Angle Crossing Option

Project Plan

July 2007

ACTEW CORPORATION

WATER security program
safe • secure • sustainable

Prepared By

atechgroup

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Abbreviations

ACT	Australian Capital Territory
ACTEW	ACTEW Corporation Ltd
ActewAGL	Public/private company operating ACT water supply under contract
CGBT	Cotter Googong Bulk Transfer
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DA	Development Application
ECGBT	Extended Cotter Googong Bulk Transfer
EIA	environmental impact assessment
GL	Gigalitre (1,000,000,000 litres)
ICRC	Independent Competition and Regulatory Commission (in ACT)
km	Kilometre
L	Litre
LMWQCC	Lower Molonglo Water Quality Control Centre
m	Metre
ML	Megalitre (1,000,000 litres)
NSW	New South Wales
SWOT	Strengths Weaknesses Opportunities Threats

Executive Summary

The *Angle Crossing* option was one of the primary recommendations of the Future Water Options report by ACTEW. The scheme involves pumping water from the Murrumbidgee River near Angle Crossing at the southern border of the ACT, to Burra Creek or Googong Reservoir. The option could provide up to 20 GL/year, which is a third of Canberra's average annual use.

The option was postponed, as after further work, it was considered more prudent to abstract water from the Murrumbidgee River via the existing pumps at the Cotter Pump Station, and to augment the treatment capacity of Mount Stromlo Water Treatment Plant to treat river water.

However, based on the results of an annual ACTEW review of climate variability and climate change, ACTEW has decided to reconsider the *Angle Crossing* option.

The purpose of this report is to provide a project plan for the *Angle Crossing* option, which can allow implementation to commence immediately following a decision by the ACT Government.

The summary program of work is outlined in below.

Program	**Studies/Issues**
Planning and Environmental Approvals (see section 4 of report)	Development Approvals Cultural Heritage Analysis Terrestrial Flora and Fauna Aquatic Ecology Catchment and Landscape
Infrastructure (see section 5 of report)	Technical Design
Water Resource Management (see section 6 of report)	Diversions and Environmental Flows Allocations and Licence to take water Water Quality
Financial, Economic, Environmental and Social (see section 7 of report)	Financial and Economic Costs and Benefits Environmental Costs and Benefits Social Costs and Benefits
Project Delivery (see section 8 of report)	Project Management Risk Management Financing and Pricing
Consultation (see section 9 of report)	Consultation Plan Consultation Report

Over the past 3 years, the *Angle Crossing* option has undergone considerable analysis and these results will be used as much as possible to complete the abovementioned program of work.

The project is feasible from an engineering perspective, and the regulatory and administrative issues are also regarded as manageable.

The option is estimated to cost approximately $70 million (at 2007 prices), with an uncertainty factor of ± 30%. The final cost will depend on the transfer capacity and pipeline and length.

It would take approximately 3 years to complete including planning approval time of 12 months, and construction time of 24 months. However, the exact timeframe for approval will depend on the level of assessment required. The delivery time may also be impacted on by the availability of steel pipe, which is currently in short supply internationally.

1 Introduction

1.1 Context

ACTEW has been reviewing the ACT water supply options for the past few years. The past three years have seen an intensive amount of work undertaken to secure ongoing water supply for the ACT community in the future.

2004

In April 2004, the ACT Government released: *Think water, act water - a strategy for sustainable water resources management* (ACT Government, 2004a and b). The strategy defined actions to achieve sustainability objectives for water use in the ACT out to 2050, including to:

- increase the efficiency of water use; and
- provide a long-term reliable source of water for the ACT and region.

2005

In 2005, ACTEW produced the *Future Water Options* series of reports which identified a range of measures necessary to secure water for the Capital Region (Future Water Options, 2005a to e). This work was based upon the following six key assumptions:

- climate variability and climate change,
- impact of bushfires on inflows to ACT reservoirs,
- future population growth in Canberra and Queanbeyan and the possibility of servicing additional areas,
- reduction targets in per capita water use set by the ACT Government in *Think water, act water* (ACT Government, 2004a and b),
- environmental flow requirements, and
- acceptable levels for the duration, frequency and severity of water restrictions during times of drought.

