Appendix A

Part 3A declaration and Director-General's requirements

NSW GOVERNMENT | Planning

Contact: Belinda Scott
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Our ref.: 10_0235

Chris Devitt
Director Technical Services
Orange City Council
PO Box 35
Orange NSW 2800

Orange City Council
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Dear Mr Devitt

Subject: Orange Drought Relief Connection (10_0235)

I refer to your correspondence dated 3 December 2010 seeking confirmation that the above proposal is a project to which Part 3A of the *Environmental Planning and Assessment Act 1979* (the Act) applies.

On 16 December 2010, the Minister, declared the proposal to be a project to which Part 3A of the Act applies, under section 75B(2)(a) of the Act. The project is therefore subject to determination by the Minister for Planning under Part 3A of the Act.

Section 75E of the Act requires you to lodge an application for your project with the Director-General. The application must include a completed application form (available at http://www.planning.nsw.gov.au/assessingdev/pdf/part3a_applicationform.pdf) and a Preliminary Environmental Assessment. Please include both hard and electronic copies of each of these documents.

The Major Project Application Number for this project is 10_0235. Please use this number in all correspondence with the Department. Your contact officer for this proposal, Belinda Scott, can be contacted on (02) 9228 6472 or via email at Belinda.Scott@planning.nsw.gov.au. Please mark all correspondence regarding the proposal to the attention of the contact officer.

Yours sincerely,

17/12/10

Daniel Keary
Director Infrastructure Projects

Refer C Devitt

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Project	Orange drought relief connection consisting of an approximate 40 kilometre pipeline, pumping stations, transmission line and associated infrastructure to transfer water from the Macquarie River to Orange's water supply system.
Site	The pipeline corridor will generally run in a north-south direction between the Macquarie River and the township of Orange, passing through Orange and Cabonne local Government areas.
Proponent	Orange City Council
Date of Issue	24 March 2011
Date of Expiration	24 March 2013

General Requirements	The Environmental Assessment (EA) must include:
	• an **executive summary**;
	• a **detailed description** of the project including:
	    • proposed construction methods of all components of the project clearly defining the proposal corridor, types of watercourse and infrastructure crossings and ancillary infrastructure;
	    • location and alignment of project components, operation details, including pumping technology and water quality standards to be applied, interfaces with watercourses, energy requirements and associated greenhouse gas emissions and any staging;
	    • any implications for the existing operational capacity (including water volumes and treatment procedures) for Orange water treatment facilities;
	    • details of the operation of the offtake (in terms of river flow and off take volumes) under different climatic conditions and the preferred option for securing a water entitlement under the *Water Act 1912*;
	    • details of maintenance activities (for the pipeline and corridor) including contingency management in the case of pipeline failure.
	• justification for undertaking the project with consideration of the benefits and impacts of the proposal;
	• consideration of any **relevant statutory provisions** including the consistency of the project with the objects of the *Environmental Planning and Assessment Act 1979;* the *Central West Catchment Action Plan* and any subsequent revision; the *Blayney, Cabonne and Orange Rural and Industrial Lands Strategy 2008; Macquarie-Cudgegong Water Sharing Plan, Water Act 1912 and Water Management Act 2000; NSW Office of Water's Guidelines for Controlled Activities and Crown Lands Act 1989*.
	• an **assessment of the key issues** outlined below, during construction, operation and de commissioning (as relevant). The EA must provide an equal level of assessment for all route options for connections at the Macquarie River and Orange should a preferred option not be determined at the time of the EA lodgement;
	• a **draft Statement of Commitments** detailing measures for environmental mitigation, management and monitoring for the project;
	• a **conclusion justifying the project** taking into consideration the environmental, social and economic impacts of the project; the suitability of the site; and the public interest; and
	• **certification by the author** of the EA that the information contained in the Assessment is neither false nor misleading.

Key Assessment Requirements

The EA must include assessment of the following key issues:

- **Strategic Planning and Project Justification** – the EA must clearly:
  - outline the regional strategic context of the project, having regard to existing and future development in the Orange and the Central West Catchment area, regional water supply, water management and water demand including the effect on downstream users of the Macquarie River including demonstrating that there is an adequate and secure water supply for the proposal during operation.
  - describe the need, scale, scope, location and objectives of the project; and provide justification for the preferred project taking into consideration the objects of the *Environmental Planning and Assessment Act 1979* and consistency with relevant State and regional planning policies;
- **Alternatives –** the EA must detail all alternatives considered, both in terms of water supply and corridor selection (including alignment within the identified corridor). Clear reasons and justification for the selected corridor/alignment must be presented, demonstrating how environmental, social and economic issues have been addressed in this process.
- **Land Use Planning Impacts -** analyse the site suitability of the project considering potential conflicts with existing and future landuses and infrastructure (including existing residential and other sensitive landuse, known future development, infrastructure and utility corridors, land of high agricultural value, land of high conservation value, recreational land and Crown land), taking into account local and strategic land use objectives and potential pressure for further development in Orange and Cabonne local government areas due to the availability of water security to existing low density development.
- **Ecological Impacts** – the EA must:
  - include a flora and fauna impact assessment consistent with the *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) taking into consideration impacts on any threatened species, populations, ecological communities, critical habitat, riparian, in stream ecology, water dependent ecosystems (including RAMSAR wetlands) and groundwater dependent communities affected by the project including consideration of the *NSW Groundwater Dependent Ecosystems Policy* and/ or relevant recovery plans; any impacts to local or regional biodiversity corridors; and riparian vegetation at watercourse crossings and downstream of the water offtake in the Macquarie River.
  - include a management framework outlining the measures to be implemented to avoid, mitigate, manage, monitor and/ or offset flora and fauna impacts during construction and operation, including but not necessarily limited to progressive rehabilitation works.
  - provide sufficient details to demonstrate the availability of viable and achievable options to offset the impacts of the project. Where impacts are unavoidable, how impacts would be minimised, mitigated and offset consistent with either the *Biobanking Methodology* or by following the *Principles for the use of biodiversity offsets in NSW.*
  - outline any ongoing management requirements to maintain biodiversity values in perpetuity and associated responsibilities.
  - include details of the ongoing management of erosion, weeds and flora and fauna along any of the areas disturbed by the project.
  - assess the impacts of construction of the offtake pump on fish passage during construction including how the operation of the pump would be designed to avoid entrainment or entrapment of fish eggs and larvae.

- **Heritage Impacts** – the EA must include sufficient information to demonstrate the likely impacts on Non-Indigenous and Aboriginal heritage values (archaeological and cultural) that may be impacted by the project with details on subsurface archaeological investigations undertaken for potential archaeological deposits and outline proposed mitigation measures to avoid or minimise any impacts.

  - The Aboriginal heritage assessment must be consistent with the Draft *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC, 2005). The EA must demonstrate effective consultation with Aboriginal communities has been undertaken in determining and assessing impacts, developing options and selecting options and mitigation measures.

- **Surface and Groundwater Impacts** – the EA must:
  - assess the potential risks to surface and groundwater quality during construction and operation activities (including the proposed offtake, pump infrastructure and pipeline maintenance activities), demonstrating that the project can be designed and managed consistent with the principle of a neutral or beneficial effect on water quality in the water catchment*;*

  - include a site water balance clearly identifying and quantifying water use for the project including: annual water demand and sources of input; water reuse and recycling measures; waste water generation and disposal requirements; and stormwater management;

  - include an assessment of potential impacts on other groundwater and surface water users, and the environment under different climatic conditions with details of how existing water access rights will be protected, including with respect to availability, quantity and quality of water in the Macquarie Catchment;

  - include a framework for the mitigation, management and monitoring of surface and groundwater quality impacts during construction and operation including reference to the *Managing urban stormwater soils and construction volume 1 and volume 2.*

  - assess the potential for impacts to watercourses, including the Macquarie River, which are to be impacted by the project, including a risk assessment justifying the proposed construction method depending on stream classification and environmental significance and a strategy for the rehabilitation of any watercourses disturbed by the project to an existing or better standard.

- **Geomorphology and Hydrology –** the EA must:
  - identify significant watercourses in terms of hydrological, hydraulic or ecological characteristics or sensitivity and an assessment of the impacts to the stability of these watercourses including the Macquarie River from the construction and operation of the project. The assessment must also include measures to monitor or mitigate any identified impacts during construction and operation;

- **Infrastructure Impacts –** the EA must include an impact assessment on infrastructure, including roads, communications, electricity, gas and water supply infrastructure. Mitigation measures to address these impacts shall be described, including the need for road upgrades and rectification of road damage.

- **Traffic and Transport** – the EA must include an assessment of impacts to the local and regional road network and intersections during construction, including direct impacts from traffic rerouting and any access restrictions to property, as well as details on the nature/ mode of traffic generated from the project, transport routes and traffic volumes. Consideration must also be given to the impact of the project on any existing and proposed railway infrastructure in the area.

- **Noise and Vibration –** the EA must include an assessment of noise and vibration impacts during construction and operation and in a cumulative context with existing development. The assessment must take into account the following guidelines, as relevant: *Industrial Noise Policy* (EPA, 2000), *Assessing Vibration: A Technical*

	Guideline (DECC, 2006) and *Interim Construction Noise Guideline* (DECC, 2009). The assessment is to identify sensitive receptors that have the potential to be impacted by the project and the likely impacts; and include a framework for the mitigation, management and monitoring of impacts during construction and operation (as relevant) with specific reference to noise and vibration -intensive construction works/ activities (drilling, blasting, bulk excavation) and heavy vehicle movements. • **Visual Amenity –** the EA is to fully describe all project components and their locations. A photographic assessment clearly demonstrating the potential visual amenity impacts of the proposal from key viewing locations must be provided along with a clear description of the visual impact amenity mitigation and management measures. • **Contamination and Spoil Management** – the EA must include: o the identification of any contaminated land affected by the proposal and the potential to contaminate land, and identify mitigation measures; o estimates of likely spoil generation, including identification of known or potential contamination issues, and options for spoil management, reuse and/ or disposal. • **General Environmental Risk Analysis –** notwithstanding the above key assessment requirements, the Environmental Assessment must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), an outline of the proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, a framework for the consideration of the additional key environmental impact(s) must be included in the Environmental Assessment.
Consultation Requirements	You must undertake an appropriate and justified level of consultation with the following parties during the preparation of the Environmental Assessment: • NSW Department of Environment, Climate Change and Water; • NSW Office of Water; • Industry & Investment NSW; • Central West Catchment Management Authority; • NSW Roads and Traffic Authority • Land and Property Management Authority; • Cabonne Shire Council; • relevant utility and service providers; and • the local community, including the Local Aboriginal Lands Council(s) and affected landowners. The Environmental Assessment must describe the consultation process, document all community consultation undertaken to date and identify the issues raised (including where these have been addressed in the Environmental Assessment).

NSW GOVERNMENT | Planning & Infrastructure

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Our ref: 10/21484-1
Your ref:

Mr Chris Devitt
Director Technical Services
Orange City Council
PO Box 35
ORANGE NSW 2800

Dear Mr Devitt

Proposed Orange Drought Relief Connection – Orange and Cabonne Local Government Areas (MP 10_0235; EPBC 2011/6202) – Supplement to the Director-General's Requirements

I refer to the Director-General's requirements issued for the above project on 24 March 2011.

As you are aware, the project was declared a Controlled Action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 22 December 2011, for likely impacts on wetlands of international importance, listed threatened species and communities, and listed migratory species. In accordance with section 75F(3) of the NSW *Environmental Planning & Assessment Act 1979*, I have enclosed the Commonwealth's requirements for the assessment.

I also confirm that the interim administrative procedures in relation to the accredited assessment process will apply to the assessment of this project under the EPBC Act, so that the Department can undertake an environmental impact assessment of the project to satisfy the requirements of both NSW and Commonwealth legislation.

You must ensure that the Environmental Assessment adequately addresses the Director-General's requirements issued on 24 March 2011 and the supplementary requirements attached to this letter.

If you have any enquiries about these requirements, please do not hesitate to contact Ms Swati Sharma on the above contact details.

