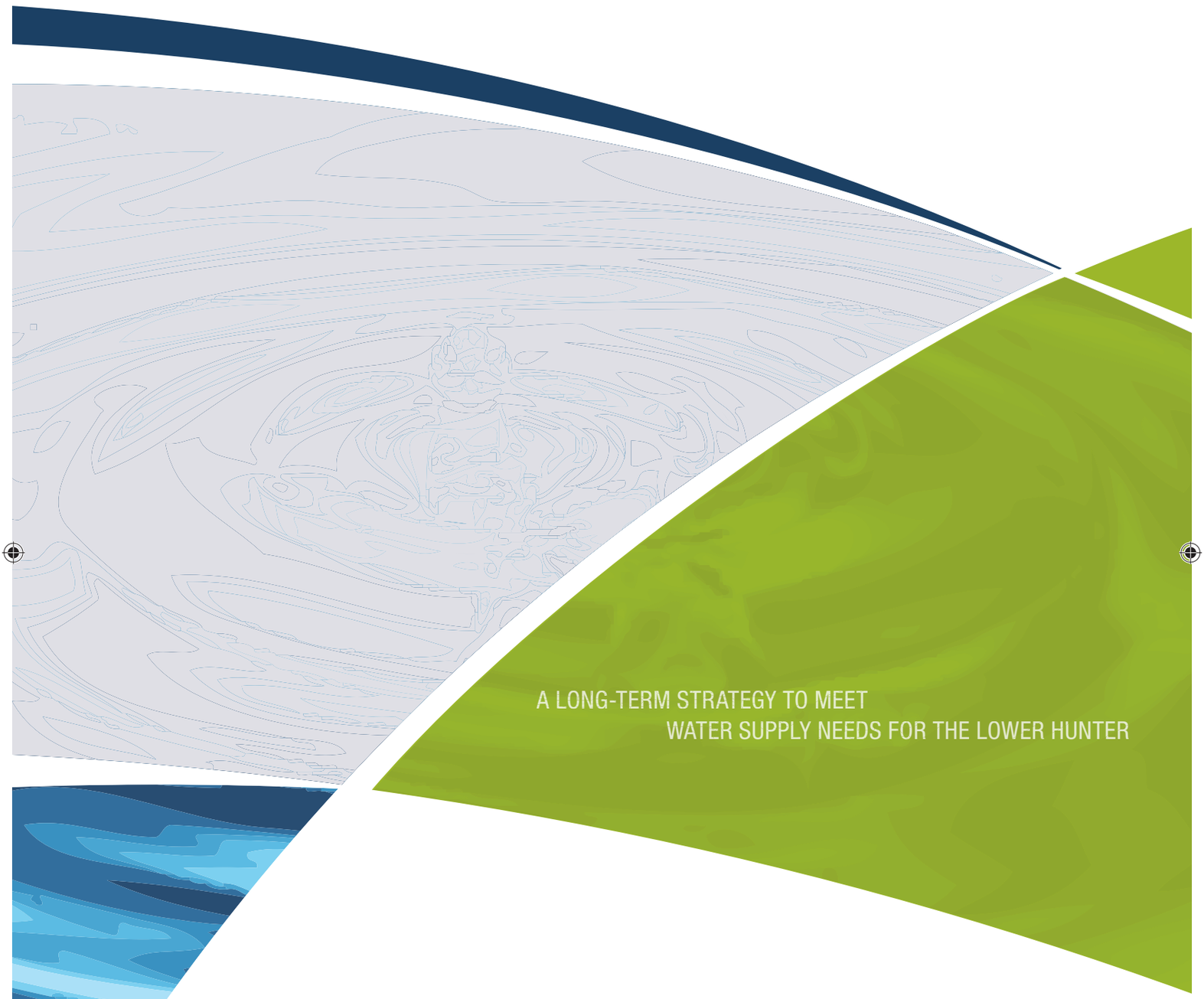
TILLEGRA DAM PROJECT

Securing Our Water Future



A LONG-TERM STRATEGY TO MEET
WATER SUPPLY NEEDS FOR THE LOWER HUNTER

Tillegra Dam Planning and Environmental Assessment

VOLUME 1 ENVIRONMENTAL ASSESSMENT REPORT

aurecon

Statement of validity

Submission of environmental assessment

Prepared under Part 3A of the Environmental Planning and Assessment Act 1979

Environmental assessment prepared by:	
Name:	Chris Masters
Qualifications:	BA, MA(Hons), MEngSc, MBA (Tech Mgt)
Address:	Aurecon Australia Pty Ltd
	Level 2, 116 Military Road
	Neutral Bay NSW 2089
In respect of:	Tillegra Dam
Applicant name:	Hunter Water Corporation
Applicant address:	36 Honeysuckle Drive
	Newcastle NSW 2300
Proposed development:	Construction and operation of embankment for 450 GL water supply storage and ancillary infrastructure; relocation of approximately 16 kilometres of Salisbury Road; replacement of Quart Pot Creek area access; relocation of affected community facilities including Quart Pot/Munni cemetery and Bendolba Rural Fire Service Station.
Land to be developed:	Land generally required for the construction and operation of the proposed development, as shown in Figure 6.1.
Environmental assessment:	An environmental assessment is attached which addresses all matters in accordance with Part 3A of the Environmental Planning and Assessment Act 1979.
Declaration	I certify that I have prepared the contents of this environmental assessment in accordance with the Director General's requirements dated 8 January 2008 and the supplementary Director General's requirements dated 9 May 2009, and that to the best of my knowledge, the information contained in the environmental assessment is not false or misleading.

Signature: 

Name: Chris Masters

Date: 28 August 2009

Aurecon came into existence in March 2009 through the merger of Connell Wagner Pty Ltd and two South African companies, Africon (Pty) Ltd and Ninham Shand (Pty) Ltd. This post-dated Hunter Water Corporation's engagement of Connell Wagner in July 2007 for professional services for the Tillegra Dam Planning and Environmental Assessment. All references to Connell Wagner in this report should be taken to now refer to Aurecon.