The main Future Water Options (2005a to e) recommendations included:

- A transfer system from the Cotter to the Googong catchment, called the *Cotter to Googong Bulk Transfer* (CGBT) option.
- A transfer pipeline from the Murrumbidgee River near Angle Crossing to Googong Dam, called the *Angle Crossing* option.
- Continued studies and annual reviews of water planning assumptions and security of supply.

2006

In ACTEW decided to implement the CGBT option (Future Water Options, 2006a). Further analysis resulted in the deferral of the *Angle Crossing* option and instead, the implementation of the *Extended Cotter to Googong Bulk Transfer* (ECGBT) option, which could be implemented earlier and at less expense (Future Water Options 2006b). The *ECGBT* option involved pumping water from the Murrumbidgee River, near the Cotter Pump Station to the Mount Stromlo Water Treatment Plant to supplement supply to the city. Any excess water could be pumped to Googong Reservoir for storage. ACTEW left open the possibility of also abstracting water from Angle Crossing in the future. Pumping from the Cotter location was possible by the end of 2007, whereas the pumping system from Angle Crossing would not have been completed by this time.

Additionally, in its 2006 annual review, ACTEW identified that there had been a fundamental change to one of the assumptions on climate variability and climate change (ACTEW, 2006). Based upon work by CSIRO, it was predicted that by 2030, inflows into storages would decrease by 30%, on average. Over the past six years however inflows have decreased by more than 60% and by nearly 90% in 2006.

2007

On 31 January 2007, the ACTEW Board of Directors decided to commit in principle to enlarging the Lower Cotter Dam to increase its storage capacity from 4 GL to 78 GL.

It also committed in principle to the further purification of water from the Lower Molonglo Water Quality Control Centre (LMWQCC) to drinking water standard. After extensive treatment at the LMWQCC, the purified water would be piped to a stream in the Lower Cotter catchment and then into the Cotter Reservoir to blend with the natural water. The water would then be piped from the Cotter Dam for final treatment at the Stromlo Water Treatment Plant. These two projects formed the *Water2WATER* proposal.

The ACTEW (2006) review of the climate variability and climate change prompted ACTEW to reconsider previous studies and look at further options to secure supply, including the *Angle Crossing* option.

1.2 Angle Crossing Option

Pros

- Provides additional diversification
- Quick to implement
- Cost effective
- Better use of Googong Reservoir

Cons

- Inter-jurisdictional approvals
- Pumping costs

The *Angle Crossing* option was a primary recommendation of Future Water Options (2005a to e). The scheme involves the installation of a weir and pumps in the Murrumbidgee River at or near Angle Crossing at the southern border of the ACT. Water would be pumped, via a pipeline, from Angle Crossing, under the Monaro Highway, along the road alignment of Williamsdale Road to Burra, before being discharged into Burra Creek, inside the Googong catchment boundary, or piped all the way to Googong Reservoir (please see Appendix A for a map of the proposed pipeline alignments).

The capacity of the pumps were not determined at the time of *Future Water Options*, but options ranging from 30-60 ML/day were modelled, providing about 10 to 20 GL/year, depending on flows.

The exact length of the pipeline required will depend on several factors, such as whether it feeds directly into Googong Reservoir or whether it feeds into a creek system (Burra Creek), that flows into Googong. It will also be dependent on the exact path the pipeline takes. It is estimated the pipeline will be approximately 13 to 20 km long.

The option was postponed, as after further work, it was considered more prudent to abstract water from the Murrumbidgee River via the existing pumps at the Cotter Pump Station, and to augment the treatment capacity of Mount Stromlo Water Treatment Plant to treat more river water (Future

Water Options 2006b). Taking water from the Murrumbidgee River at the Cotter Pump Station had the additional benefit of also capturing flows from the Gudgenby River.

However, the ACTEW (2006) review of the climate variability and climate change prompted ACTEW to reconsider the *Angle Crossing* option.

The present capital cost for the *Angle Crossing* option is around $70 million and operating costs are in the order of $2 million/year (depending on the volume transferred).

1.3 Purpose of this report

The purpose of this report is to:

- Provide a draft project plan for the *Angle Crossing* option, which can progress the option sufficiently to allow implementation to commence immediately following a decision by the ACT Government.

2 Angle Crossing Option

2.1 Description of Proposal

The *Angle Crossing* option involves accessing water from the Murrumbidgee River near Angle Crossing and transferring it to Googong Reservoir. This includes the construction of a pump station, potentially a weir at Angle Crossing and a pipeline to Googong Reservoir.