Yours sincerely

27/2/12

Glenn Snow
A/Director – Infrastructure Projects
as delegate for the Director-General

Environment Assessment Requirements for input into the Director-General Requirements

The delegate for the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities has declared the proposal to construct a 36 kilometre pipeline and ancillary infrastructure (including a powerline) from the Macquarie River to the Suma Park Dam near Orange and the abstraction and pumping of water from the Macquarie River to Suma Park Dam, in New South Wales (EPBC 2011/6202) to be a controlled action under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as it is likely to have a significant impact on:

- Listed threatened species and communities (sections 18 & 18A) including the Trout Cod (*Maccullochella macquariensis*)
- Wetlands (Ramsar) (sections 16 & 17B)
- Listed migratory species (sections 20 & 20A).

In accordance with the one-off accredited assessment process for this project, the environmental assessment of the impacts of the controlled action must be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Pursuant to section 75F(3) of Part 3A of the EP&A Act, the Director-General is required to notify the proponent of these requirements.

The assessment must include enough information about the controlled action and its relevant impacts to allow the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities to make an informed decision whether or not to approve the controlled action under the EPBC Act.

The following assessment requirements are to be integrated into the assessment required for part 3A of the EP&A Act. The following matters in the EPBC Act and schedule 4 of the *Environment Protection and Biodiversity Conservation Regulations 2000* should be considered.

1. General information

The background of the action including:

(a) the title of the action;

(b) the full name and postal address of the designated proponent;

(c) a clear outline of the objective of the action;

(d) the location of the action;

(e) the background to the development of the action;

(f) how the action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action;

(g) the current status of the action; and

(h) the consequences of not proceeding with the action.

2. Description of the action

A description of the action, including:

(a) all the components of the action;

(b) the precise location of the preferred option for any works to be undertaken, structures to be built or elements of the action that may have relevant impacts;

(c) how the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts;

(d) to the extent reasonably practicable, a description of any feasible alternatives to the controlled action that have been identified through the assessment, and their likely impact, including:

(i) if relevant, the alternative of taking no action;

(ii) a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action; and

(iii) sufficient detail to make clear why any alternative is preferred to another.

(e) A description of long-term and short-term economic and social considerations regarding the project.

3. A description of the relevant impacts of the action;

An assessment of all relevant impacts that the action has, will have or is likely to have on:

(a) threatened ecological communities and threatened species potentially present and listed under sections 18 and 18A of the EPBC Act;

(b) migratory species listed under sections 20 and 20A of the EPBC Act and potentially present in the vicinity of the proposed action site and the Macquarie Marshes Ramsar site; and

(c) the Macquarie Marshes Ramsar site (sections 16 & 17B).

Information must include:

(a) a description of the nature, location and extent of all vegetation types occurring on-site;

(b) a description of the nature, location and extent of threatened species and their suitable habitat (including habitat critical to the survival of threatened species) within the site and in surrounding areas that may be impacted by the proposal;

(c) where there is a potential habitat for EPBC Act listed species, such as the Trout Cod, surveys must be undertaken. These surveys must be timed appropriately and undertaken for a suitable period of time by a qualified person[1].

(d) a description of the relevant impacts of the action on listed threatened species and ecological communities and migratory species (including, but not limited to the species and ecological community listed at Appendix A);

(e) a detailed assessment of the nature and extent of the likely short term, long term, direct and indirect relevant impacts as a result of the action including, but not be limited to, an assessment of any habitat loss, degradation or fragmentation;

(f) a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;

(g) analysis of the significance of the relevant impacts; and

[1] Where available, species-specific survey guidelines can be obtained on the department's *Species Profile and Threats Database*: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

(h) any technical data and other information used or needed to make a detailed assessment of the relevant impacts.

(i) analysis of the potential impacts on the ecological character of the Macquarie Marshes Ramsar site (refer to Appendix A).

4. Proposed safeguards, mitigation and offset measures

A description of feasible mitigation measures, changes to the action or procedures, which have been proposed by the proponent or suggested in public submissions and which are intended to prevent or minimise relevant impacts. Information must include:

(a) a consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the proponent;

(b) a description and an assessment of the expected or predicted effectiveness of the mitigation measures;

(c) any statutory or policy basis for the mitigation measures;

(d) the cost of the mitigation measures;

(e) an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including the person or agency responsible for implementing these programs and any provisions for independent environmental auditing;

(f) the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;

(g) in the event that impacts cannot be avoided or mitigated, a description of any offsets to compensate for any predicted or potential residual impacts on threatened species; and

(h) the description of any offsets package should include how the offset compensates for the residual impacts, when the offset will be delivered and how the offset will be managed.

5. Other approvals and conditions

Any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. Information must include:

(a) details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:

(i) what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy; and

(ii) how the scheme provides for the prevention, minimisation and management of any relevant impacts.

(b) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the relevant Act) including any conditions that apply to the action;

(c) a statement identifying any additional approval that is required; and

(d) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.

6. Environmental record of person proposing to take the action

Details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

(a) the person proposing to take the action; and

(b) for an action for which a person has applied for a permit, the person making the application.

7. Information sources

For information given in an environment assessment, the draft must state:

(a) the source of the information;

(b) how recent the information is;

(c) how the reliability of the information was tested; and

(d) what uncertainties (if any) are in the information.

8. Consultation

(a) Any consultation about the action, including:

(i) any consultation that has already taken place;

(ii) proposed consultation about relevant impacts of the action; and

(iii) if there has been consultation about the proposed action - any documented response to, or result of, the consultation.

(b) Identification of affected parties, including a statement mentioning any communities that may be affected and describing their views.

Appendix A

Listed threatened species and communities and listed migratory species

The Macquarie River to Orange pipeline is likely to have a significant impact on threatened species and ecological communities and migratory bird species listed under the EPBC Act.

These include, but are not limited to the following:

1. Regent Honeyeater (*Anthochaera phrygia*)
2. Swift Parrot (*Lathamus discolor*)
3. Superb Parrot (*Polytelis swainsonii*)
4. Australian Painted Snipe (*Rostratula australis*)
5. Murray Cod (*Maccullochella peelii*)
6. Booroolong Frog (*Litoria booroolongensis*)
7. Large-eared Pied Bat (*Chalinolobus dwyeri*)
8. Spot-tailed Quoll (*Dasyurus maculatus maculatus* (SE mainland population))
9. Euphrasia arguta
10. Thesium australe (*Austral Toadflax*)
11. White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Ecological community

Macquarie Marshes Ramsar site

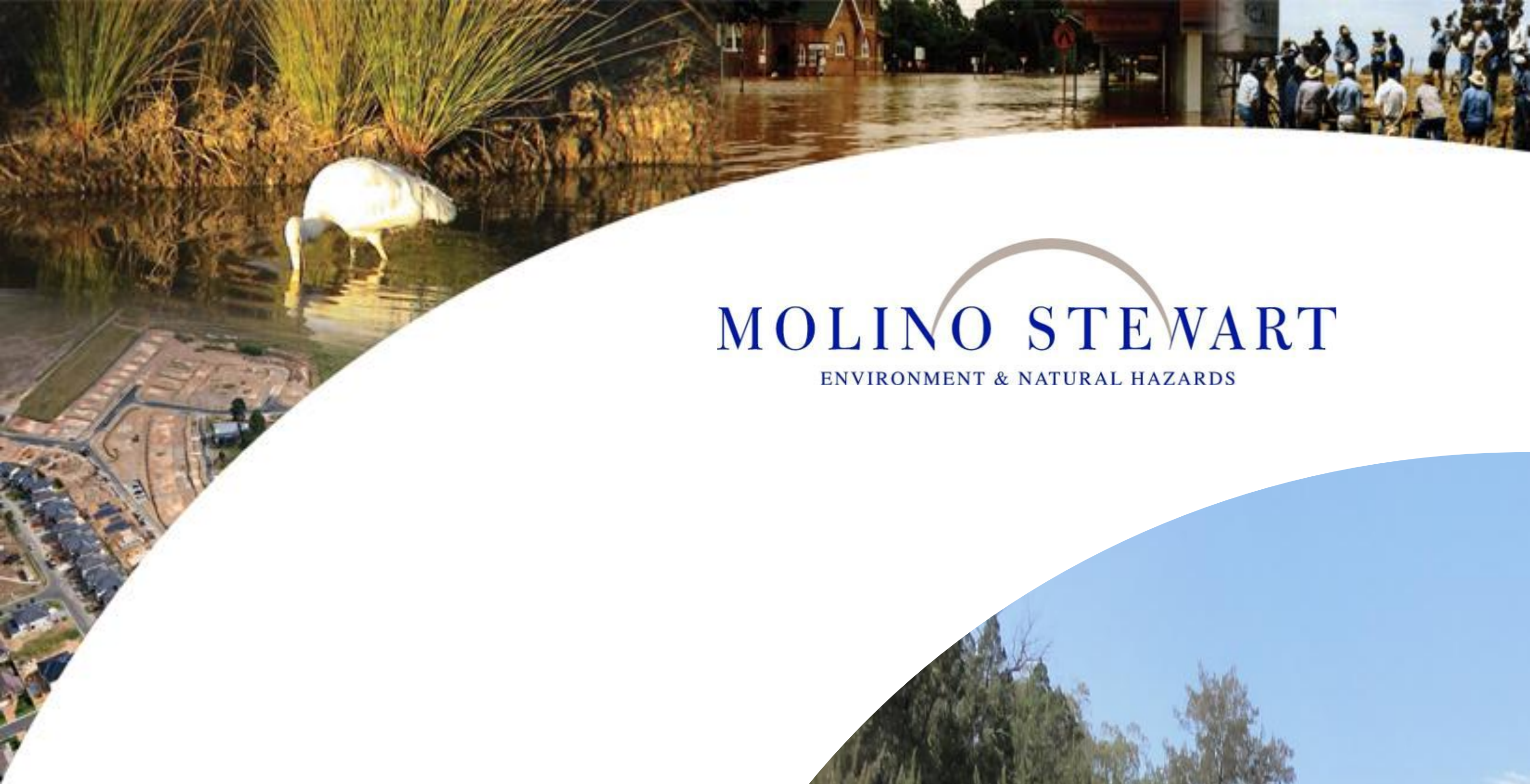
The EA must address potential impacts on the ecological character of the Macquarie Marshes Ramsar site.

Whilst the department does not require complex hydrological modelling of drought flows in the Macquarie River from upstream of the abstraction site to the Macquarie Marshes, the EA must provide estimates of (and assess) the likely impact of the proposed extraction rates on water flowing into the Macquarie Marshes in drought periods.

The EA must assess the proposed abstraction volumes as a portion of the drought flows past the abstraction point and into the Macquarie Marshes, rather than comparing the proposed abstraction volumes with long term average flows in the river in non-drought periods.

Appendix B

Strategic planning and project justification (Mollino Stewart)



MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

ORANGE
Australia's Colour City

The Macquarie River to Orange Pipeline Project Strategic Planning and Project Justification

Final

The Macquarie River to Orange Pipeline Project
Strategic Planning and Project Justification

FINAL

for

Orange City Council

by

Molino Stewart Pty Ltd

ACN 067 774 332

JULY 2012

MOLINO STEWART PTY LTD ABN 95 571 253 092 ACN 067 774 332

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Project	The Macquarie River to Orange Pipeline Project Strategic Planning and Project Justification
Document Type	Final
Author	Steven Molino

REVISION HISTORY

Date	Version	Name	Comments
16/3/2012	1.1	Steven Molino	Draft with some Geolyse graphics inserted
27/3/2012	2.1	Steven Molino	Incorporation of OCC comments
1/4/2012	2.2	Steven Molino	Incorporation of OCC comments
3/5/2012	3.1	Steven Molino	Revised Draft Based on Additional Information
13/5/2012	3.2	Steven Molino	Incorporation of OCC comments and updated Geolyse data and graphs
21/5/2012	3.3	Steven Molino	Incorporation of OCC comments
30/5/201	3.4	Steven Molino	Incorporation of NOW comments – draft for adequacy review
13/07/201	4	Steven Molino	Final
30/07/2012	4.1	Steven Molino	Final – revised to reflect minor operating rule changes

DOCUMENT APPROVAL

For Molino Stewart	
Name	Steven Molino
Position	Principal
For Orange City Council	
Name	Chris Devitt
Position	Director Technical Services

CONTENTS

APPENDICES

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LIST OF FIGURES

1 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

Orange City Council proposes to undertake the Macquarie Orange Pipeline Project (referred to in this report as 'the project'). An environmental assessment is being prepared for the project in accordance with the requirements of Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

This report has been prepared by Molino Stewart to address the need for the project, the strategic water supply alternatives considered and the justification of the preferred alternative. It does not consider design alternatives (e.g. pump location, pipeline route etc.) for the preferred alternative.