A person using Aurecon documents or data accepts the risk of:

a) Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.

b) Using the documents or data for any purpose not agreed to in writing by Aurecon.

Authors:	C Masters, C Chapman
Reviewers:	D van Senden, B Crichton, C Holloway, L Coletta
Approved By:	D van Senden
Signed:	
Date:	28 August 2009
Project No.:	43471

Executive Summary

aurecon

Hunter Water

Executive Summary

Introduction

Hunter Water Corporation (HWC) is proposing to construct a 450 gigalitre dam at Tillegra near the town of Dungog in the Hunter Valley. The dam would substantially increase the total existing water storage capacity of the Lower Hunter region. Existing dams at Grahamstown and Chichester currently hold a maximum of 210 gigalitres. The dam is an essential component of the NSW Government's State Plan A New Direction for NSW to secure the water future of the region for the next 50 years.

This document comprises the environmental assessment for the construction and operation of Tillegra Dam together with related works such as the construction of a new section of Salisbury Road. It has been prepared by Aurecon Australia Pty Ltd (formerly Connell Wagner Pty Ltd) on behalf of HWC in accordance with the process and requirements of Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Project location and description

The Project is located within the Williams River catchment, a subcatchment of the Hunter River catchment. The Williams River rises in the Barrington Tops National Park and flows to meet the Hunter River estuary at Raymond Terrace. The Chichester River joins the Williams River near Bandon Grove downstream of Tillegra. The Project is located in the Dungog local government area (LGA) within the Hunter region of NSW, approximately 74 kilometres north of Newcastle. The Project area covers the immediate localities of Tillegra and Munni along the Williams River and the broader Dungog area (and part of the Port Stephens LGA).

The key elements of the Project are described in the following table.

COMPONENT	KEY ASPECTS
Dam wall	Concrete face rock fill dam (CRFD), approximately 76 m high and 800 m long located at Tillegra
Spillway	Simple chute spillway controlled by an ogee crest located on the right abutment (looking downstream). The spillway would be 40 m wide at the crest and approximately 600 m long. The spillway is designed to handle the probable maximum flood (PMF) with a full storage prior to flood inflow and a dry freeboard of 1.3 m above the design flood level.
Multi-level offtake tower	The dam design provides for an offtake tower with full height selective withdrawal facilities. This would allow selection of water at optimum quality for releases.
Mini hydroelectric power plant	The dam outlet works include provision for installation of a mini hydroelectric power (HEP) plant to take advantage of environmental flow releases and bulk water transfers from the dam. The plant could generate up to 3,000 MWh of electricity annually which is roughly equal to the energy demands of 500 households. HWC would invite expressions of interest for installation and operation of the plant. Operation would be required to conform to the environmental flow release and bulk water transfer strategies.
Transfer pipeline and pump station	The design provides for a pipeline to transfer water from the dam to the Chichester Trunk Gravity Main (CTGM) which conveys water from Chichester Dam to Dungog water treatment plant, and then delivery to various towns and settlements in the Lower Hunter. The pipeline would be used as a backup to the existing water supply from Chichester Dam in the event of a water quality problem in the Chichester catchment. The pipeline could ultimately permit the transfer of water between storages, however planning approval for such water transfers is not being sought at this stage. The pipeline would run generally within the road reserve on the northern side of Salisbury Road.
Chlorination plant	In conjunction with the transfer pipeline and pump station noted above, a chlorination plant would be installed at Tillegra Dam to disinfect water prior to treatment at the Dungog Water Treatment Plant. Disinfection is required as there are non-standard connections to the CTGM that allow residential supply, prior to full treatment of water at Dungog.
Dam access roads	Access to the dam wall would be provided from below the dam. A temporary bypass road would be established around the dam construction site. Part of this road would be retained for future access to the dam wall. A bridge across the Williams River is required to replace the existing Tillegra Bridge for the temporary bypass road. A footbridge across the crest of the spillway would also be constructed to provide access over the longer term.
Salisbury Road realignment	The impoundment of water behind the dam wall would flood or isolate approximately 17 km of the existing Salisbury Road. The dam wall itself would be situated across the road at Tillegra bridge (which is also within the dam footprint). The relocated section of the road would be 16.8 km long and located on the eastern side of the storage. This would require a new bridge over the Williams River approximately 500 m downstream of Tillegra Bridge. There would be a second bridge crossing over the Williams River above the storage area in the vicinity of Underbank. A bridge is also required to span Moolee Creek. The road would be one lane in each direction with 3.5 m lane widths and 0.5 m shoulders/verges. It would comply with appropriate road design standards and the requirements of the local road authority.

COMPONENT	KEY ASPECTS
Provision of other access roads	Access to the Quart Pot Creek locality is currently via Quart Pot Creek Road which runs off the section of Salisbury Road in the inundation area. Alternative access would be provided to the locality off Salisbury Road above the inundation area through construction of a new 7.5 km road of which approximately half the length would be sealed.
Relocation of Quart Pot/Munni Cemetery	Quart Pot/Munni Cemetery is located within the inundation area of the dam. The cemetery covers an area of 0.85 ha and contains 80 known burials within 55 graves. Options available to affected families include leaving graves as they are, or partial or complete relocation to a new cemetery.
Relocation of utilities and public infrastructure	The Project would impact a number of utilities which currently cross the inundation area. These include approximately 20 km of telecommunications and electrical supply. The Rural Fire Service (RFS) currently has a station located within the inundation area. An alternative location has been identified above the storage close to where the new section of Salisbury Road would join the existing Salisbury Road.
Ancillary works	A number of ancillary works are being considered as part of the Project. These include look outs and viewing areas, walking tracks, a boat ramp, information centre, caretaker's residences, HWC office building and storage sheds, as well as a river flow gauging station.
Property boundary adjustments	Not all land acquired by HWC would be required for the Project. This activity would involve the subdivision or consolidation, as appropriate, of surplus land for subsequent divestment.