The *Angle Crossing* option helps diversify and supplement Canberra's existing water supply as it makes better use of existing storage capacity by accessing and storing water that would otherwise flow through the ACT. This enables Canberra to supplement its water supplies in times of good flows and could provide up to 20 GL/year in additional water, which is approximately a third of average annual use. The *Angle Crossing* option would also assist with any future releases from Tantangara Dam in NSW, because these releases could be pumped to and stored in Googong Reservoir.

The *Angle Crossing* option is estimated to cost approximately $70 million (at 2007 prices) with an uncertainty factor of ± 30%. The cost will depend on the transfer capacity and pipeline route and length. It would take approximately 3 years to complete including planning approval time of 12 months, and construction time of 24 months.

Murrumbidgee River water would be pumped from near Angle Crossing via a pipeline to Burra Creek from where it runs by gravity into Googong Reservoir. An alternative is to run the pipeline all the way through to the Reservoir. The facility has the potential to pump in the order of 100 ML/day or more from the Murrumbidgee River, although its actual pumping rate will depend on flows, extraction rules and pumping protocols. Initially, average pumping capacity is planned to be 30-60 ML/day, thus providing about 10 to 20 GL/year.

The *Angle Crossing* option has undergone considerable analysis (Future Water Options, 2005a to e) but no extraction site has been chosen and the exact pipeline route is yet to be determined. Preliminary discussions with Palerang Shire Council indicate a preference for locating the pipe in the road reserve of Williamsdale Road. The project is feasible from an engineering perspective, and there has been independent corroboration of the likely capital costs. The regulatory and administrative issues are also regarded as manageable.

The *Angle Crossing* option does not require further modifications or additions to the Googong water treatment system as it is judged to present a level of risk approximately equal to the water quality levels currently experienced in the Googong system (Future Water Options, 2006b: Water Futures, 2006a).

A predictive terrestrial flora and fauna analysis has been undertaken (Biosis Research, 2005b), and whilst there is evidence of Aprasis (Pink Tailed Worm Lizard) it is not considered an impediment to the program. The proposal of locating the pipeline in the road reserve raises issues of remnant vegetation, common in rural areas. Many significant trees exist in the road reserve which would need to be considered.

Minimum flows in the Murrumbidgee River would need to be maintained which would influence the pumping regime.

Consultation with local residents raised concern about disruptions and road closures during construction. These concerns would need to be addressed. Given that Googong is a populated

catchment, consideration would need to be given to discharge points from the proposed pipeline route.

2.2 Planning and Construction

To deliver this proposal will require the following:

- Engagement of a consulting engineer and project planner to carry out all design works and preliminary investigations. This will include the identification of the preferred route based on engineering issues, flora, fauna and heritage issues, land owner assessment, and a detailed, construction standard design of the weir, pump station and pipeline.
- Negotiation with the NSW Government agencies, the Palerang Shire Council and ACT Government agencies concerning relevant approvals and environmental assessments.
- Preparation of appropriate environmental assessment documentation, lodgement of a development application in accordance with ACT and NSW planning statutory requirements. It is likely that about 12 months will be required to prepare and have approved all necessary documentation.
- A construction period of about 24 months is envisaged. A major factor influencing this is the supply of pipe for the project. Mechanisms for compressing this timeframe, including early ordering of pipe, will be investigated.

Given the above, a likely timeframe from commencement to completion of the *Angle Crossing* option is approximately 3 years.

2.3 Main Issues

The main issues consist of:

- Weir Location – suitable sites exist just over the NSW/ACT border, at Angle Crossing and further downstream near the Gigerline Nature Reserve. A study will need to be undertaken to determine the best site from an engineering perspective, but other considerations include fish management, topography, works near the nature reserve, recreation/swimming and vehicular access at Angle Crossing. Different options will alter the costs.
- Pipeline Route – At approximately $1.25 million/km (at 2007 prices), the ultimate route of the pipeline will be a major cost determinant. The preliminary studies will plan the preferred route from a cost perspective, but will also factor in environmental considerations, including flora and fauna issues, and land ownership/acquisition issues. The capacity of Burra Creek to take extra flows will also be assessed, as the further upstream the water can be discharged, the less pipeline is required. Additionally, an analysis of the confining of the route to the road reserve as opposed to running through leasehold and freehold land, with consequent compensation implications, needs to be completed.
- Impact on Local Residents – during construction there is likely to be disruption to residents as much of the work is in the public domain. Road closures, in particular, are likely if the pipeline is routed in the road reserve. Close consultation will be required. Possible community benefits from the project should also be considered such as sealing roads disturbed during construction (currently gravel) and providing raw water to Burra for public open space irrigation.