The report addresses the requirements of the Director-General of the NSW Department of Planning and Infrastructure (the Director-General's Requirements) dated 24 March 2011.

1.2 PROJECT OVERVIEW

The project is one step to improving the water security for Orange. It involves construction and operation of infrastructure required to transfer approximately 12ML/day of water a distance of approximately 37 km from the Macquarie River to the Suma Park Reservoir at Orange.

The infrastructure required to transfer the water includes an intake and pump stations, an underground pipeline (approximately 37 km in length), an outlet structure, and ancillary infrastructure (power supply).

In summary, the project would involve construction and operation of the following infrastructure:

- 37 km of 375 mm diameter water rising main between the Macquarie River and Suma Park Reservoir
- an intake and pump station located at the upper Macquarie River
- two booster pump stations and break tanks along the pipeline route
- power supply to pumps and other infrastructure
- telemetry controls to enable remote operation of the infrastructure including pumps and valves etc.
- a discharge structure at the Suma Park Reservoir.

1.3 SCOPE AND STRUCTURE OF THE REPORT

1.3.1 Scope

This report discusses:

- The need for water supply augmentation
- Alternative water supplies identified
- Shortlisting of viable options
- Selection of a preferred alternative

Options for various pumping station locations, pipeline routes, operating triggers and other design features of the scheme are discussed in other documents.

While it is recognised that in recent years there have been various regional and local processes and forums for investigating improved water supply to Orange, this document does not comment on those processes nor the recommendations which they have made. Rather, it:

- includes all of the options identified and evaluated through those processes, as well as some others
- takes evaluation information from those former processes and supplements it with newer information
- presents a summary of the options and Orange City Council's rationale for proposing the Macquarie Pipeline as its preferred option

In doing so it draws on information supplied by Orange City Council and its consultants, Geolyse, GHD and MWH. Molino Stewart has accepted the data and other information supplied to it for these purposes and has not undertaken its own investigations into the quality of this information.

1.3.2 Where Director-General's requirements are addressed in report

The Director General of the Department of Planning and Infrastructure has issued Director General's Requirements (DGRs) for the Environmental Assessment. This report covers in whole or in part the following DGRs:

1. *Justification for undertaking the project with consideration of the benefits and impacts of the proposal*

Chapter 2 explains why a water supply augmentation project is needed and Section 2.7 summarises the project's benefits. Chapter 4 compares the project with alternative methods of augmenting water supply and justifies the proposed project with reference to broad benefits and impacts. This report does not assess the detailed construction and operational impacts of the preferred project.

2. *Outline the regional strategic context of the project, having regard to existing and future development in the Orange and the Central West Catchment area, regional water supply, water management and water demand including the effect on downstream users of the Macquarie River including demonstrating that there is an adequate and secure water supply for the proposal during operation.*

Section 2.1 explains the regional and local strategic context of the project and Section 2.2 provides details of current and projected water demand in Orange which is a key driver of the project.

3. *Describe the need, scale, scope, location and objectives of the project; and provide justification for the preferred project taking into consideration the objects of the Environmental Planning and Assessment Act 1979 and consistency with relevant State and regional planning policies*

Chapter 2 explains the strategic water supply objectives, the project's scale and scope and its justification.

4. *Alternatives – the EA must detail all alternatives considered, both in terms of water supply and corridor selection (including alignment within the identified corridor). Clear reasons and justification for the selected corridor/alignment must be presented, demonstrating how environmental, social and economic issues have been addressed in this process.*

Chapter 3 describes the full range of strategic water supply options which were considered and Chapter 4 explains how these were evaluated and the preferred alternative arrived at. It does not discuss alternative pump locations and pipe alignments or other design details.

Attached to the DGRs were comments from other government authorities which informed preparation of the DGRs. The following are of relevance to this report.

a) Central West CMA

"It is imperative that consideration is given to ensuring this major development can demonstrate its alignment to the Central West CMA CAP… We would also strongly suggest that a comprehensive analysis of alternatives such as water efficiency measures, storm water harvesting, access to alternative water supply such as Lake Chifley, etc. be considered in the PEA."

A comprehensive analysis of alternatives including those listed is presented in Chapter 4 of this report.

The Draft Central West CMA Catchment Action Plan (CAP) 2011-2021 has four "water theme" targets supported by 13 priority actions. The actions which are relevant to strategic water supply options are:

- All water sharing plans contributing to management of priority river reaches, groundwater dependent ecosystems
- Manage hydrological regimes for ecological outcomes
- Multiple beneficial use including water reuse and recycling
- Improve water use efficiency
- Improve connectivity of water flow laterally, longitudinally and vertically

All of the options shortlisted for detailed assessment for this project align with the relevant water sharing plans. Improved water use efficiency and beneficial reuse options are considered and the impacts of options on hydrological regimes and connectivity are considered in the evaluation of options.

b) Office of Water

"The proponent is advised that Water Sharing Plans for both surface water and groundwater have not been commenced under the Water Management Act 2000 within the project site. Water licensing for this project is therefore covered by the Water Act 1912 *which is not exempt under Section 75U of the* Environmental Planning and Assessment Act 1979. *Please note however that the Macauarie River flows in to Burrendong Dam which is covered by the Macquarie-Cudgegong Water Sharing Plan. Potential impacts to water availability for operation of this plan will need to be addressed in the EA."*

Since the time the Office of Water wrote its letter, the draft *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources* has been released for comment. It applies to the catchments within and around Orange.

The draft water sharing plan makes provision for Orange City Council to have a water access entitlement for town water which allows it to extract a total of 7,800ML per year from within the catchments. All water supply options being considered for Orange for the next 50 years would keep Orange within that entitlement. In addition, Orange City has an option to purchase an existing 640ML per year unregulated water licence which gives it a total entitlement of 8,440ML per year.

c) Department of Planning and Infrastructure

"Future residential development for the sub-region of Blayney, Cabonne and Orange local government areas (BCO) has been strategically identified and planned for the next 25 years by the BCO Rural and Industrial Lands Strategy 2008*. This strategy identifies new settlement opportunities in close proximity to and within established towns, villages and Orange City, including Mullion Creek and the impact of the pipeline should be reviewed against this context."*

The demands for future increased water supply have been determined in the context of the future residential strategy for the sub-region. However, the water supply options are focussed entirely on increasing water supply to Orange City.

1.3.3 Structure of the Report

Chapter 2 of this report sets out the drivers for the project including supply and demand. Chapter 3 provides an overview of the options which have been considered and Chapter 4 provides an evaluation of these options and the reasoning behind selection of the Macquarie River to Orange Pipeline Project as the preferred alternative.

2 PROJECT DRIVERS

2.1 STRATEGIC PLANNING

2.1.1 Regional Level

Central NSW Regional Organisation of Councils (Centroc) undertook a Water Security Study to investigate and recommend solutions to improve water security across 17 LGA's (MWH, 2009). This study identified that 29 towns were at risk, and required substantial water security improvements. Orange was one of these towns at risk.

It was determined that an integrated program of water conservation and demand management measures, coupled with new and upgraded water supply and storage infrastructure was required. The recommended region-wide town water security strategy is centred around an augmented Lake Rowlands with various infrastructure to provide strategic regional connections (MWH, 2009, p45).

The study also recommended contingency actions for emergency situations which included the construction of a pipeline connection between Orange and the Macquarie River.

Orange City Council adopted to support the outcomes of the Centroc Water Security Study including the promotion of the expansion of Lake Rowlands. This was resolved by Council in November 2009.

2.1.2 Local Level

At its meeting of 19 November 2009, Orange City Council also adopted its own Comprehensive Water Supply Management Strategy for Orange. The strategic objective of the strategy is:

To establish a broad based water supply strategy for the next 50 years and beyond which focuses on ongoing water conservation, quality and demand management and the provision of key water supply infrastructure at least 10 years in advance of projected demand.

The ultimate aim of the strategy is to see fewer restrictions, improved security, and capacity for ongoing growth based on the following:

- A holistic/integrated approach which meets national water initiative requirements – essentially a balanced portfolio of realistic demand and supply options
- Achievable and very significant levels of demand management
- Achievable and very significant levels of user education
- Achievable and very significant levels of water system efficiency
- Proper inclusion of climate change and climate correction
- Proper analysis of yield, reliability and security compared to population and growth
- After consideration of the above, the identification of the need for further sources to meet growth and improve yield, reliability and security
- Identification of local and regional sources to take the city forward several decades with an appropriate cushion/contingency

The strategy outlined a number of actions aimed at meeting its strategic objective. These actions addressed the following elements:

- Water conservation and quality and demand management
- Provision of infrastructure – priority local options, priority regional options and alternative options
- Management, promotion and lobbying
- Funding

The actions identified for water conservation and demand management have been incorporated into 50 year future water demand projections for the city that reflect a far more water efficient community compared to current and recent historical demand.

Infrastructure options identified in the Strategy and their current status are summarised in Table 1. In addition to the significant advances which have been made with regard to investigating and implementing structural options, demand management, water efficiency and community education actions have been undertaken.

Table 1: Water supply management strategy infrastructure options

Component	**Comment**	**Status**
Priority local options		
Fast tracking the development and construction of the Ploughmans Creek Stormwater Harvesting scheme as an emergency water supply project, subject to compliance with appropriate environmental and regulatory requirements, for completion in the first half of 2010.	Construction of the Ploughmans Creek stormwater harvesting scheme was completed in mid-2011. A licence was granted under Section 10 of the *Water Act 1912* (Licence 80SL96331) for the permanent operation of the scheme in August 2011. The scheme has not been operated to date due to adequate water storages levels.	Complete
Commissioning of bores at the Orange Showground, Clifton Grove and Endeavour Field (following agreement with existing users) as an emergency water supply project, subject to compliance with appropriate environmental and regulatory requirements, for connection to the water supply system in the first half of 2010.	Licensing granted in March 2012 for the extraction of a combined 462ML/year from the Showground, OCC Depot and Clifton Grove bores. The Endeavour Field bore will no longer be considered as part of the water supply system.	Complete
Completion of safety upgrading works at Suma Park Dam including the adoption of operational rules which do not require the dam to be raised above its existing full supply level but enable the existing storage to be utilised more efficiently through the development of additional points of supply, such as stormwater harvesting.	Investigation and design work in progress. This includes examining the option of raising the dam to increase water supply capacity. Environmental flow studies are also being undertaken.	In progress
Priority regional options		
Undertake a detailed feasibility analysis immediately into the establishment of an emergency water supply pipeline connection from the Macquarie River downstream of Bathurst to Orange, and as a secondary option, from Lake Rowlands to Orange (subject to the availability of suitable water volumes and agreement on business arrangements with Central Tablelands Water (CTW)), to confirm concepts and, if suitable, undertake the necessary statutory assessments to prepare for construction in order to optimise delivery of project/s, ideally within 2 years.	**Macquarie Pipeline:** Feasibility study completed May 2010 Concept study completed January 2011 Statutory approval process commenced March 2011. **Lake Rowlands Pipeline:** Lake Rowlands yield study completed November 2011. Secure yield results indicate that there is unlikely to be significant “spare” secure yield to supply Orange, particularly when climate change is considered. Furthermore, the Draft Water Sharing Plan for Lachlan Unregulated and Alluvial Water Sources has had to place limitations on water access entitlements.	In progress

