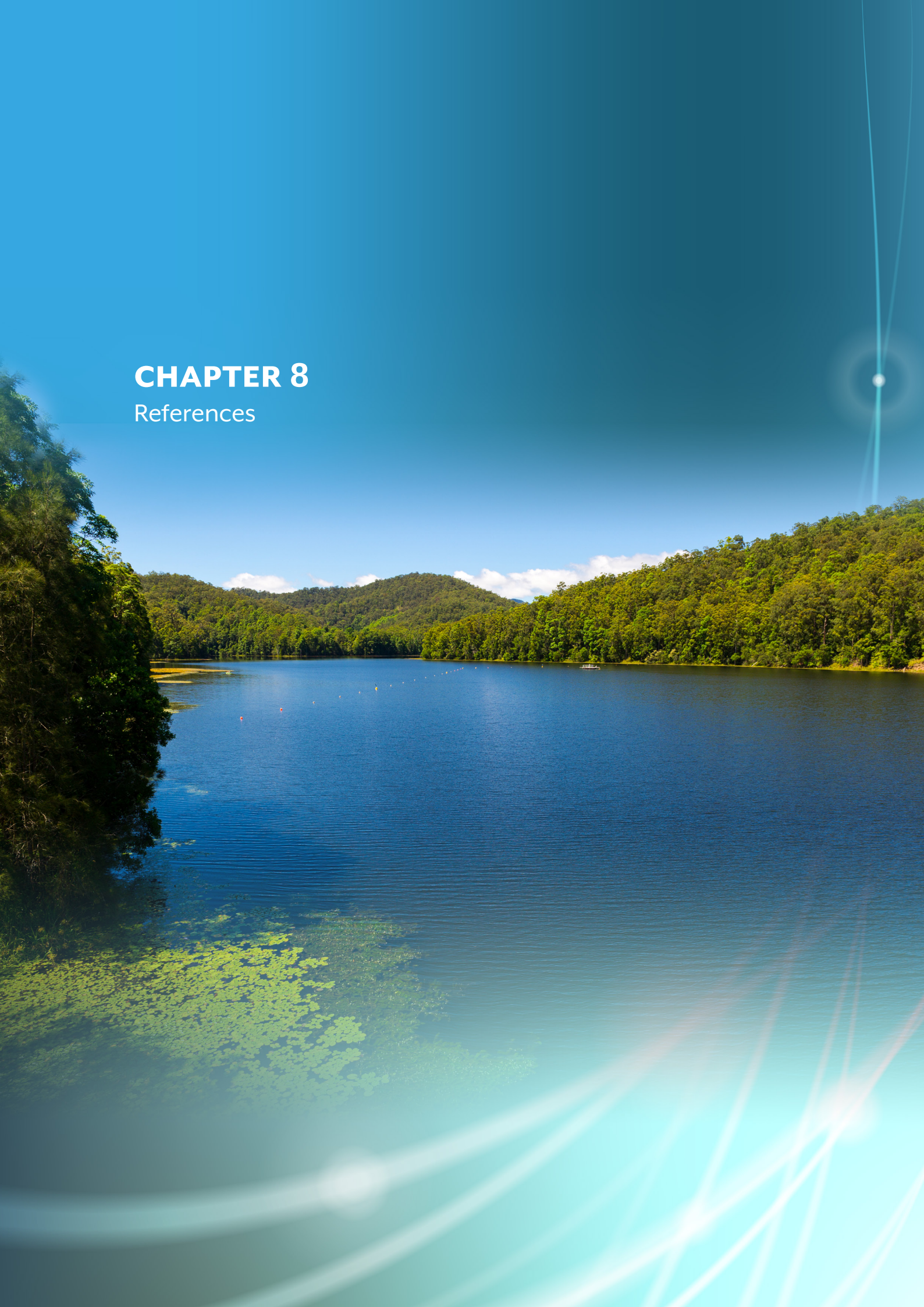
Where impacts are unavoidable, mitigation measures and safeguards have been identified or developed to reduce the likelihood, consequences and magnitude of any residual impacts. Whilst the majority of impacts associated with the Proposal can be mitigated, there are impacts to water, biodiversity and heritage that would require alternative management approaches and offsets. These alternative approaches and offsets are detailed in sections 6.1, 6.2, 6.3 and 6.5 and have been informed by consultation with the relevant government agencies and Aboriginal participants.

If the Proposal were not to proceed, the existing Clarrie Hall Dam would continue to operate with ongoing risk to water security within the Tweed Shire region. Alternative options to water supply augmentation would be required at significant cost and delay to Council and ratepayers. Additionally, identified impacts of these alternative options (section 7.2) have the potential to become greater than the impacts identified for the Proposal in the EIS. Furthermore, should a worst-case dry climate scenario eventuate, the Tweed Shire region would not have adequate water supply to satisfy the water needs of a growing population during a prolonged period of drought(s).

The Proposal should be approved as:

- it aligns with:
  - The NSW Water Strategy (DPE 2021)
  - The North Coast Regional Plan 2041 (DPE 2022a)
  - The Far North Coast Regional Water Strategy (DPE 2023a)
  - Community Strategic Plan 2022–2032 (TSC 2022a)
  - Delivery Program 2022–2026 and Operational Plan 2023–2024 (TSC 2024a)
  - Tweed Local Strategic Planning Statement (TSC 2020a)
  - Integrated Water Cycle Management Strategy 2014 (Hydrosphere 2014)
  - Water Supply Strategic Business Plan (TSC 2019d)
- it addresses climate change and would provide a drought resilient option to improve water security for the region
- the Tweed Shire region would be provided with adequate water supply until at least 2065, ensuring there would be little need to augment the water supply until 2065
- planning for and implementation of emergency water supply options would not have to be undertaken by Council when the dam water level is at 97% or 100%, saving time and resources
- local economic impacts during construction would benefit local businesses and provide both direct and indirect jobs over the duration of the construction period
- impacts can be appropriately managed, and viable offset options would be developed in consultation with the Biodiversity Conservation Trust and DPI-Fisheries to ensure positive conservation outcomes can be achieved within the region.

In considering the impacts and benefits of the Proposal, it is considered that the long-term benefits of improved water security and climate resilience outweigh the mitigated environmental impacts and costs. The raising of Clarrie Hall Dam would meet the identified Proposal objectives and would satisfy the critical need to ensure the Tweed Shire region has adequate water supply until at least 2065.



CHAPTER 8
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8 References

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