2.4 Previous Consideration

ACTEW previously recommend to the ACT Government that planning commence for the *Angle Crossing* option. ACTEW further advised that a similar outcome could be achieved more quickly by the *ECGBT* option (pumping water from the Murrumbidgee River near the Cotter Pump Station), thus deferring the need for pumping at Angle Crossing.

The *EGCBT* option is now in operation, pumping up to 50 ML/day during mid 2007, with pumping capacity now being upgraded to 100 ML/day. However, the ACTEW (2006) review of climate variability and climate change prompted ACTEW to reconsider the *Angle Crossing* option. Consequently, ACTEW has recently asked the ACT Government to consider agreeing to implementing the *Angle Crossing* option.

3 Scope and Summary Program of Work

ACTEW has developed the *Angle Crossing* option to a concept design phase in the first stage of *Future Water Options* (Future Water Options, 2005a to e). Now the *Angle Crossing* option will be developed to a stage sufficient to proceed with final implementation should the ACT Government endorse the proposal. The information that is required will include water resource management issues, financial, economic, environmental and social costs and benefits, preliminary design of engineering works, investigation of environmental impacts, documentation for regulatory approvals and project management.

An assessment is required of the extent of work needed for each major element. In some cases the commissioning and completion of the work will be required as a condition precedent for the next phase of the project. Other matters may require a preliminary assessment, or alternatively the development of a brief for commissioning work once a decision has been made by the ACT Government (or in some cases the NSW Government, and/or the Palerang Shire Council). Regulatory authorities may not be prepared to accept applications in advance of government decisions, but may provide guidance on matters to be addressed in such applications.

The summary program of work is outlined in the Table 1 below.

Table 1: Angle Crossing Option summary program of work

Program	**Studies/Issues**
Planning and Environmental Approvals (see section 4 below)	Development Approvals Cultural Heritage Analysis Terrestrial Flora and Fauna Aquatic Ecology Catchment and Landscape
Infrastructure (see section 5 below)	Technical Design
Water Resource Management (see section 6 below)	Diversions and Environmental Flows Allocations and Licence to take water Water Quality
Financial, Economic, Environmental and Social (see section 7 below)	Financial and Economic Costs and Benefits Environmental Costs and Benefits Social Costs and Benefits
Project Delivery (see section 8 below)	Project Management Risk Management

	Financing and Pricing
Consultation (see section 9 below)	Consultation Plan Consultation Report

The scope of work for these programs is described in the following sections.

4 Planning and Environmental Approvals

The scope of work for planning and environmental approvals will most likely consist of:

- Development Approvals:
  - Identify all required approvals.
  - Identify jurisdictions and relevant approving authorities.
  - Intergovernmental relations and cross border urban settlement policy implications.
  - Advise on all land ownership issues, including mechanisms for lease withdrawal, creation of easements and compensation issues.
  - Assemble supporting documentation to enable commencement of development application (DA) or environmental impact assessment (EIA), once approval is provided.
- Cultural Heritage Analysis:
  - Build on the cultural and heritage assessment undertaken for Future Water Options by Navin Officer (2005).
  - Determine any archaeological, cultural or heritage issues that would be affected by the implementation of the pipeline.
  - Determine any indigenous issues.
  - Advise on the implications and develop a management plan.
  - Consult with relevant Aboriginal organisations.
- Terrestrial Flora and Fauna:
  - Build on the terrestrial flora and fauna assessment undertaken for Future Water Options by Biosis Research (2005a and b).
  - Carry out a survey of the areas affected by the pipeline and related infrastructure and determine any significant vegetation and fauna issues such as significant trees, threatened woodlands, habitat trees, threatened colonies etc and propose management strategies.
- Aquatic Ecology and Fish Species:
  - Build on the aquatic ecology and fish species assessments undertaken for Future Water Options by the CRC for Freshwater Ecology (2005), the Water Research Centre UC (2005), and Environment ACT (2005).
  - Establish requirements for fish passage in the Murrumbidgee River.
  - Analyse the effects on aquatic ecology and fish species from the reductions in flow in the Murrumbidgee and from additional flows in Burra Creek.
- Burra Creek Catchment and Landscape:

- Build on the catchment and landscape assessments undertaken for Future Water Options by Ecowise Environmental and Barry Starr (2005), and Gippel and Nayar (2005).
- Assess the impact on catchment and landscape aspects of Burra Creek, including geomorphologic and biophysical issues to inform pipeline outlet location.

5 Infrastructure

The scope of works for infrastructure will most likely include the final site selection, detailed design and costing for infrastructure to DA standard, including:

- Engineering design:
  - Build upon relevant work undertaken in Future Water Options (2005a to e).
  - A 'fish friendly' structure on the Murrumbidgee River near Angle Crossing to facilitate pumping (Ebner, Johnston and Lintermans, 2005; Ebner *et al*, 2006).
  - A pumping station to pump water from the Murrumbidgee River to Burra Creek.
  - Pipelines, tunnels, and associated structures to transfer pumped water from the Murrumbidgee River to Burra Creek.
  - Additional design options to provide non-potable water supply to rural residential areas near Burra Creek.
  - Outlet structure into Burra Creek or Googong Reservoir.
- Assessing project greenhouse implications and developing proposals for offsets, by building upon relevant work undertaken in Future Water Options (2005a to e), and Nagy and Parker (2005).
- Project costs:
  - Build upon relevant work undertaken in Future Water Options (2005a to e).
  - Confirmation of Project Preliminary Estimates of construction costs.
  - Modeling operational costs.

6 Water Resource Management

The scope of work for water resource management will most likely need to:

- Build upon relevant work undertaken in Future Water Options (2005a to e).
- Confirm of Operating Rules for diversions and environmental flows.
- Confirm of system capacity and performance requirements to inform engineering design.
- Document and support a Water Allocation and License for the *Angle Crossing* option.
- Develop a water quality plan, including analysis of Murrumbidgee water quality issues, impacts on Googong reservoir, treatment implications and water quality monitoring regime, by building upon relevant work undertaken in Future Water Options (2005a to e), and in Water Futures (2006 a to c).
- Investigate catchment management arrangements for the Upper Murrumbidgee, water quality implications and possible strategies for improvement of arrangements.
- Consider strategic implications for regional water resource management.

7 Financial, Economic, Environmental and Social

The scope of work for financial, economic, environmental, and social costs and benefits will most likely need to:

- Build upon relevant work undertaken under Future Water Options (2005a to e; 2006b), and Centre for International Economics (2005 and 2006).
- Provide an updated assessment of financial and economic costs and benefits.
- Provide an assessment of environmental costs and benefits.
- Provide an assessment of social costs and benefits.

8 Project Delivery

The scope of work for project delivery will most likely consist of:

- Consideration of project delivery methodology, including:
  - Governance arrangements for project implementation.
  - Arrangements for Project Direction.
  - Project delivery options, including Project Management.
- Development of a Risk Management Strategy for the project.
- Financing to review funding options for ACTEW to implement the *Angle Crossing* Option.
- Identification of requirements for ICRC consideration of pricing implications.
- Development of an outline Implementation Plan.

9 Consultation

Preliminary consultation occurred in 2005, with the NSW Government, Palerang Shire, and the Burra Residents Association. It recommended that follow-up contact be made with the Mayor of Palerang Shire as soon as possible if the Angle Crossing option is expected to proceed.

A follow-up program of consultation will also be needed.

A scope of work for this follow-up consultation includes development of a plan to engage stakeholders and document outcomes by:

- Building on the work already undertaken during Future Water Options (Webb and Dickson 2005).
- Providing strategies for community engagement, particularly with stakeholders affected by the pipeline.
- Identifying key stakeholders/interest groups.
- Managing consultation issues with people in the community directly affected by the pipeline.
- Documenting issues as part of the planning process.