Component	Comment	Status
Pursue State and Federal Government funding for regional pipelines in the priority order of both the Macquarie River and Lake Rowlands pipeline (subject to agreement with CTW) firstly, failing which, the Macquarie River pipeline only.	State and Federal Government funding totalling $38.2 million approved in March 2011 for the Macquarie Pipeline Project. Pipeline from Lake Rowlands has not progressed due to issues relating to limited availability of secure yield from Lake Rowlands.	Complete Centroc Study being reviewed
Failing State and Federal Government funding of the Macquarie/Rowlands pipeline options, the Macquarie River pipeline be targeted to be secured in the medium term and the CTW connection in the medium/long-term (again subject to agreement with CTW on suitable volumes and business arrangements).	State and Federal Government funding totalling $38.2 million approved in March 2011 for the Macquarie pipeline project.	Complete
Support the outcomes of the Centroc Water Security Study including promotion of the expansion of Lake Rowlands and associated pipelines in principle for the pursuit of State and Federal funding and for the negotiation of suitable access, volume, water charges and business arrangements and for full feasibility analysis.	Council has continued to work with Centroc to progress this strategy. The issues relating to Lake Rowlands are currently being examined before the outcomes from the Centroc Study can be progressed.	In progress
Alternative options (to be pursued following the above options or in lieu of the priority options if they cannot be achieved in the short term		
Connection of Lake Canobolas into the city's water supply network, subject to compliance with appropriate environmental and regulatory requirements including the establishment of appropriate operating rules to regulate operation of this system.	Investigations completed in March 2011 Recommended as emergency connection only. To be used when main storage levels fall to less than 25%. Making Lake Canobolas part of the permanent water supply system would have very limited supply capacity benefits (100ML secure yield) and significant licensing and water access issues.	Investigation complete
Direct connection from Gosling Creek Dam into the city's water reticulation network, including provision of appropriate water treatment infrastructure, subject to compliance with appropriate environmental and regulatory requirements including the establishment of appropriate operating rules to regulate operation of this system.	Maintaining storage levels and using stored water when the main storage levels fall to less than 25% by transfer through to Spring Creek reservoir now considered to be more appropriate than direct connection.	Investigation complete

Component	Comment	Status
Development of the second stage of the Blackmans Swamp Creek Stormwater Harvesting Scheme generally as outlined in the original approval for this project.	Council is participating in a process to resolve objections to the licensing of Stage 1. Until this is resolved, Stage 2 will not be pursued. Further, Council needs to comply with a water quality approval process before expansion of the stormwater harvesting schemes will be considered.	Waiting outcome of Blackmans Swamp Creek Stormwater Harvesting Scheme Stage 1 licence application
Investigation into the feasibility of developing a Managed Aquifer Recharge system in conjunction with the Federal Government.	Managed Aquifer Recharge (MAR) business case prepared June 2011. Recommended MAR trial to establish operational information relating to aquifer storage and reuse.	In progress

2.2 WATER DEMANDS

Any water supply scheme must be able to meet the reasonable demands of its customers and be able to reliably supply water through adverse climate conditions. A scheme built now must be designed to meet the needs of future customers in a future climate. While the future is uncertain, existing and historical water demand and climate information can be used to make reasonable projections of future water demand.

The Comprehensive Water Supply Management Strategy acknowledged that there was a significant gap between water supply and demand in Orange and that actions needed to be taken to close that gap and ensure ongoing security of supply in the future. At the same time, Council was preparing an Integrated Water Cycle Management (IWCM) Evaluation Study which, amongst other things, aimed to estimate future water demands in Orange. The following discussion draws upon the analyses undertaken as part of the IWCM Evaluation Study.

2.2.1 Historical Water Demand

Water demand fluctuates from year to year and is influenced by a number of factors including:

- The population size and amount of business activity
- The weather: with more water being demanded in hotter, drier conditions
- Water restrictions
- Community attitude to use
- The price of water

Figure 1 shows the annual water demands of Orange between January 1992 and December 2011 and highlights some of the influences on water demand.

The blue line represents the actual total water demand for each year. This shows that it has fluctuated between a high of 7,120ML per year in 2002 to a low of 3,708ML per year in 2010. The red line is the Estimated Resident Population (ERP) and it fluctuated between 2000 and 2006 but then grew rapidly after that. The ERP is provided by the Australian Bureau of Statistics and is based on census data and is updated every year to account for births, deaths and migrations.

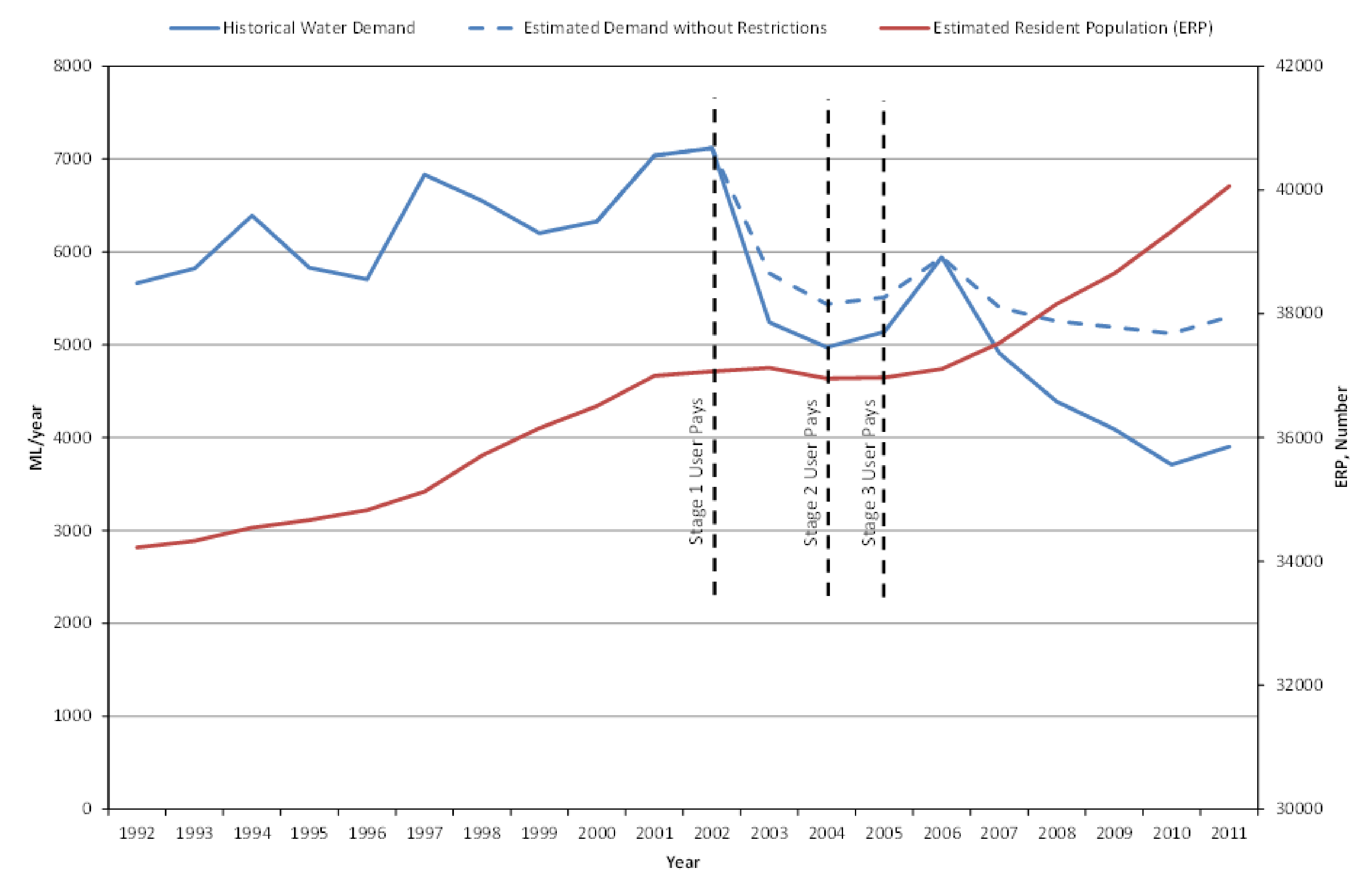

Figure 1 Annual Water Demands and Population

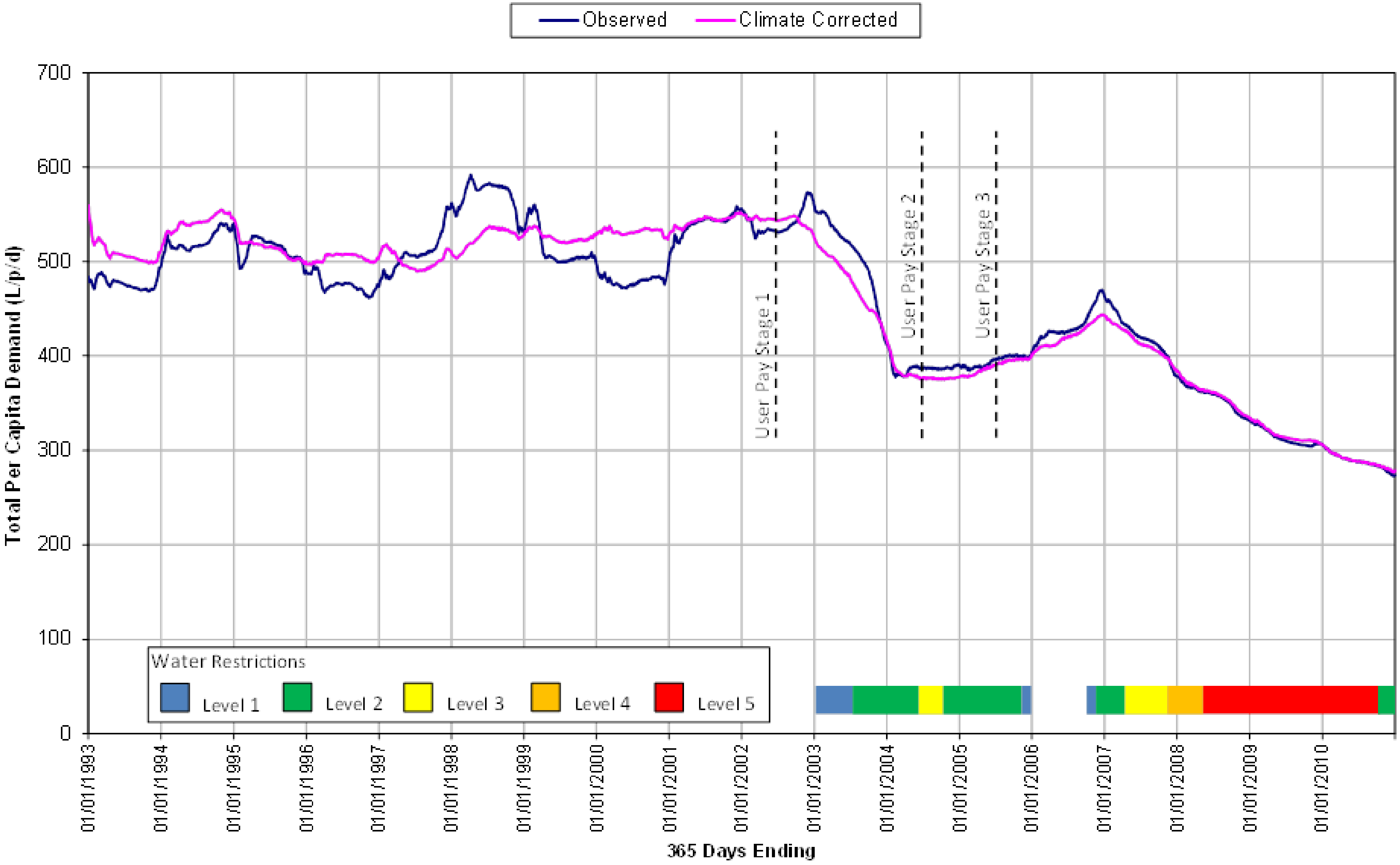

Figure 2 Influences on Water Demands

When the blue line showing annual demand is compared with the red line showing population, it is clear that changes in demand have not simply been driven by changes in population.

Figure 2 indicates some of the other influences on water demand. The blue line shows the total daily water demand divided by the population for that year. When considered on its own it shows the marked influence of daily weather on daily demand.

When climate data is used to normalise the daily demand graph the pink line is the result. This is referred to as the climate corrected demand and is what the total daily per capita demand is expected to have been if the variation between actual and seasonal average temperature, rainfall and evaporation are removed.

The coloured bars at the bottom of the graph indicate what level of water restrictions were in place since January 2003. It is clear from the graph that the imposition of water restrictions had a significant impact on water demand. The lowest level of annual demand occurred when the most severe water restrictions since 2003 (Level 5) were in place. It also shows that when water restrictions were scaled back in 2005, and then lifted temporarily in 2006, water demand increased markedly but when they were reimposed in 2007 demand was again pushed down significantly.

The three vertical lines on both graphs show when the three stages of user pay pricing were introduced. Before the introduction of user pay pricing, residential consumers simply paid an annual water supply fee which was not affected by the amount of water which they used. During this time climate corrected per capita demand ranged between 490 and 555 litres per person per day.