Project need

Around the world, the water industry has begun assessing the impacts of climate change on water resource management. The practices and policies of past decades are proving inadequate to the challenge.

Water efficiency and demand management initiatives are being accompanied by a greater focus on issues such as stormwater capture, leakage management, pressure control to reduce leakage and consumption rates as well as an increase in the use of recycled water to meet appropriate needs.

The current proposal to build Tillegra Dam has come about as a result of:

- the need to improve drought security for existing customers in the Lower Hunter region
- significant predicted growth in the Lower Hunter region as reported in the NSW Government's Lower Hunter Regional Strategy (2006)
- long term climate change implications and the recent drought experienced across the country.

For the Lower Hunter, the key water resource planning issue relates much more to the volatility and vulnerability of the water supply system to drought and climate change than to ongoing supply augmentation. Modelling of drought conditions has shown a significant reduction in the reliable system yield of the Hunter region. Doing nothing would potentially place the community of the Lower Hunter at an unacceptable risk of running out of water during periods of drought. Uncertainty with respect to climate change would only exacerbate these concerns.

Tillegra Dam would have the capacity to store 450 gigalitres of water. This additional storage volume

would increase the reliable system yield by 55,500 ML/yr. The dam would provide almost three generations of growth potential for the Lower Hunter region. Even with the prospect of climate change, Tillegra Dam is considered to be the best solution for the region in adding to the diversity of supply options.

Additionally, in an extreme drought Tillegra Dam would provide significant additional lead time for the decision-making process relating to the commitment of substantial funding (approximately $900 million) for drought contingency measures such as new groundwater infrastructure at North Stockton and a climate-independent desalination plant.

Tillegra Dam would therefore provide significant water security for the region and provide HWC with significant leeway in relation to the timing of financial decision-making for the costly drought contingency measures noted.

Option development

Supply augmentation options considered include new dams, upgrades to existing dams together with climate-independent options such as desalination and indirect potable reuse. New groundwater sources have not been considered as the current systems are already operating at their reliable limits. The only viable additional new groundwater resource is the North Stockton sand beds. While this resource is part of the region's existing drought contingency plan, it does not have sufficient capacity to operate as an ongoing supply and more recently has been gazetted as a National Park, State Conservation Area and Regional Park (known as the Worimi Conservation Lands).

The following source options have been investigated as part of the ongoing water resource planning process:

- Williams River schemes comprising new (separate) dams at Chichester and Tillegra
- further upgrades of Grahamstown Dam
- Karuah Scheme (Mammy Johnsons Dam)
- Paterson River Scheme (Lostock Dam)
- desalination
- indirect potable reuse.

Of these, Tillegra Dam was identified as the preferred option to meet HWC's objectives to secure the water supply.

Concept design

Concept design stage investigations at the dam site were completed in 2008 by the NSW Department of Commerce. The concept design notes the significant project elements required to be completed to operate the dam, operational aspects requiring consideration in design, the underlying environmental characteristics of the project site (including geotechnical and hydrological aspects) as well as design parameters and schematics for the main river diversion tunnel, dam wall (embankment), spillway, outlet works, electrical supply, telemetry, roads and access.

Developing a good understanding of the site's geology has been a significant component of the concept design work completed to date and has included numerous activities such as extensive geological mapping, excavations of test pits and trenches, water pressure testing, petrographic analysis of rock types, unconfined compressive strength testing, geomorphologic mapping, and landslide analysis and risk assessment.

An independent review panel comprising recognised national and international experts was convened to provide independent advice to HWC on matters related to geology and the dam. A report on reservoir rim stability and the dam concept design has been submitted to the panel.

In general, the geological conditions at the site are considered more favourable for a dam than is found at most dam sites. Investigations in the vicinity of the dam embankment have found no geological impediment to construction of the dam and no unusual provisions are expected to be required to prepare the foundations.

The report has been reviewed by the NSW Dams Safety Committee which has advised that its requirements relating to reservoir stability have been satisfied. The committee has also given in principle endorsement of the concept design report.

Additional design work has been completed by Opus International Consultants for the replacement of Salisbury Road. Design standards, underlying geology, drainage, route geometrics, pavement and surfacing requirements have been analysed and detailed. Concept design drawings for the road, bridges and other items of supporting infrastructure have been completed. The detail design for Salisbury Road is currently being finalised.

The above reports, and other related reports, are attached as Technical Annexures to the EA Report.

Statutory position and approvals

The Tillegra Dam project is considered to be of State or regional environmental planning significance in that it addresses the security of water supply for the existing population of the lower Hunter region and for projected population growth in the region.

The Proposal is subject to Part 3A of the EP&A Act through an Order made by the Minister for Planning under Section 75B(1)(a) on the basis that it is of State or regional significance. The Minister for Planning has also declared the Tillegra Dam project to be a critical infrastructure project under Section 75C of the Act.

The Project has been referred to the Department of the Environment, Water, Heritage and the Arts under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* in relation to potential impacts on matters of national environmental significance (NES). The Department subsequently advised that the Project was deemed a 'controlled action' in view of the potential impacts on the Hunter Estuary Wetlands which is a designated Ramsar site.

Community and stakeholder involvement

Consultation with the local community has principally been through the Tillegra Dam Community Reference Group (TDCRG) which was established in early 2007. The purpose of the TDCRG is to facilitate the flow of information between HWC and the local community, support the community engagement process and, where necessary, to provide advice to facilitate improved Project and community outcomes. The TDCRG has operated under defined Terms of Reference and was intended to run for the duration of the environmental assessment phase of the Project. It has met monthly and additionally as required. The TDCRG has been independently chaired by a facilitator external to HWC.

A variety of community-related issues have been raised through the TDCRG. These include:

- location of new roads
- potential recreational uses of the storage and surrounding areas

- the loss of farming land
- future tourism and recreational opportunities for Dungog Shire
- stocking of the dam with fish
- the potential for cycle tracks around the dam and storage
- recreational facilities such as boat ramps and camping areas
- tourism opportunities.