10 Timing Considerations for Program of Work

The key deliverables and dates are:

Scope and commit all preliminary work, including	December 2007

- Planning analysis.
- Cultural heritage.
- Terrestrial flora and fauna.
- Aquatic ecology and fish species.
- Burra Creek catchment and landscape.
- Engineering design.
- Infrastructure.
- Greenhouse implications and offsets.
- Hydrology.
- Water quality.
- Catchment management arrangements.
- Financial, economic, environmental, and social costs and benefits.
- Regional water resource management.
- Regulatory analysis.
- Legal review.
- Consultation.

Completion of preliminary studies	April 2008
Preparation of preliminary issues report	May 2008

11 Regulatory Issues

The *Angle Crossing* option will need to meet two general regulatory requirements:

- Licence to Take Water (i.e. obtain appropriate licences to take water for the *Angle Crossing* option.
- Finance (i.e. obtain appropriate funding for ACTEW to implement the *Angle Crossing* option).

In addition the *Angle Crossing* option has some specific regulatory issues, such as:

- Agreement and approval from a number of NSW government agencies (such as NSW Department of Environment and Conservation, NSW Fisheries, NSW Department of Natural Resources).
- Agreement and approval from relevant NSW local governments such as Palerang Shire Council for the pipeline from Angle Crossing to Burra Creek, or Googong Reservoir.
- Planning, environmental and construction requirements for the pipeline from Angle Crossing to Burra Creek, or Googong Reservoir.
- Landholder agreement and/or land acquisition for the pipeline from Angle Crossing to Burra Creek, or Googong Reservoir.

12 Financial Issues

The capital cost of the *Angle Crossing* option was initially estimated at $40 million for 60 ML/day, and $70 million for the 180 ML/day (Future Water Options, 2005a to e). These costs were based on extrapolations from similar projects, and the accuracy is not expected to be better than about ± 30%. These costings were in the absence of any geotechnical investigations of the weir site, and do not include any land acquisition costs. An escalation rate of a minimum of 25% should be assumed to reflect the cost in 2007 dollars.

Annual operating costs (at 2006 prices), have been estimated at $1.6 million (Centre for International Economic, 2006),

Both the capital and operating costs will be updated in detail as part of the financial and economic costs and benefits (section 7). However, at the present time, the most likely capital cost estimate is approximately $70 million with an uncertainty factor of ±30%, and the most likely operating cost estimate is about $2 million per annum.

13 Overall Timetable

The project is expected to take approximately 3 years from approval to commissioning. This consists of about 12 months for statutory planning approvals, and 24 months for construction.

However, the exact timeframe for approval will depend on the level of assessment required.

The delivery time may also be impacted on by the availability of steel pipe, which is currently in short supply internationally. Mechanisms for compressing this timeframe, including early ordering of pipe, will be investigated.

14 Summary of Angle Crossing Option (SWOT Analysis)

The summary of the *Angle Crossing* option is presented below in the form of Strengths, Weaknesses, Opportunities and Threats (SWOT), based on Future Water Options (2006b).

Table 2: Angle Crossing Option SWOT analysis

Strengths	**Weaknesses**
➢ River water quality improvement from dilution in Googong Reservoir ➢ Can pump into Googong Reservoir regardless of water supply reticulation network load ➢ Use of the significant Murrumbidgee River water resource	➢ Capital and operating costs ➢ Greenhouse gas production due to need for pumping ➢ Pipeline route land acquisition ➢ Catchment upstream of extraction point is all in NSW which may be more difficult to influence in terms of changes to reduce non-point and point source pollution into the Murrumbidgee River ➢ Requires a weir and/or fish ladder on the Murrumbidgee River ➢
Opportunities	**Threats**
➢ Link with NSW and hence may sell Murrumbidgee River water to Yass, via Googong ➢ Opportunity to later increase capacity and seek transfers from Tantangara Reservoir ➢ Remains an option even if not built now	➢ Stranded asset if Googong Reservoir fills ➢ Burra Creek environmental and flow issues ➢ Burra residents requiring water from the scheme ➢ Environmental concerns in Murrumbidgee River ➢ Licence to pump water from Murrumbidgee River ➢ Concern in NSW about pumping from the Murrumbidgee River ➢ Upstream development and land use and catchment management practices

15 References

ACTEW (2006). 2006 Annual Review of Planning Variables for Water Supply and Demand Assessment.

ACT Government (2004a). Think water, act water. Volume 1. Strategy for sustainable water resource management in the ACT. ISBN 0642 60273 5.