Stage 1 of user pay pricing was introduced in July 2002 but water restrictions were introduced after six months because of reduced storage levels in the reservoirs. This involved consumers paying an access charge and a per kilolitre, excess water usage charge if more than 150kL was used per year.

By the beginning of 2004, total per capita water demand had dropped to around 380 litres per person per day but it is difficult to know to what extent this was influenced by user pay pricing or by the water restrictions.

After Stage 2 user pay pricing was introduced in July 2004, total per capita demand remained fairly flat but rose rapidly once restrictions were lifted and then dropped again when restrictions were reimposed. This suggests that Stage 2 user pay pricing, which involved payment for every kilolitre of water used, did not significantly reduce total per capita demand.

The third stage of user pays pricing involved an inclining block tariff which means the tariff per kilolitre increases by 50% when more than 450kL is used. This occurred in July 2005 yet after this was introduced per capita water consumption increased (Figure 7). This occurred not long after water restrictions were relaxed from Level 3 to Level 2. The rate increased more markedly when water restrictions were removed at the beginning of 2006.

In 2009, Orange City Council undertook a major leak and pressure reduction program to reduce system losses. An audit of the program found that these measures to improve the efficiency of the water delivery system had saved 500ML per year. This equated to about a 31 litre (7%) reduction in total daily per capita demand.

In summary, Orange City Council has:

- implemented a leak and pressure reduction program to permanently reduce total demand
- introduced user pay pricing to reduce per capita demand
- imposed water restrictions when required to temporarily further reduce water demand when storages are low

Council has been rolling out additional demand management measures (e.g. community education, showerhead exchange program, water audits) but their impacts will be more significant in the future and they are therefore discussed in Section 2.2.3 which considers future water demand.

2.2.2 Current Water Demand

As can be seen from the preceding discussion and graphs, there have been many influences on water demand over the past 15 to 20 years. Some have been transitory such as water restrictions and weather fluctuations and others have been permanent such as population growth and user pay pricing. During 2011 the population continued to grow, there were Level 2 water restrictions in place, and Orange experienced its third wettest March and third wettest November in the past 45 years. This makes it challenging estimating the current underlying annual demand.

It was determined that the 2006 climate corrected total per capita demand was the best starting point for estimating current underlying demand because it was the most recent time when there was unrestricted water supply and it was after the user pay pricing had been introduced. At the end of 2006 the climate corrected total per capita demand was 435 litres per person per day. When this was adjusted to account for the 500ML per year saved through the leak and pressure reduction program, the baseline total per capita demand was 404 litres per person per day. Multiplying this by the estimated 36,582 people who were served with water in 2010, it equates to an annual unrestricted demand of 5,400ML per year.

Although the actual water demand in 2010 was 3,708ML, it must be remembered that this was achieved with Level 5 water restrictions in place, and is the lowest it has been in the past 20 years. This would not be an appropriate starting point for future water planning because it is not representative of the typical annual water demand and is significantly less than the 6,000ML per year which was used in 2006 which was the last time water was supplied unrestricted.

In 2011, with Level 2 water restrictions still in place and some of the highest rainfall in March and November in recent decades, which would have further suppressed demand, annual demand rose to 3,903ML for the year. This shows that even when conditions were conducive to low demand, demand rose above the 2010 levels.

Of a total demand of 5,400ML per year, the residential component would account for about 3,405ML. This works out to be about 259 litres per person per day which is equivalent to Council's demand target of 260 Litres per person per day under Level 1 water restrictions. This confirms that the estimate for annual demand using the 2006 climate corrected data is reasonable as it expects that a more "water wise" community will use less water per person than it has historically.

In light of all of the variables which affect demand, Orange City Council adopted an underlying, climate corrected annual demand of 5,400ML per year in 2010 as a starting point for demand projections.

2.2.3 Future Water Demand

a) Demand Management

Orange City Council has implemented several measures to further reduce per capita water demand including:

- Permanent water conservation measures to prevent excessive outdoor water usage
- Community education/ public awareness campaigns to eliminate water wastage
- National Water Efficiency Labelling scheme to encourage purchase of more water efficient appliances
- A showerhead exchange program to make internal water use more efficient
- Residential and non-residential water audits to help businesses identify ways to reduce water consumption

This will reduce per capita water demand on all existing and future developments.

Furthermore, all new houses and redevelopments in Orange must meet the NSW BASIX requirements which include minimum water efficiency measures. In addition, some new residential subdivisions are being built in Orange with dual water reticulation systems which enables them to receive non-potable water for use outdoors. These measures mean that new houses will use less potable water per person than existing houses.

For demand forecasting purposes it was assumed that all existing measures to reduce demand would remain in place and that over time they would lead to a reduction in average per capita water demand.

Table 2 shows how residential per capita demand is expected to reduce over time. It also shows how total per capita demand, which includes non-residential water demands, will also reduce between now and 2060. The details of the assumptions in arriving at these reductions in demand are provided in Appendix A.

Table 2 Forecast Per Capita Water Demand

Demand	2010	2020	2030	2040	2050	2060
Total per capita water demand (L/p/d)	404	370	362	357	351	346
Residential Water Demand (L/p/d)	259	236	232	228	225	223

The current level 2 water restriction target is 240 litres per person per year. As can be seen from the table, the implementation of these further demand management measures is expected to lower total per capital demand to that target level by 2020 without imposing water restrictions. Water restrictions would further lower demand when required.

Water supply planning for Orange assumes that these measures will be in place and will be effective and Orange will have become significantly more water efficient than it currently is.

b) Development and Growth in Orange

While the per capita water demand is expected to decrease in coming decades, Orange's population is expected to grow and business development increase.

Table 3 shows the Estimated Resident Population (ERP) for the City of Orange as produced by the Australian Bureau of Statistics (ABS). The annual change in population has varied, with low to negative growth from 2001 to 2006 followed by high growth from 2007. The average annual growth over the ten year period is 0.8% pa.

Orange is trending to grow because of the new mining activity in the area with the currently expanding Cadia mine which is projected to keep producing until at least 2030. This will lead to more people living in Orange and new businesses establishing in the City. The city is also becoming a regional centre for medical services with its new public hospital which is attracting a strong medical industry to grow around it. It has a campus of Charles Sturt University which is building more student accommodation. Orange is being promoted as one of seven EvoCities which are encouraging people to relocate to these rural centres and the Orange LEP proposes to rezone several areas to accommodate increased residential and commercial land use. The BCO Rural and Industrial Land Use Strategy also identifies the need for additional industrial development in Orange.

It is critical that Council plans water supplies to meet this projected future growth. If it fails to do so then water supply may become a constraint to growth in Orange, particularly if nearby regional cities have more secure water supplies.

Several future population projections have been prepared for the City of Orange including projections undertaken for the preparation of the City's Local Environmental Plan (LEP).

Table 3 Historical Population Growth 2001-2009

Year (ending 30 June)	Estimated Resident Population	Annual Population Change	% Change
2001	36,999	-	-
2002	37,066	67	0.2%
2003	37,126	60	0.2%
2004	36,956	-170	-0.5%
2005	36,970	14	0%
2006	37,108	138	0.4%
2007	37,525	417	1.1%
2008	38,158	633	1.7%
2009	38,646	488	1.3%
2010	39,261	615	1.6%
2011	40,062	801	2.0%

Source: Australian Bureau of Statistics Estimated Resident Population (ERP) http://profile.id.com.au/Default.aspx?id=262&pg=210&gid=10&type=enum

Based on the projections used for the LEP, Orange City Council has adopted the following long term growth assumptions for the IWCM Evaluation Study:

- Medium growth rate – 0.8% pa
- High growth rate – 1.1% pa

Projected population is presented in Table 4 and show graphically in Figure 3.

When these population projections are multiplied by the total per capita demand projections an annual average demand can be arrived at.

Demand projections to 2060 are summarised in Table 5. This shows that by 2020 the annual demand is projected to be less than the current unrestricted 5,403ML per year despite a medium growth in population and only slightly higher than current demand in a high growth scenario. This is because it is forecast that the various demand management measures which have been put in place will be having a more significant impact on total per capita demand than they are now.

Beyond 2020, however, the growth in population is expected to negate the ongoing reductions in per capita demand and result in increasing annual water demands each year.

Consideration was also given to the impacts of additional demand management on average annual demand. There are limited opportunities for further demand management measures in Orange because so many have already been adopted. The introduction of conservation pricing for residential users was modelled and the results are presented in Table 6. This indicates that under a medium growth scenario the current unrestricted annual demand would be exceeded shortly before 2030. This is a difference of more than 200ML per year between the two demand management scenarios in 2030.

The various demand growth scenarios with alternative population growth and demand management assumptions are summarised in Figures 4 and 5 which also provide a comparison with projected demand were there no demand management measures in place other than user pays pricing and the loss reduction program

Table 4 Medium and high population growth scenarios, City of Orange

Year	**Estimated Resident Populations**	
	Medium Projections 0.8% pa	**High Projections 1.1% pa**
2009	38,685*	38,685*
2010	38,994	39,111
2015	40,579	41,309
2020	42,229	43,632
2025	43,945	46,085
2030	45,731	48,676
2035	47,590	51,413
2040	49,524	54,304
2045	51,537	57,357
2050	53,632	60,581
2055	55,812	63,988
2060	58,080	67,585

* population projections based on 2009 ERP published in 2010. 2009 ERP published in 2011 (see Table 3) had 39 less people but the difference was so insignificant that the projections were not altered

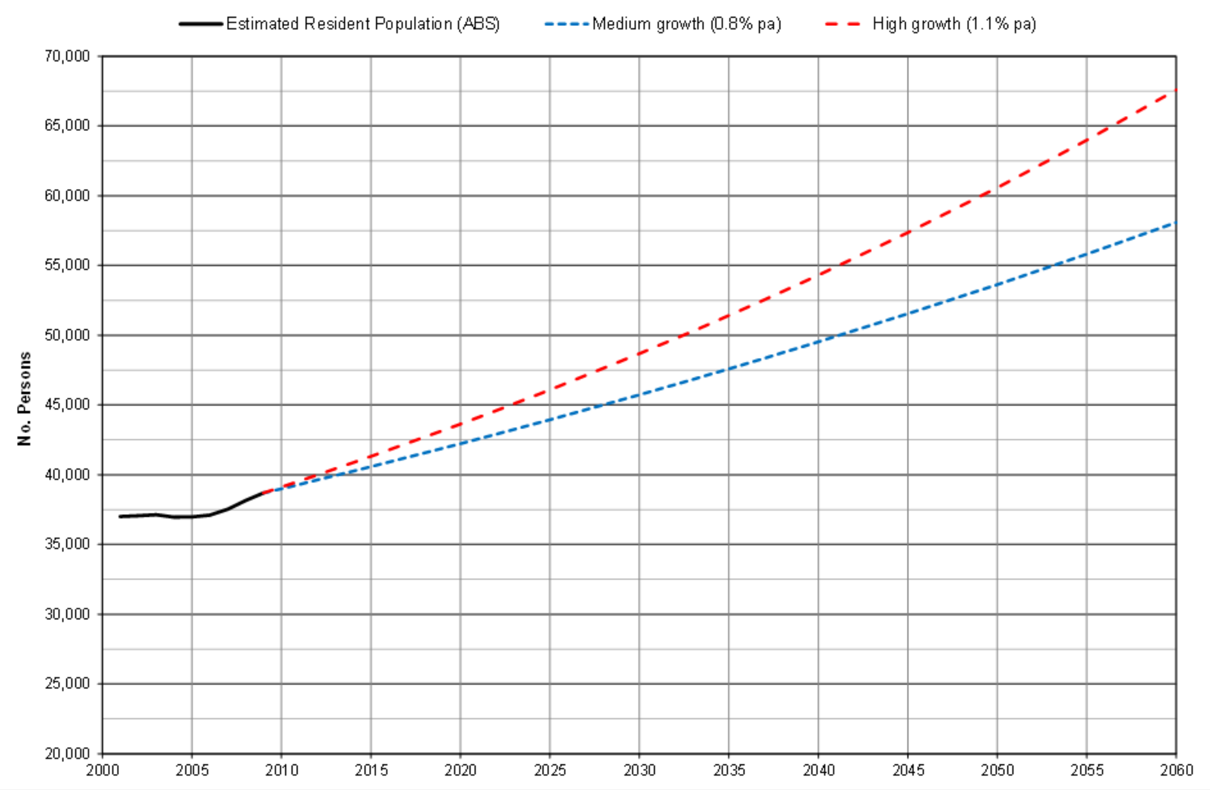

Figure 3 Population projections, City of Orange – 2010 to 2060

Table 5 Orange forecast water demand - current demand management

Demand	**Growth**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Total Per Capita Water Demand (L/p/d)	na	404	370	362	357	351	346
Average Annual (ML/a)	Medium: 0.8% pa	5,403	5,349	5,681	6,058	6,478	6,948
	High: 1.1% pa	5,403	5,515	6,045	6,655	7,347	8,135