These, together with a range of other issues, have been considered in the environmental assessment and the development of impact mitigation and environmental management strategies.

In addition to the establishment of the TDCRG, HWC has undertaken a range of consultation activities including holding regular 'open house' sessions at Munni House, provision of information on the Project through media releases, newsletters, HWC's website, public information sessions, and meetings with community organisations and interest groups.

In January 2008 a Whole of Government Taskforce was established to coordinate the State government's response to issues outside the formal planning processes for the Tillegra Dam project. Various government agencies and public authorities, including HWC, were represented on the Taskforce. The Taskforce has worked with Dungog Shire Council and the local community to examine future issues/opportunities that may arise as a result of the Project.

Formal consultation with State and local government authorities was undertaken initially through a planning focus meeting (PFM) held on 11 October 2007. The purpose of the PFM was to provide an overview and history of the Project as well as explain the Project timetable, key features of the preferred option and to invite comment regarding key issues requiring further consideration in the planning process. Further meetings have subsequently been held with individual government agencies and public authorities regarding specific aspects of the Project.

Consultation activities have also formed part of the contemporary heritage and Aboriginal heritage investigations.

Consultation would continue during and after the exhibition of the EA Report. Specific activities would include making the Preferred Option Report (if prepared) publicly available. If the Project is approved, the Minister for Planning's approval and any associated conditions, together with HWC's determination would also be made publicly available.

Impacts on the Williams River

While the flow regime within the Williams River is already modified due to the operation of Chichester Dam, Seaham Weir and in general, the abstraction of water from the river for irrigation and other purposes, the proposed dam would further alter the natural flow regime of the river, affecting channel morphology and influencing water quality downstream of the dam.

As a direct consequence, it is likely that the aquatic and riparian ecology of the river would respond to these changes. The extent of the response would be dependant on the sensitivity of the flora and fauna to changing conditions in the river and whether elements of their life cycles were negatively or positively affected. Various interactions between both the biotic and abiotic components of the ecosystem add an additional layer of complexity to the assessment process.

Characterisation of likely and potential impacts has been undertaken holistically to assess the flow requirements of the many interacting components of the Williams River system. This approach has facilitated assessment of the water requirements of the complete system including such components as the source area, river channel, riparian zone, floodplain, groundwater, wetlands and estuary, as well as important features such as rare and endangered species.

Operational and environmental release strategy

A major function of the dam is to provide drought security for the Lower Hunter region. This would entail keeping a large volume of water in reserve for time of need. In this regard it is planned to operate the dam so that it is generally kept between 90-100 per cent full for the majority of the time.

It is proposed to constantly release the smaller base inflows to the dam as they occur so as to maintain flow in the river below the dam and the river's ecology below the storage. The majority of water stored in the dam would originate in larger flood flows which, on average, occur less than 30 per cent of the time.

This would require the release of 'transparent' environmental flows from the dam. Flows to the 30th percentile (the historically observed flows that occur 70 per cent of the time) would be released from the dam, matched to inflows. This will ensure that a range of low flows and moderate freshes in the river below the dam would be preserved.

The principal means for delivering water into the treatment and distribution system of the existing water supply network would be by making run-of-river transfers from Tillegra Dam to Seaham Weir. Water would then be pumped from the weir pool to Grahamstown Dam via the Balickera Canal.

It is proposed to release these flows in volumes of up to 4,300 megalitres at a time and in a manner that mimics natural flows in the river that carry similar volumes of water. Releases would also be made to ensure that they occur at the correct time of the year to maintain the seasonality of flows in the river. A number of smaller releases of up to 270 megalitres would occur at other times of the year to assist in maintaining fish migration events and the downstream aquatic ecology.

The proposed release strategy proposed would comprise:

- Tillegra Dam – transparent release to 30th percentile (100 ML/d)
- Chichester Dam – increasing the existing transparent release to the 95th percentile (from the existing 14M L/d to 20ML/d)
- releasing run of river transfers within a specifically tailored event based transfer protocol of 4,300 megalitres, consisting of a peak discharge of 1,500 megalitres declining over a 10 day period as well as making available smaller 270 megalitre peaked releases for fish migration and other environmental needs
- ensuring releases occur at the correct time of year to maintain the seasonality of flows within the river.
- preferential use of multi-level off take tower to limit extent of uncontrolled spillway flows.

This strategy may be refined following consideration of issues arising from the exhibition of the EA Report.

The proposed operational release strategy has been designed to specifically take into account the environmental requirements of the ecology downstream as well as existing use rights such as irrigation needs. Environmental requirements have included consideration of:

- protecting natural low flows
- protecting moderate flows and freshes
- maintaining and mimicking natural flow variability, at different temporal scales
- maintaining natural rates of rises and falls of the river, within natural bounds
- managing releases to prevent water quality impacts from releases from the storage
- assessing the biological requirements of fish communities with a view to providing flexibility in flow delivery to accommodate such needs.

Releases of water from Tillegra Dam would ultimately be undertaken in accordance with the Hunter Unregulated Water Sharing Plan which is currently in preparation by the Department of Water and Energy.

There are 177 surface water extraction licences in the Williams River water source with a total entitlement of about 8,300 ML/yr (Dept of Natural Resources 2007). The majority of access points for the licences are downstream of the Williams and Chichester Rivers confluence and around 97 per cent of licences are used for irrigation purposes.

Water extraction from the Williams River also occurs to support basic landholder rights and domestic and stock access licences. HWC also holds an existing major utility licence to take water at both Chichester Dam and at Seaham Weir.

No impacts are predicted for any licensed water users reliant on flows within the Williams River. The operational release strategy for the dam has been designed to specifically maintain the existing flow patterns and general water availability within the river. Contingency measures have been identified to manage the risk of poor water quality (primarily from decomposition of vegetation) during the initial filling of the storage.

The operating strategies would be the principal mechanism for mitigating and managing impacts on the Williams River.