ACT Government (2004b). Think water, act water. Volume 2. Explanatory document. ISBN 0642 60274 3.

Biosis Research (2005a). Terrestrial flora, fauna and vegetation study. Future Water Options. Report for ACTEW.

Biosis Research (2005b). Draft Preliminary Vegetation Assessment: Angle Crossing to Burra Creek. Report for ACTEW.

Centre for International Economics (2005). Economic benefit-cost analysis of new water supply options for the ACT.

Centre for International Economics (2006). Gross benefits, costs and net benefits of updated options. 10 July 2006.

CRC for Freshwater Ecology (2004). Ecological risk assessment of ACT water source options. Future Water Options. ACTEW.

Ebner B., Johnston L. and Lintermans M. (2005). Re-introduction of Trout Cod into the Cotter River Catchment. Report by Environment ACT to the Natural Heritage Trust.

Ebner B. Thiem J., Lintermans M. and Gilligan D (Editors) (2006). An ecological approach to re-establish Australian freshwater cod populations: an application to trout cod in the Murrumbidgee catchment. Project number 2003/034 Fisheries Research and Development Corporation and NSW Department of Primary Industries.

Ecowise Environmental and Barry Starr (2005). Catchment and landscape analysis of the future water source options for the ACT. Future Water Options. ACTEW.

Environment ACT (2005). Fish impact study. Future Water Options. ACTEW.

Future Water Options (2005a). Future Water Options for the ACT Region — Implementation Plan. A summary of the recommended strategy to increase the ACT's water supply. ACTEW.

Future Water Options (2005b). Future Water Options for the ACT Region — Implementation Plan. A recommended strategy to increase the ACT's water supply. ACTEW.

Future Water Options (2005c). The Cotter Dam Option. A report assessing various alternatives for the use of Cotter Dam for future ACT water supply. ACTEW.

Future Water Options (2005d). The Tennent Dam Option. A report assessing various alternatives for the use of a new Tennent Dam for future ACT water supply. ACTEW.

Future Water Options (2005e). The Tantangara Dam Option. A report assessing various alternatives for the use of Tantangara Dam for future ACT water supply. ACTEW.

Future Water Options (2006a). Summary Report CGBT Phase 2. A Summary of the Cotter Googong Bulk Transfer (CGBT) Phase 2 Project. Report by ActewAGL to ACTEW.

Future Water Options (2006b). Options for the Extraction of Water from the Murrumbidgee River. A Comparison of Angle Crossing and ECGBT. Report by ActewAGL to ACTEW.

Gippel C. and Nayar M. (2005). Prediction of Transition Losses in Burra Creek. Report by Fluvial Systems and Marsden Jacob Associates for ACTEW.

Nagy L. and Parker B. (2005). Greenhouse gas emissions. Future Water Options. ACTEW.

Navin Officer (2005). Cultural heritage assessment. Future Water Options. Report for ACTEW.

Water Futures (2006a). Risk Assessment of the Murrumbidgee River Catchment as a Water Supply. Draft 5 May 2006.

Water Futures (2006b). Murrumbidgee Monitoring Program. Client Draft Version 1. 26 May 2006