Table 6 Orange forecast water demand - High level demand management

Demand	**Growth**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Total Per Capita Water Demand (L/p/d)	na	404	365	349	344	339	334
Average Annual (ML/a)	Medium: 0.8% pa	5,407	5,157	5,474	5,838	6,244	6,698
	High: 1.1% pa	5,407	5,316	5,824	6,410	7,078	7,838

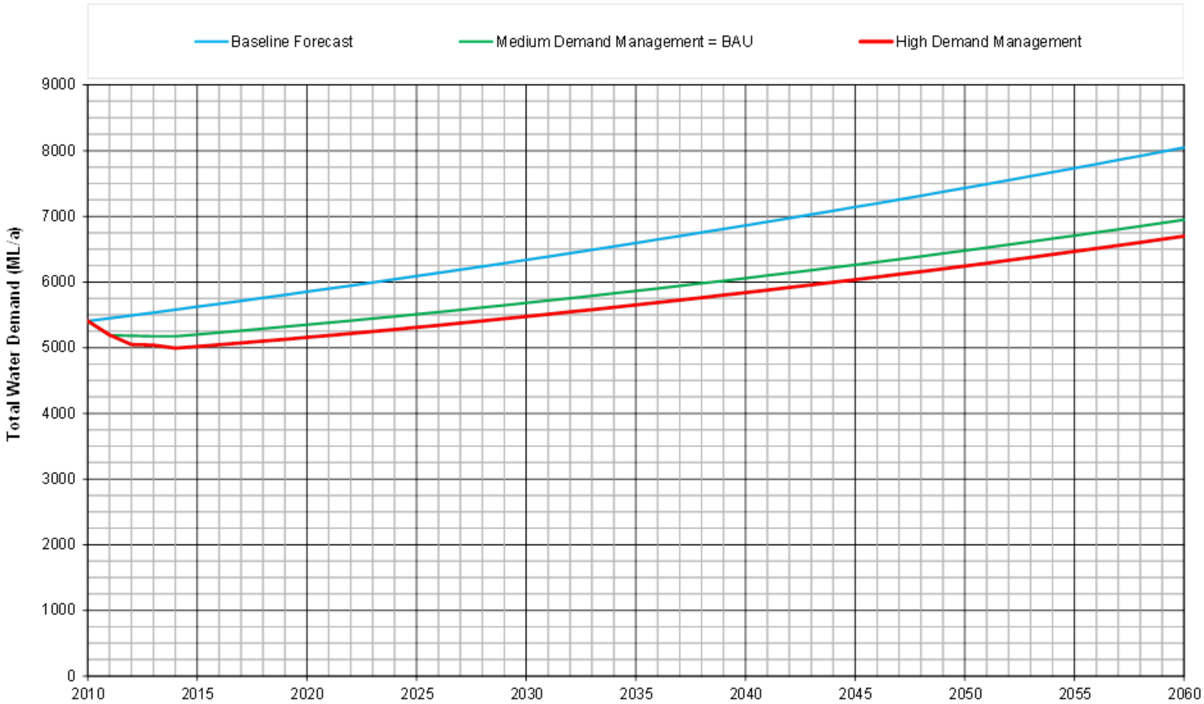

Figure 4 Forecast total annual potable water demand – City of Orange, medium growth

Figure 5 Forecast total annual potable water demand - City of Orange, high growth

2.3 WATER SUPPLIES

2.3.1 Regional context

Orange is in the Macquarie River catchment and currently draws all of its water from surface and ground waters in small catchments surrounding the town which are mostly part of the larger Summer Hill Creek catchment. Summer Hill Creek flows into Lewis Ponds which joins the Macquarie River 47km from Orange and 12km downstream of the junction of the Macquarie River the Turon River. A small section of the City is located within the Ploughmans Creek catchment which forms part of the Bell River catchment which enters the Macquarie River downstream of Burrendong Dam.

Oberon Dam on the Fish River and Chifley Dam on the Macquarie River are two major water supply dams in the Macquarie Catchment well upstream of Orange. Burrendong Dam is a major water supply dam on the Macquarie River downstream of Orange and about 70km directly north of the city. None of these dams supply water to Orange.

2.3.2 City's water supplies

a) Built and fully operational

Orange's water supply system has many components with operational, licensing and water quality delivery requirements.

Suma Park Reservoir is a 17,290ML storage on Summer Hill Creek which supplies water directly into Orange's potable water supply via Icely Road Water Treatment Plant and is the main water supply for Orange.

Spring Creek Reservoir, a 4,449ML storage, is upstream of Suma Park Reservoir and, if required, can service part of the city using the Spring Creek Water Treatment Plant. This plant is currently decommissioned. Spring Creek Reservoir is used for water storage with water being transferred to Suma Park Reservoir when the downstream storage falls to less than 25%.

Gosling Creek Reservoir, on Gosling Creek south of Orange, has a 524ML storage capacity and transfers water to Spring Creek and Suma Park reservoirs when their combined storages are projected to drop below 25%. Its current operating rule is that transfers cease when Gosling Creek Reservoir drops below 50% but a 2009 study suggested that it could be dropped to as low as 10% without adverse environmental impacts.

Ploughmans Creek Catchment has a stormwater harvesting scheme constructed within it which collects a portion of the high creek flows and transfers them to the 230ML Blackmans Swamp Creek holding pond subject to licence conditions (see Section 2.3.3). Water from the holding pond is transferred to Suma Park Reservoir after treatment to ensure appropriate water quality.

In addition to these surface water supplies, Orange City Council had a licence to extract 75ML per year from a groundwater bore near the Showground for many years. A second bore has been developed in the Council Works Depot and other existing bores in Clifton Grove have been connected to Suma Park Reservoir. A Borehole Impact Management Plan was prepared which suggested that together, potentially 450ML/year could be extracted from all of these bores.

In March 2012 OCC was granted a license to permit it to extract a total of 462ML/year from all of these bores.

Treated effluent from the Orange Sewage Treatment Plant (STP) is another water source. It is currently used as a non-potable source for industrial water supply.

Orange City Council has a supply agreement with Cadia Mine to supply the mine with most of this effluent. Cadia is Orange City Council's largest customer.

The transfer pipeline has a maximum capacity of 13ML/day. Under the contract, Orange STP must provide Cadia with all available effluent up to 10ML/day when the mine needs it. Council has a contracted right to any effluent in excess of 10ML/day and under 13ML/day but if it does not use this water it can be sent to the mine if required.

When the mine does not require this much water from the STP the effluent is discharged to Summer Hill Creek in accordance with licence conditions.

Generally, the mine either takes the entire daily flow or no effluent depending on its daily demands. On this basis, the mine has been taking an average of about 8.2ML/day in recent years. This is a major water source for the mine which is dependent on this water for its ongoing operations.

This arrangement started in December 1997 and is set to continue "for the life of the mine". The Cadia East Project has a planning consent to extract material until 2040. Additionally there is further mineralisation which is the basis of additional exploration and potential expansion/longevity on the site. Council has a contract with Cadia Valley Operations for the provision of effluent, the price of which is currently the subject of renegotiation. The Cadia East Project Environmental assessment stated that the project is expected to continue until approximately 2030. Minimal effluent would be available for other purposes until at least that date.

b) Built and partly operational

Blackmans Swamp Creek is a tributary of Summer Hill Creek and has an urban stormwater harvesting scheme which diverts collected stormwater into Suma Park Dam. It currently has an emergency authorisation to operate when flows in the Creek exceed 1,000 L/s and Suma Park Reservoir is less than 50% full. Subject to licensing, it can operate to trigger when Suma Park Reservoir falls below 100% and Creek flows exceed 1,000 L/s. Council is seeking a permanent licence to operate the scheme at full capacity. This is Stage 1 of a proposed three stage scheme.

Objections have been raised by some sectors of the community that permanent operation at the 100% trigger would have a long term detrimental impact on the ecology of Summer Hill Creek, particularly since the diversion of the STP effluent has taken 8-10ML/day base flow out. Another concern which has been raised is that downstream licence holders will have reduced opportunities to extract their full water entitlement. These objections to Council's licence application have resulted in the application being referred to a hearing of the Local Land Board. It may be that the 100% trigger will only be approved if compensatory environmental flow releases are made from Suma Park Dam.

Furthermore, the NSW Office of Water has expressed concerns about the quality of the water from the Blackmans Swamp Creek catchment and the long term impact its use could have on Orange City Council's ability to meet National Health and Medical Research Council guidelines for drinking water quality.

The Draft Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources (NSW Office of Water, 2011) applies to the Summer Hill Creek water source. Clause 54(2) states:

A water supply work approval must not be granted or amended to authorise a new in-river dam in the following water sources:

(v) Summerhill Creek Water Source

This means that the proposed larger harvesting weir for Blackmans Swamp Creek Stage 3 could not be approved unless Ministerial approval was obtained. Other advice suggests that it would require an amendment to the Water Sharing Plan.

Licence negotiations for the scheme have been ongoing since 2009 and there is still some uncertainty that Council will be able to obtain a permanent licence to operate Stage 1 of Blackmans Swamp Creek stormwater harvesting scheme, as built, at full capacity. There is even less likelihood that stages 2 and 3 will be approved.

c) Requiring Modification

Suma Park Dam, because of its size, it is a referrable dam under the NSW Dams Safety Act. As such, Council is legally required to assess the probability and consequences of dam failure.

Council has completed this assessment and an extreme flood could overtop the dam and cause it to fail. Dam failure could result in loss of life downstream and would certainly result in severe water restrictions for Orange for many years. Such consequences class it as a high hazard dam. To meet current NSW Dam Safety Committee requirements for high hazard dams, Suma Park Dam needs to be upgraded so that it can safely pass a Probable Maximum Flood. These requirements did not exist when it was built. Investigations to date suggest that the most cost effective way to meet these requirements would be to improve spillway capacity.

Investigations have been undertaken to see if additional water supply capacity could be provided by raising the dam wall at the same time as the dam safety improvements are made. These have shown that for structural reasons it is not possible to increase the dam's full supply level by more than about 1m.

A 1m increase will increase the FSL volume from 17,290 to 18,970ML and provide an additional 100 to 200ML/year secure yield.

The environmental flow issues raised during licensing of Blackmans Swamp Creek Stormwater Harvesting Scheme suggest that the approval process for increasing the storage capacity, and therefore total flow harvesting, of Suma Park Reservoir may also require its environmental flow rules to be reassessed. It may be required to release more of its stored water to the environment as environmental flows than it does now. The result could therefore be that the additional yield provided by increasing the storage may be negated by the water which would have to be released to meet new environmental flow requirements. This increase in storage may therefore be close to a nil sum gain.

2.4 SECURE YIELD

As explained in Section 2.2.1, water demand fluctuates daily, seasonally and annually and is strongly influenced by prevailing weather conditions. Similarly, inflows into the water supply systems experience daily, seasonal and annual fluctuations which are dictated by the weather. It is often the case that when demand is highest, during periods of hot dry weather, inflows are at their lowest. To overcome the frequent mismatch between supply and demand, water from wet periods is stored in reservoirs and other storages for use during dry periods.

Every component of Orange's current water supply system works on this basis, even the borefields which rely on a natural underground storage of groundwater.

The amount of water which a system can regularly supply is referred to as its yield. The length of time that water can be drawn from a system, without additional inflows, can be increased if from time to time users are willing to take less water when there is less available. The greater the frequency and severity of water supply restrictions, the more water which is available at other times.

The NSW *Best Practice Management of Water Supply and Sewerage Guidelines* recommend that for water restrictions in regional urban water supply systems the:

a) Duration of restrictions should not exceed 5% of the time;

b) Frequency of restrictions should not exceed 10% of years (i.e. 1 year in 10 on average); and

c) Severity of restrictions should not exceed 10%. Systems must be able to meet 90% of the unrestricted water demand (i.e. 10% average reduction in consumption due to water restrictions) through a repetition of the worst recorded drought, commencing with the storage drawn down to the level at which restrictions need to be imposed to satisfy a) and b) above.