Hydrology and water quality

Impacts on hydrology and water quality would occur during construction, initial filling and operation but would vary in nature and magnitude. During construction, management of impacts on water quality would be a significant matter for attention. Little effect is expected on flows as these would be diverted around the dam construction site.

Following completion of construction and closure of the Williams River diversion, the hydrological regime would be changed permanently. As the storage fills, approximately 19 kilometres of the main river channel and its associated tributaries would be progressively inundated, eventually becoming a large body of still water.

Changes would also occur downstream of the dam, these being most marked in the reach below the dam down to the confluence with the Chichester River. There would be fewer flood flows and these would be lesser in magnitude compared to the pre-dam situation. There would also be potential for water quality impacts such as cold water pollution. The multi-level offtake tower would be a key tool in managing water quality. Adoption of an integrated plan to manage activities around within the storage, thereby promoting sensible land use, will further aid in managing water quality.

The effect of the dam would decrease with distance downstream as catchment area increases and other tributaries join the Williams River. Negligible impacts are anticipated on groundwater.

Fluvial geomorphology

The altered frequency, duration and timing of channel maintenance flow events in the Williams River downstream of Tillegra would potentially lead to changes in the physical channel structure that could impact ecological processes. The channel would initially become more stable and have denser instream vegetation cover.

There would be reduced sediment transport in the Williams River downstream of Tillegra due to trapping by the dam. This could potentially lead to changes in the physical channel structure that could impact ecological processes. The capacity to transport material in the river bed (bedload) would be reduced downstream of the dam by a factor of three, but scour would occur due to the dam removing the upstream supply that would otherwise replace the transported material

The altered bedload transport regime would present a low risk to increased bank instability. The risk to the stability of instream structures such as revetments and grade control structures is similarly considered to be low.

Within the storage itself, potential issues include foreshore erosion and deposition of material transported into the storage from further up the catchment. Neither are considered to pose significant risks in relation to operation of the dam.

As part of the proposed multi-million dollar aquatic offset package a large woody debris/engineered log jam project is proposed. This will aid in mitigating geomorphological impacts.

Aquatic ecology

Aside from the direct effects of construction, principally at the dam wall and spillway locations, and the waterway crossings, impacts on aquatic and riparian ecology are expected to be more medium to long term in effect. These would be principally related to:

- the permanent presence of a significant barrier within the Williams River, ie the dam wall and its storage
- the loss of approximately 19 kilometres of existing aquatic and riparian habitat upstream of Tillegra (ie the location of the dam wall) through inundation
- changes to the existing hydrological regime affecting downstream aquatic habitats, particularly between Tillegra and the confluence with the Chichester River
- the water quality of releases made from the storage, particularly where there were significant differences between the water quality of the storage and downstream of the dam and especially in the reach above the confluence with the Chichester River.

The dam would form a barrier approximately 76 metres high and 800 metres wide across the Williams River at Tillegra permanently isolating the uppermost 54 kilometres of the main river channel and associated tributaries (representing approximately 15 per cent of the total catchment at the Hunter River confluence). This would effectively prevent upstream and downstream movement of aquatic species along the river permanently.

Twelve species of native fish have been identified in the Williams River near Munni and are considered likely to occur further upstream as well. Eight of these 12 species migrate to estuarine habitats as part of their life cycle, with six of these eight species needing to migrate to estuarine waters to spawn. The provision of a fishway at Tillegra Dam has been considered as a mitigation strategy. The cost of this has been estimated at approximately $30 million. This would not be an insignificant cost to the Project and it is considered there would be greater environmental and social benefits for less cost by taking a catchment-wide view of opportunities to offset impacts.

The dam would have an effect on flows right across the current flow range but is expected to be largely limited to the reach between Tillegra Dam and the confluence of the Williams and Chichester Rivers. The geomorphological investigations noted that as a consequence of the reduction in the frequency of flow events, there would be reduced bed material mobilisation in turn encouraging macrophyte colonisation and reduced disruption to instream vegetation. The consequence of this would be a reduction in the channel area useable by aquatic biota, though lessening with distance downstream from the dam.

During initial filling, water quality in the storage would be affected by the decomposition of vegetation inundated as water level rises. This would be reflected in elevated levels of nutrients and possibly low dissolved oxygen. These would reduce over time as the storage volume increases and provides a dilution effect, particularly following significant inflows. These potential water quality issues would be considered in the release strategy, particularly for the reach downstream of the dam to the Chichester River confluence.

Considerable attention has been given to the development of an extensive aquatic ecosystem package to manage and mitigate impacts on aquatic ecology. Elements of the package would include funding to construct and install a vertical slot fishway at Seaham Weir to improve connectivity between the Williams River and Hunter estuary as well as the remediation of a suite of other priority barriers to fish passage that currently exist across the lower Hunter. Sponsorship of a comprehensive monitoring and research program into fisheries conservation issues relevant to river regulation will also occur. Additional funding would be made available for aquatic habitat management including a habitat enhancement program relevant to the establishment of large woody debris/engineered log jams within the river channel. Such structures are known to provide important fish habitat.

In addition it is proposed to establish an applied research program focussing on the river below Seaham Weir to better understand the environmental affects of this existing structure. This information would better inform the development of management arrangements for the weir that would be incorporated into the water sharing plan in 2013.

Terrestrial flora, fauna and riparian ecology

The project would cause 2,100 hectares of land to be incorporated into the storage area. Of this, the majority of the land (1,800 hectares) is predominantly cleared pasture used for beef cattle and dairying. Within this area, 315 flora species and 157 fauna species were identified.

While species diversity was considered to be high in forested remnants, only eight threatened animal species (and no threatened plant species) were observed within the Project area. Threatened fauna comprised koala, brush tailed phascogale, squirrel glider, speckled warbler and four species of bats. An additional three species of bats were tentatively identified at the proposed construction site from calls recorded on Anabat survey equipment. None of the identified species are considered to be significantly affected by the proposal as there is limited habitat within the cleared farmland.