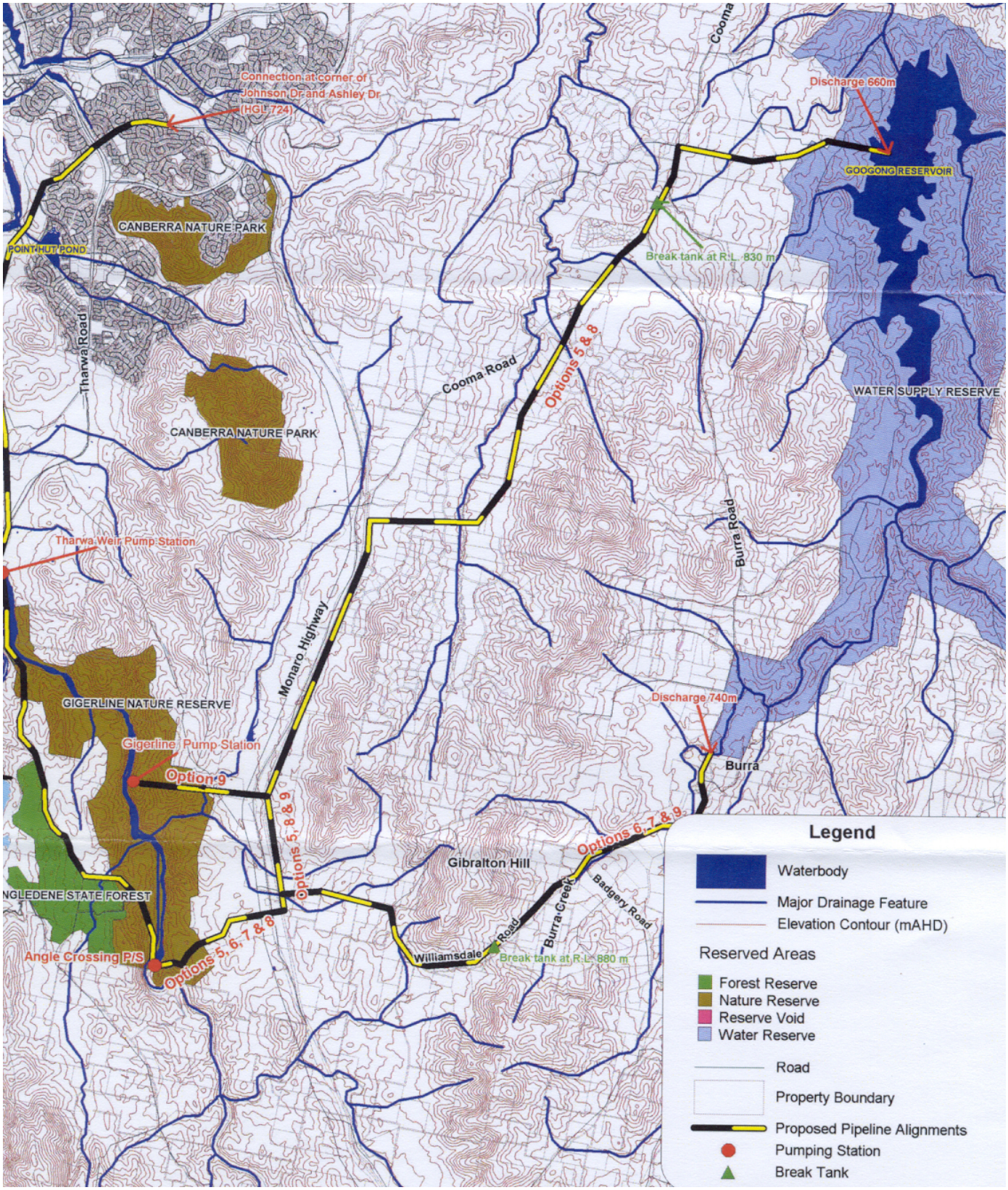
Water Futures (2006c). Murrumbidgee Pumping Rules. Client Draft Version 1. 26 May 2006.

Water Research Centre, UC (2005). Aquatic Ecology Study. Future Water Options. ACTEW.

Webb C. and Dickson K. (2005). Consultation report. Future Water Options. ACTEW.

APPENDICES

Appendix A – Map of Angle Crossing Option Proposed Pipeline Alignments


Connection at corner of Johnson Dr and Ashley Dr (HGL 724)
Discharge 660m
GOOGONG RESERVOIR
CANBERRA NATURE PARK
POINT HUT POND
Break tank at R.L. 830 m
Tharwa Road
Cooma Road
Options 5 & 8
WATER SUPPLY RESERVE
CANBERRA NATURE PARK
Burra Road
Tharwa Weir Pump Station
Monaro Highway
GIGERLINE NATURE RESERVE
Discharge 740m
Gigerline Pump Station
Option 9
Burra
Options 5, 8 & 9
Options 6, 7 & 8
Gibralton Hill
NGLEDENE STATE FOREST
Badgery Road
Burra Creek
Road
Angle Crossing P/S
Options 5, 6, 7 & 8
Williamsdale
Break tank at R.L. 880 m
Legend
Waterbody
Major Drainage Feature
Elevation Contour (mAHD)
Reserved Areas
Forest Reserve
Nature Reserve
Reserve Void
Water Reserve
Road
Property Boundary
Proposed Pipeline Alignments
Pumping Station
Break Tank