This is commonly referred to as the 5/10/10 rule and the secure yield of a system is defined as the highest annual water demand that can be supplied from a water supply system while meeting this rule.

A computer simulation of the existing water supply system was run using more than 115 years of climate and streamflow data. This showed that the Federation Drought from 1895 to 1902 would have had the greatest impact on the Orange Water Supply System and is the critical drought for the Orange system. It therefore determines the secure yield for the Orange Water Supply System when the 5/10/10 rule is applied to the simulation.

Based on the results of that simulation, the existing secure yield is estimated to be 4,750ML per year and is summarised in Table 7.

2.5 COMPARING YIELD WITH DEMAND

2.5.1 A growing gap

The existing secure yield of 4,750ML/year is 650ML/year short of current unrestricted demand of 5,400ML/year. This mismatch between supply and demand won't be seen in average or wet conditions; only in a prolonged drought. Best practice water supply design requires the system to be designed and built now to get Orange through such a drought.

Table 7 Existing Water Security Measures

Water Sources	**Additional Secure Yield from Source ML/year**	**Total Secure Yield ML/year**
Suma Park Dam, Spring Creek Dam and Gosling Creek Dam	3,400	3,400
Approved harvesting schemes: Blackmans Swamp Creek Harvesting operating on 50% trigger *Ploughmans Creek harvesting operating on 100% trigger*	900	4,300
Licensed bore extraction: *Four bores supplying 462ML/year*	450	4,750

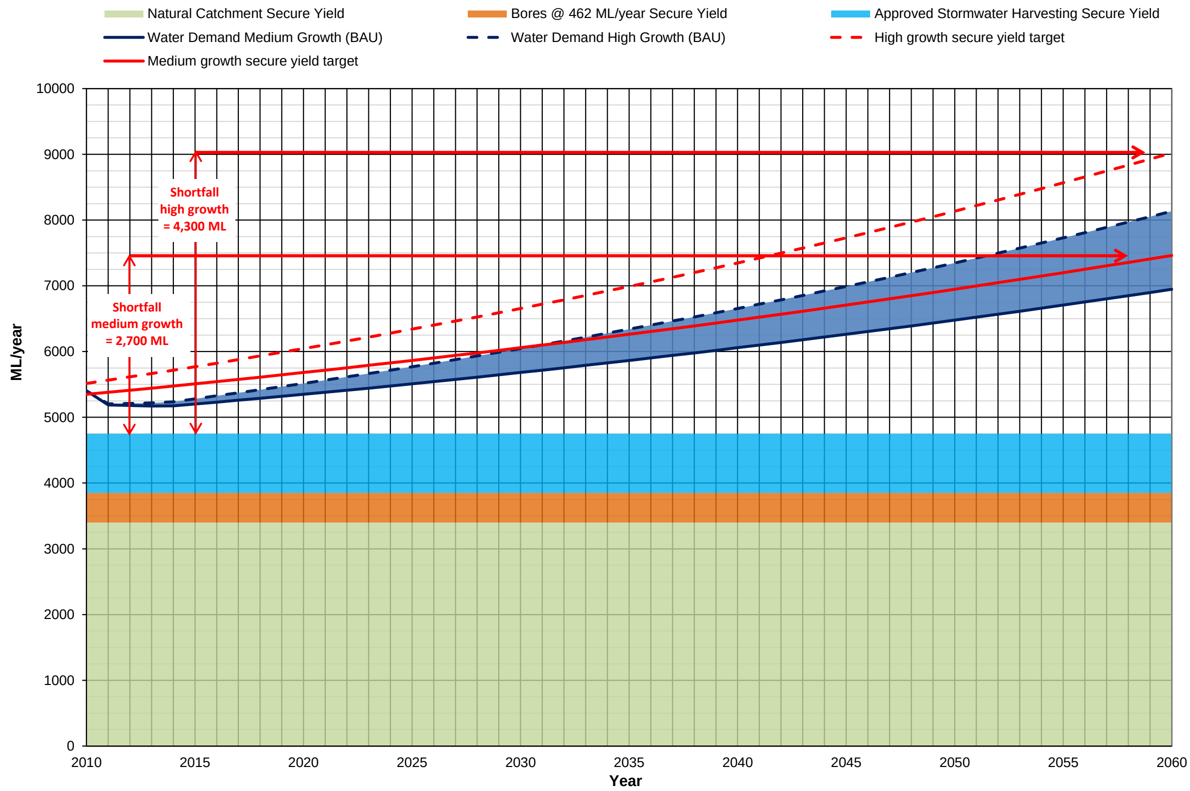

Figure 6 Water security for existing water supply infrastructure – no climate change

Furthermore, as growth occurs demand will grow and the gap will widen. This is illustrated in Figure 6 which is the basis of the following discussion.

Orange City Council has adopted the approach of having a water supply scheme capable of meeting projected water demands at least 10 years in advance. This is a prudent measure to provide sufficient lead time should the gap between secure yield and demand be smaller than forecast and further system augmentations are required sooner than expected.

For example, if approval for augmentation of the water supply system is sought in 2012 and it is built and operational by 2015, then it must be designed to at least meet the forecast water demands for 2025. Even then, this would only just meet 10 year projection so approval of the next increment would have to be sought shortly thereafter.

Orange City Council has adopted a 50 year planning horizon to ensure long term water supply security for the city. This means that planning needs to be carried out now for the water supply infrastructure which will be required in 2060 and that infrastructure needs to be able to meet the projected water demands in 2070.

This is illustrated in Figure 6 where the solid dark blue line represents a medium growth in demand and the dotted dark blue line a high demand growth. The red dotted line represents the secure yield which needs to be provided in each year if a supply system to meet high demand projections is available 10 years in advance and the solid red line if medium demand is to be met 10 years in advance.

The gap between the red lines and the horizontal blue band shows the increment in secure yield which is required to be in place in any year to meet the target of being able to match demand 10 years in advance.

Using Council's 50 year adopted planning horizon, Figure 6 shows that an increment of 2,700ML is needed to meet projected medium demand growth or 4,300ML to meet high demand growth.

The figure also shows that there is currently a significant gap between demand and yield and by 2025 the system would have to securely supply between an extra 770ML per year and 1,020ML per year than it currently does, depending how quickly population grows. By 2035 this would increase to between 1,150ML per year and 1,590ML per year.

Realistically, approvals are needed now for an additional secure yield of between about 770 and 1,020ML per year just to meet existing demand and projected growth in the next 10 years. Augmenting by 770ML per year would last only until 2020 should high population growth occur. Even a 1,020ML per year increase would require approvals for further augmentation shortly thereafter.

In summary, this means that a yield increment in the order of 2,700ML per year is needed to meet long term medium demand growth but the means chosen for delivering that yield increment must be able to deliver about 1,000ML per year immediately. If demand growth is high the 2,700ML per year increment will be fully allocated by 2040 but this would be sufficient time to implement other supply options in the interim.

2.5.2 Sensitivity of Projections

a) Climate Change

The Earth's climate has never been static and there have been small fluctuations in climate over centuries, larger ones over millennia and even greater ones over longer time spans. Climate data in Australia has only been directly recorded for less than 200 years and in that time there have been prolonged dry and prolonged wet periods and significant fluctuations in average temperatures. While the Federation Drought from 1895 to 1902 was the longest drought experienced by Orange in the past 200 years, that does not mean that it is the worst drought that has been or could be experienced under current climatic conditions.

There is irrefutable evidence that globally carbon dioxide levels and those of other "greenhouse" gasses have increased significantly in the Earth's atmosphere over the past 200 years. In that time, 10 of the past 13 years have been the hottest recorded. The Intergovernmental Panel on Climate Change (IPCC) states that the Earth's average temperature is increasing because of these greenhouse gases and forecasts that this will impact on the world's climate. While there are many computer models which forecast how various climate parameters such as temperature and rainfall may change in terms of averages and spatial and temporal distribution, there is wide variance in results.

The NSW Government has undertaken a pilot study to see how changes in climate might affect water supply secure yields and provided a guideline on what should be assumed will be the change in secure yield by 2030 (Samra and Cloke, 2010). The intention of the guideline is to strike a balance between prudent provision of water supply infrastructure which can accommodate a potential reduction in yield over the next 20 years without over investing in assets which may not be required.

Orange City Council applied the NSW Government Guideline methodology to its water supply system. The method assumes that secure yield is reduced by 8% by 2030 and there is a linear reduction between now and then.

Such changes in climate might not only result in a reduction in yield but a hotter or drier climate or more variable rainfall may also result in an increase in demand. The Centroc Water Security Study (MWH, 2009) provided an assessment of the possible impact of climate change on water demand. For Orange, this assessment indicated that potable water demand could increase by around 7% or about 400ML per year (in 2050).

As shown in Figure 7, the gap between current supply and future demand would widen in this scenario with the shortfall for a 50 year planning horizon being between about 3,800 and 5,400ML per year.

b) Additional demand management

As explained in Section 2.2.3, there are limited options for demand management in addition to those which have already been adopted. With the introduction of conservation pricing for residential areas it might be possible to reduce medium growth demand to 5,474ML per year by 2030 and 5,824ML per year in the same year should growth rates be high, a reduction of between 200 and 250ML per year.

The only other demand management option readily available would be to increase the frequency and/or severity of water restrictions to increase the secure yield of the system. This approach would represent a departure from NSW Government Best Practice Guidelines regarding prudent water planning. It also requires residents of Orange to accept using less water than most other communities in NSW bringing with it potential adverse social and economic impacts. Nevertheless, this option is considered further in Chapter 3.

2.6 SELECTING A TARGET YIELD

From the preceding discussion it is clear that the existing secure yield falls significantly short of current demand and that gap will grow over time.

It is also clear that there is uncertainty as to how quickly that gap might grow and it will be highly dependent on population growth, climate change and the effectiveness of demand management.

Orange City Council has a policy to have sufficient secure yield to meet demands in ten years' time so an increment of at least 1,000ML per year is needed just to meet this immediate target. However, it would be somewhat short sighted to augment supply to only meet 10 year forecasts and then almost immediately have to augment further.

Council has resolved that it needs to plan water supply augmentation to meet demands in 2060. This could range from an additional 2,700ML per year for medium demand growth with no climate change to 5,200ML per year with high demand growth and climate change.

Planning for an increment now of about 2,700ML per year would be sufficient until about 2037 under high demand growth and climate change which would provide enough time to track actual changes and have time to plan and implement an appropriate response should this scenario eventuate. This would be a manageable risk should the gap between yield and demand grow faster than expected.

Orange City Council has decided that a minimum yield augmentation of around 2,700ML per year needs to be planned for now with the ability to deliver at least 1,000ML per year almost immediately. This is considered to be an appropriate compromise between:

- closing the existing and immediately foreseeable gap between demand and secure yield
- meeting the 50 year planning horizon for medium demand growth projections under existing climatic conditions

- having sufficient time to organise further augmentation should the gap between secure yield and demand increase rapidly due to climate change or high population growth or both
- ensuring there is not an overinvestment in infrastructure within the 50 year planning horizon.

2.7 SUPPLY DIVERSITY

A further consideration in selecting an appropriate water supply strategy is the diversity of water sources. The greater the diversity of water sources, the more resilient the water supply is to the effects of:

- Water quality incidents
- Mechanical failure of water supply infrastructure
- Drought
- Climate change.

2.8 BENEFITS OF THE STRATEGY

Unless Orange immediately increases its secure yield the existing population and businesses face a high risk of frequent and severe water restrictions.

An appropriately augmented water supply would ensure that:

- the secure yield of Orange City Council's water supply system meets best practice for major urban centres
- the City would have adequate water to see it through a drought more severe than the worst recorded drought
- there is adequate future capacity in the system to have time to properly respond to rapid increases in demand or decreases in yield due to climate change or other factors in the future
- water supply security is not a constraint to the city's growth as a regional centre
- it will have water supply security equivalent to that of surrounding regional centres such as Bathurst and Dubbo.