This notwithstanding, several different initiatives to improve conservation outcomes for State-listed threatened species are proposed. These include, for example, artificial roosting habitat for micro-bats under new bridges, installation of nest boxes and the recovery of hollow logs to enhance fauna habitat in the project area.

The most significant vegetation community remaining in the area is that fringing the riverbanks. Accordingly, the principal ecological impact would occur through the inundation of this vegetation along approximately 19 kilometres of the main channel of the Williams River above the dam wall. A number of tributaries (eg Quart Pot Creek) that flow into the Williams River along this reach would be similarly affected. As the storage fills, there would be a progressive loss of the existing habitat.

The Riparian Forest community was predominantly comprised of river oaks and was considered to be a variant of the *River-flat Eucalypt Forest on Coastal Floodplains* EEC (endangered ecological community) due to the absence of eucalypts in large sections of the riparian vegetation. In some intersecting gullies and drainage lines intergrading forms of the Subtropical Coastal Rainforest EEC were also considered to occur. The impact on the riparian forest community would occur on top of historic land use changes and river channel management activities which have already substantially contributed to the extensive decline in species diversity and areal extent of this vegetation community (and others).

There is some uncertainty as to whether the Riparian Forest community actually matches the NSW Scientific Committee's description of the River-flat Eucalypt Forest on Coastal Floodplains EEC and this is noted in Working Paper E. The final determination of the NSW Scientific Committee identifies a range of criteria to define this EEC and it is considered that there is a degree of ambiguity with respect to the characteristics of the Riparian Forest community satisfying the definitions of several essential criteria. Effectively, it appears that the Riparian Vegetation community along the upper Williams River has already been impacted upon by such an extent by land clearing and instream flood mitigation works that it no longer meets the description issued by the Scientific Committee for the River Flat Eucalypt Forest on a Coastal Floodplain EEC.

While the Project would clearly have an impact on the Riparian Forest community within the inundation area (and in the vicinity of the dam construction site), whether this would comprise an impact on the *River-flat Eucalypt Forest on Coastal Floodplains* EEC is subject to debate, with both supporting and dissenting views. From an overall Project perspective, it is largely irrelevant how the vegetation is technically described. The most important fact to acknowledge is that the existing vegetation is extremely important from a broad biodiversity conservation perspective. The Project therefore incorporates mitigation measures to contribute substantially toward replacing and enhancing biodiversity values at the Project site.

Firstly, it is proposed to invest $1.6 million in a riparian vegetation improvement program across an equivalent 19 kilometre length of the Williams River. This is in addition to the 1,800 hectare biodiversity corridor proposed to be developed via dedicated tree planting using endemic species and natural revegetation. This biodiversity corridor will provide replacement terrestrial habitat for that lost with the inundation area of the dam as well as functioning as a habitat corridor for fauna movements between the Barrington Tops National Park and other areas. The proposed biodiversity corridor has an area approximately the same size as the storage.

Sixteen different frog species were identified in the upper Williams catchment with none considered threatened or endangered. The stuttering frog (vulnerable) was considered as having some potential to occur in the area, however, no individuals of this species were found in the field. Two small areas of potential habitat for this species were identified as occurring in the proposed storage area. These areas are small, fragmented and isolated. As a consequence should individuals of this species actually occur, their long term persistence is considered to be already severely compromised.

Both the platypus and Australian water rat utilise the riparian zone of the Williams River and would potentially be affected by the dam. The inundated section of the river would become unsuitable for occupation by platypus through loss of burrows and alteration of foraging areas. There could also be the consequential effect of a potential increase in predation as individuals are displaced as the water level in the inundation area rises. Downstream of the dam, the altered hydrological regime could also affect the platypus. Management of downstream impacts would largely be addressed through the operating regime which would mimic pre-dam conditions as far as practicable, and would provide for maintenance of environmental requirements.

The impacts on the Australian water rat are unlikely to be as great as those identified for the platypus. The species is more terrestrial than the platypus, has a higher birth rate and it forages on a wider range of prey species, including terrestrial vertebrate species.

Hunter estuary and Ramsar wetland

In general, there would be minimal impact of the dam on the Hunter estuary and on the Ramsar wetland. In the hydrodynamic modelling undertaken of the estuary, all Tillegra Dam flow scenarios (including Tillegra Dam filling, construction and operation) would have limited impact on the flows received at the Hunter estuary wetland due to the overriding control of flows at Seaham Weir. Further, inflows from the Hunter River mask any discernable impacts on the estuary's hydrology that would otherwise be apparent. Flood, advection, dispersion and tidal modelling results, as well as nutrient mass balance estimates only showed minor deviations in baseline water quality and hydrological parameters.

Similarly, there would be negligible changes in water quality that could affect the wetland. Simulation of salinity concentrations in the Hunter River show relatively minor differences (typically less than 0.5 ppt) in salinity as a result of changes in flow at Seaham Weir along the South Arm and North Arm of the Hunter River. Modelling indicates that the total nitrogen and total phosphorus loads to the estuary would be reduced by 1.1 per cent and 1.3 per cent respectively. This can be attributed to the expected reduction in flow volume downstream of Tillegra Dam.

Analysis of the results of the water and nutrient budget illustrate the relatively small contribution of loads to the estuary from the Williams River catchment. Flow inputs from the Williams River are less than 1.5 per cent of the total volume of inputs considered by the budget. Consequently, changes to the concentration of TOC (total organic carbon) as a result of Tillegra Dam are not expected to result in considerable changes within the Hunter Estuary Wetland.

A specialist investigation was undertaken into the potential impacts of the Project on the Hunter Estuary Wetland which is a listed Ramsar wetland site, and which gave specific consideration to relevant NES matters. Based on the available description of the ecological character of the Hunter Estuary Wetland, material cumulative and consequential impacts from construction and operation of Tillegra Dam are not expected. The minor extent of change that would result from the proposed dam provides confidence that it would not substantially contribute to any cumulative impacts or changes to the Hunter Estuary Wetland. Further the potential impacts of climate change and, in particular, sea level rise could be severe given current climate scenario and vulnerabilities of estuarine wetlands. These are expected to far outweigh any minor environmental changes associated with the dam.

Socioeconomic issues

Based on a cost effectiveness analysis conducted in accordance with NSW Treasury guidelines, Tillegra Dam was confirmed as the most cost effective option to augment the Hunter's water supply. At $1.66 per kilolitre, it has the lowest levelised cost of a variety of alternate proposed supply options. The next closest option is the New Chichester Dam option which, when assessed on 2008/09 terms, returns a levelised cost of $2.45 per kilolitre.

Construction of the dam, however, would have a variety of social impacts. These include altering the fabric of the local community by removing a number of viable farms from the area. Approximately 38 families reside in the area that would be occupied by the dam and its associated storage. Overall the project would reduce agricultural land under production within the Dungog LGA (local government area) by 1.7 per cent (and approximately 0.1 per cent in the Lower Hunter region).

As at June 2009, HWC owned or had agreement to purchase approximately 94 per cent of the land required within the inundation area. Properties are currently leased back to interested parties.

While modest changes to the agricultural sector would occur, in the short term there would be considerable economic stimulus in the LGA from the investment of $397 million (real 2008/09) from construction activities. In the longer term, increased visitation rates related to recreation on the dam would promote commercial opportunities in the tourism market.

Overall, the economic assessment for the Tillegra Dam project indicates that the positive economic impacts of the construction phase would be significant. Some of the more prominent social and economic benefits of the proposal generated through the injection of $397 million in capital investment over a three year period from 2010 to 2013 include:

- direct employment opportunities in the construction of the dam and later in the operational phase
- increased demand and expenditure in Dungog Shire for materials, equipment, goods and services
- direct opportunities for Dungog Shire to attract workers with families that can positively impact on the age profile of the Shire and economic dependency ratio by increasing the level of household income (the LGA has an ageing population with a declining household income which suppresses economic growth opportunities for business)
- strengthening and expanding Dungog Shire by diversifying the range of economic opportunities available for business, including opportunities to increase the wholesale and retail trade sectors as well as expand construction, tourism, accommodation and food service industries, in turn generating long term flow-on benefits to other existing local businesses and promoting their ongoing viability
- a positive boost to local tourism resulting from recreational use of Tillegra Dam; increased tourism opportunities within the Shire are expected to generate private investment into retail and accommodation services to service visitor demand.

Economic modelling by Monash University commissioned for the EA Report highlights a number of benefits from the Project over the period 2009 to 2030 for the wider region. These arise from the capital and recurrent expenditure required for the Project. The modelled benefits include:

- a discounted national welfare benefit of around $2.3 billion as measured by deviations in real household consumption for the Hunter region, the rest of NSW and the rest of Australia; this occurs firstly through additional investment in the construction period that stimulates short-run employment
- increased real GRP (gross regional product) of approximately $1.18 billion in the Hunter region; this benefit is realised over the longer term as the significant economic gains derived from increased water security are only realised when growth is allowed to increase within the additional capacity of the revised total system yield
- increased aggregate employment in the Lower Hunter through the construction and operation periods, generating an additional 1,849 jobs; a rise in capital stocks as the increased supply of water as a consequence of the Project makes the Hunter region more conducive to investment with an increase in aggregate investment over 25 years of $588 million (undiscounted).

The economic modelling results are considered conservative since the modelling was based on an investment of $300 million and the modelling period only extends for 25 years to 2031. The effective asset life of Tillegra Dam is generally assumed to be well in excess of 50 years and may in fact be several hundred years.

The Tillegra Dam Project would have direct and indirect effects on the local economy during both construction and operation of the dam. These would be on a number of scales ranging from individual farming enterprises through to Shire-level effects. The Project has identified 38 properties that will require acquisition in full or in part. To date, HWC has negotiated the purchase of 32 properties. HWC has purchased these properties in accordance with the market value of the land as well as compensating landowners consistent with and beyond the provisions of the *Land Acquisition (Just Terms Compensation) Act 1991*.

The removal of up to 38 households from the district (though not all have necessarily left the Shire) would have some effect on local business activity, notwithstanding that an estimated 55-60 per cent of household spending leaks from the Shire.

During construction, it is expected that local business would experience patronage by construction workforce personnel due to Dungog's proximity to the construction site. This would provide a stimulus to the local economy during the construction period. Following construction, it is anticipated that visitor numbers to Tillegra Dam would progressively increase, particularly as the storage nears its maximum and the range and extent of water-based recreational activities increases. Visitor numbers may also be driven by other tourism developments which may be established by private operators. Again, due to Dungog's proximity to Tillegra Dam, the local economy would be expected to benefit from increased visitation levels.

While the principal objective of the Project is water supply security, the presence of a significant inland water body would present a significant range of opportunities for water and land-based recreational activities such as boating, fishing, camping and bushwalking. As part of the assessment, a draft management plan has been prepared to facilitate land use around the storage to facilitate these opportunities while managing risks to water quality. The plan would be implemented cooperatively by HWC with Dungog Shire Council.

The plan has identified a range of potential land use zonings to support these opportunities and accords with recommendations made in Dungog Shire Council's Land Use Strategy. The strategy was funded by HWC and is currently on public exhibition.

Aboriginal and contemporary heritage

The Aboriginal heritage assessment for the Project was undertaken in two stages. The first stage scoped the extent of Aboriginal heritage issues existing within the inundation area of the dam with the second stage comprising:

- an analysis of geomorphology and post-depositional processes
- consultation with the Aboriginal community pursuant to DECC guidelines
- archaeological testing and analysis of potential impacts.

Several potential and actual Aboriginal archaeological sites were located within the storage area containing stone chips and flints. During the construction period, HWC proposes to undertake full archival recording of the sites found.

The contemporary (European) heritage assessment was also undertaken in two stages to scope and understand the extent of cultural heritage material located within the proposed dam inundation area. Work was undertaken with input from the local community, including the local historical society.

Approximately 50 items of heritage significance were located within the area directly affected by the proposed dam and reservoir. This included a variety of minor items such as old stock crossings, old house sites and survey markers.

- Significant heritage items included;
- Quart Pot/Munni Cemetery
- private burial sites at Summerhill, Forster House and elsewhere in the area
- historic Munni House and complex dating circa 1860
- possible, although unlocated site for 'Mann's Hut and Stockyards' dating prior to 1860.

Affected items would be subject to archival investigation and recording. Some items may be salvaged, including high value components of the Munni Homestead Complex.

Quart Pot/Munni Cemetery is a cemetery currently used by the local community. Feedback from the community to date has indicated that detailed archaeological investigations within grave sites would be considered highly intrusive and disrespectful to the recently deceased. Accordingly, HWC does not propose to treat the area as an archaeological site requiring detailed historical investigations. Management of the cemetery would instead be treated primarily as a social issue requiring specific input from each affected family. A cemetery relocation plan has been developed to assist with this process.

Landscape and visual impacts

The dam wall, spillway and associated infrastructure would introduce significant new elements into the landscape in the Tillegra locality. As the dam fills, the newly created water body would also become a prominent feature. The new section of Salisbury Road would similarly introduce a major new linear feature into the landscape.

Nine sensitive receptors were identified with potential or likely views to the dam wall and other infrastructure. Visual impacts were ranked as high for three receptors and moderate for the remainder.

There are limited practicable opportunities for mitigating the visual effects of major items of infrastructure such as the dam wall and spillway. Where possible, elements related to the dam and spillway would be designed to minimise their profile in the landscape and would include provision of suitable external treatments such as choice of materials, colour, etc. In certain localities, the natural topography would assist in mitigating visual impacts by partially or completely blocking views to the new features in the landscape. Additional screening would be provided over time as vegetation within the habitat corridor becomes established.

The Project would introduce many new visual elements to the area, some of which may be of interest to viewers. These opportunities have been recognised and are considered in detail in the draft ILUP. These include the provision of viewing areas and walking tracks at various locations around the dam and storage area.

Cumulative and consequential impacts

Assessment of the potential cumulative effects of the Project has considered potential effects on other water supply infrastructure. This concluded there would be a beneficial effect from the Project in providing a significantly higher level of security of supply.

Potential impacts on other major projects in the Hunter region whose construction may coincide with Tillegra Dam were also considered. Presently, the Project is the only major proposed development in Dungog Shire. While Railcorp has plans to expand production at its Martins Creek quarry, no formal application has been lodged at the time of finalisation of the EA Report. There are only two other major projects (a residential subdivision at Karuah and a mixed use development in Cessnock) that would be within 50 kilometres of Tillegra Dam. As such, the potential for local and possibly regional cumulative impacts is considered to be minor.

Cumulative and consequential effects have also been considered at the local scale with respect to the key and other environmental issues examined for the Project. For some aspects such as ecological impacts, this was constrained due to the lack of suitable information. In general, however, it is considered these would not be significant. There would also be positive effects such as through the establishment of a habitat corridor, particularly around the eastern margin of the storage which would provide a connection from the Barrington Tops area and the riparian corridor below the dam.

The majority of impacts would be managed and mitigated within the immediate vicinity of the Project thereby limiting the potential consequences for cumulative impacts beyond the Project area.

Other environmental issues

A number of other environmental issues have been identified and considered in this assessment including noise and vibration, air quality, traffic and transport, resource management and contamination. None of these issues were considered to have any major consequence for the Proposal. This notwithstanding, any residual impacts associated with these issues would be addressed through well understood and established mitigation measures and safeguards.

Sustainability

The concept of ecologically sustainable development (ESD) is referenced at a statutory level under both Commonwealth and NSW legislation. Section 3A of the EPBC Act refers to ESD in the context of the need to integrate social, economic and environmental considerations into decision-making processes. In NSW, Section 5(a)(iiv) of the EP&A Act states that ESD is a primary objective of the planning process. This is reinforced in Schedule 2 to the *Environmental Planning and Assessment Regulation 2000*. The objectives of other NSW legislation such as the *Protection of the Environment Administration Act 1991* and the Protection of the Environment Operations Act 1997 include the fulfilment of ESD principles.

Sustainability issues have been considered in the planning and design of the Tillegra Dam project through development of a sustainability assessment framework. The framework has been used to assess how the Project can realise its sustainability goals from the planning and design phase through to the construction and operation phases.

Justification and conclusion

The Tillegra Dam project would generate predominantly positive short and long term economic impacts while lesser negative economic impacts will be localised in the proposed inundation area. The positive impacts are significant and will accrue at the local (Dungog Shire), regional (Lower Hunter) and State levels. At the regional level, the Project would effectively double the existing storage capacity of the Lower Hunter region. This increase in capacity in the HWC water supply network and enhanced water supply security through provision of additional yield would be pivotal in underpinning and supporting continued population and economic growth in the region.

As with any major infrastructure project, the Project would have both positive and negative social impacts. These would vary over time and be experienced predominantly at the local level through the removal of several existing farms to accommodate the reservoir.

Development of the Project has included specific consideration of likely and potential biophysical impacts. Where practicable, impacts have been removed or minimised through design refinement. Mitigation measures and strategies have been developed to manage residual impacts.

The Project would be constructed to meet existing environmental standards and performance would be monitored to make sure this is achieved. Accordingly the Project is considered justified on the basis of social, biophysical and economic considerations and in accordance with the principles of ESD.

The engineering feasibility of the Project has been investigated separately by the Dams and Civil group of the NSW Department of Commerce and by Opus (with regard to the relocation of Salisbury Road). The engineering investigations have examined specific issues including geotechnical conditions and related risk issues. These investigations have concluded the Project could be constructed and operated while adequately addressing these issues.

Overall, it is considered the Tillegra Dam project would achieve acceptable environmental and social outcomes, deliver substantial economic benefits and provide drought security well into the foreseeable future. The Project is, therefore, considered justified.