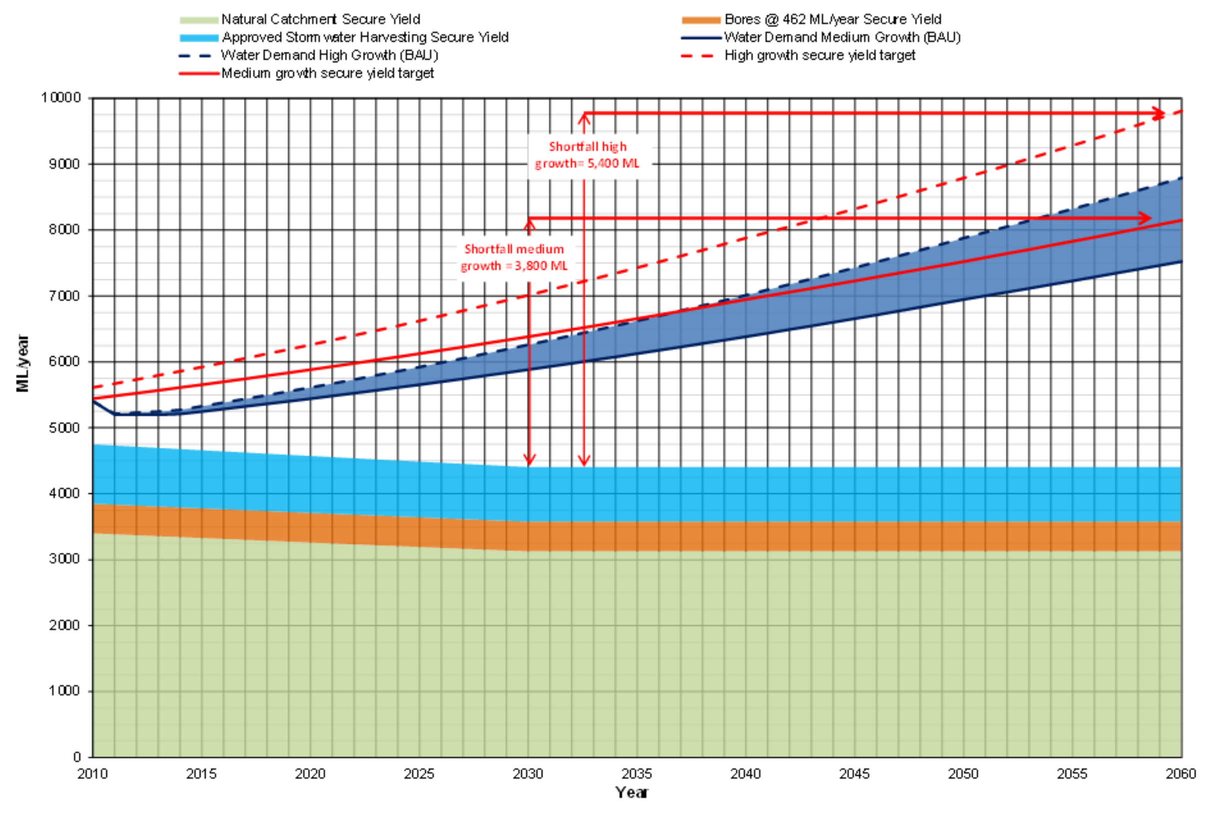

Figure 7 Water security for existing water supply infrastructure – with climate change

3 OPTIONS CONSIDERED

3.1 OVERVIEW

The Orange City Council Comprehensive Water Supply Management Strategy for Orange has as its strategic objective:

To establish a broad based water supply strategy for the next 50 years and beyond which focuses on ongoing water conservation, quality and demand management and the provision of key water supply infrastructure at least 10 years in advance of projected demand.

The ultimate aim of the strategy is to see fewer restrictions, improved security, and capacity for ongoing growth based on the following:

- A holistic/integrated approach which meets national water initiative requirements – essentially a balanced portfolio of realistic demand and supply options
- Achievable and very significant levels of demand management
- Achievable and very significant levels of user education
- Achievable and very significant levels of water system efficiency
- Proper inclusion of climate change and climate correction
- Proper analysis of yield, reliability and security compared to population and growth
- After consideration of the above, the identification of the need for further sources to meet growth and improve yield, reliability and security
- Identification of local and regional sources to take the city forward several decades with an appropriate cushion/contingency

The need for water supply augmentation and the size and timing of that augmentation has been determined by actioning the items listed above. The outcomes of those actions were described in Chapter 2 of this report.

As a result, the objectives of the water supply augmentation project can be summarised as:

- Meet best practice secure yield guidelines consistent with the 5/10/10 rule for the next 50 years
- Deliver a minimum of 2,700ML per year to meet expected demand to 2060
- Deliver a minimum of 1,000ML per year additional secure yield to close the immediately foreseeable gap between yield and demand
- Create a diversity of water supply sources which is resilient in times of drought
- Consist of components which can be delivered in the required timeframes
- Provide a strategy that can be adaptive to changes in demand/or yield if they are impacted by climate change

3.2 OPTIONS CONSIDERED FOR SHORTLISTING

There are two basic options available – reduce demand or increase supply. The following discusses briefly the full range of options considered and the reasons why some were dismissed and others shortlisted. Table 8 summarises the options and their shortlisting.

These options were developed as part of the Integrated Water Cycle Management (IWCM) Evaluation Study. The naming convention used in that study to identify options has been adopted here with the following prefixes applying:

D – Demand Management

RW – Rainwater Tanks

E - Effluent Treatment

GW – Groundwater

SH – Stormwater Harvesting

SW – Surface Water

R – Regional Infrastructure

O – Other Options

The IWCM Evaluation Study undertook a preliminary evaluation of a long list of options and created a shortlist for further evaluation. Table 8 summarises why options were not shortlisted.

Table 8: Options and shortlisting for more detailed investigation

ID	Option	Potential increase in secure yield (MLp.a.)	Short listed?	Considerations for not short-listing and other comments
D1	More frequent and longer restriction periods i.e. 10/5/10 rule	300	Yes	Not consistent with best practice but shortlisted for further evaluation
RW1	Rainwater tanks	300	Yes	
E1	IPR 1: Non-membrane system treating 10ML/day Note: IPR = Indirect Potable Reuse	3,400	No	NSW Office of water very unlikely to support an Indirect Potable Reuse (IPR) scheme without membrane technology as a barrier for public health reasons Sufficient effluent not available until at least 2030 (current estimated mine life)
E2	IPR 2: Membrane system treating 10ML/day	3,300	Yes	Option for beyond 2030 as sufficient effluent available to existing effluent supply agreement
E3	Using treated effluent to supplement flow and increase harvesting on Blackmans Swamp Creek	minimal	No	Limited by available supply Not substantially different to what is happening now
E4	Third pipe system to parks and gardens	<100	No	Very high reticulation costs into already developed areas Public health risk requires high level of treatment
E5	Wet weather flow capture at STP	<100	No	Only captures around 80 to 150ML/year of effluent High cost per ML Need to treat effluent before reuse
GW1	Increased pumping from existing bores	350	Yes	Although this was shortlisted, subsequent to the evaluation summarised in this report, a license was granted to operate this scheme and therefore it is effectively part of the existing water supply system.
GW2	New bores in Orange basalt zone	unknown	No	Basalt is too unpredictable as a groundwater source
GW3	Managed Aquifer Recharge (MAR)	Depends on inputs	No	Trial MAR investigation being undertaken as part of the Water Supply Management Strategy Information gained from the trial will be used to further assess MAR options
SH0	Blackmans Swamp Creek Stage 1b	200	Yes	
SH1	Blackmans Swamp Creek Stage 2	900	Yes	

ID	Option	Potential increase in secure yield (MLp.a.)	Short listed?	Considerations for not short-listing and other comments
SH2	Blackmans Swamp Creek Stage 3	1,000	Yes	
SH3	Upstream harvesting (Blackmans/Rifle Range Creeks south of railway)	200-400	No	Modelling indicated these systems could realise a secure yield increase in the order of 200 to 400ML/year once the catchment areas are fully developed Better considered as a longer term option that could tap into additional runoff created when these areas are developed
SW1	Raising Suma Park Dam	100-200	Yes	Additional storage likely to be needed to provide environmental flows
SW2	Lake Canobolas	100	No	Marginal secure yield increase (~100ML/year) Impact on recreational lake
SW3	Macquarie River pipeline	2,700	Yes	
SW4	Burrendong pipeline	3,400	Yes	
SW5	Mulyan Creek Dam	430	Yes	
SW6	Cadia Valley Operations water infrastructure	unknown	No	Infrastructure unlikely to be available until after approximately 2030
R1	Lake Rowlands	nil	Yes	This was originally shortlisted as it was under investigation as part of the Centroc Study. That study subsequently concluded that it has no capacity to augment water supply to Orange
R2	Molong Creek Dam	nil	No	Secure yield of Molong Dam approximately equal to the existing baseline demand. Therefore no spare capacity to provide supply to Orange
O1	Lucknow Mine	<100	No	Low yield – estimated at 100ML/year Risk of shaft collapse due to de-watering, water quality issues
O2	Browns Creek Mine	1,000	No	Estimated to provide up to 2-5ML/day, which would equate to an approximated secure yield increase of 1,000ML/year Possible impacts on surrounding groundwater tables and existing licence holders. Water quality issues
O3	Water carting	Short term only	No	Very expensive option considered as a 'last resort'
O4	De-silting Spring Creek Dam	<100	No	Estimated to only increase available storage by 150ML. No significant impact on the secure yield

3.2.1 Reduce Demand

As explained in Section 2.2.3, the demand management measures which Council has already adopted form part of the Comprehensive Water Supply Management Strategy and there are limited demand management measures available to significantly reduce demand. These have been included in the demand projection modelling and this is why per capita demand projections go down and counter population growth in the first few years and keep it lower than it otherwise would be.

The possible introduction of conservation pricing in residential areas has already been considered in the sensitivity analysis in arriving at the target yield augmentation.

There are limited further demand management options which can be implemented other than increasing the frequency and duration of water restrictions if a significant impact is to be made on secure yield.

Although best practice is to provide a water supply system which can operate to the 5/10/10 rule and the purpose of augmenting Orange's water supply is ensure it can achieve that benchmark, it was decided that the costs and benefits of operating to a different security standard should be considered.

A system which operates to 10/5/10 rule was investigated. It would have restrictions for up to 10% of the time and on average once every five years but the severity of restrictions would not exceed 10%. That is, they would be twice as frequent and twice as long as the Guideline suggests but they would be no more severe.

Option D1 – longer more frequent restrictions – was carried forward for more detailed analysis

3.2.1 Increase Supply

a) Distributed Supply

Rather than have a single large supply source, it is possible to increase supply through a multitude of small water collections and storage devices which deliver locally. The most common form of this is rainwater tanks and the possibility of installing 10,000 rainwater tanks across the city was considered.

RW1 – rainwater tanks on 70% of buildings (10,000) – carried forward for more detailed analysis

b) Treated Effluent

Orange Sewage Treatment Plant (STP) effluent can be reused and the level of treatment required depends on final use. It produces about 10ML on average each day or about 3,650ML per year which equates to a secure yield of 3,300ML per year through a membrane plant. This would be more than treble the immediately required secure yield augmentation and be sufficient to meet the longer term secure yield goal.

Currently the whole of its average 10ML/day is committed to Cadia mine. Under the contract, Orange STP must provide Cadia with all available effluent up to 10ML/day when the mine needs it. Council has a contracted right to any effluent in excess of 10ML/day and under 13ML/day but if it does not use this water it can be sent to the mine if required.

The mine's historical usage fluctuates but averages out at 8.2ML/day. While this suggests that 1.8ML/day (660ML/year) on average would have been available over last 15 years, the mine is entitled to the full amount, so this water cannot be relied upon in the future.

Furthermore, there are times when the full 13ML/day is required depending of actual production and availability of water from its other sources. Even if the mine's take were limited to 10ML/day, the average production from the STP would not exceed this until about 2032 under a medium growth scenario and 2026 under a high growth scenario. This is because as demand management measures take effect the total effluent production will decrease from the current 3,650ML per year to as low as 3,481ML per year.

Five different effluent usage options were considered which would use some or all of the effluent.

Option E1 would involve indirect potable reuse of the water without using membrane technology to treat the water before sending it to Suma Park Reservoir for mixing with the other water stored there. It is very unlikely that the NSW Office of Water and Health NSW would support indirect potable reuse with this level of treatment because of public health concerns.

Option E2 is the same as option E1 but with membrane technology providing the treatment. This is more likely to be acceptable to the regulatory bodies and the community but that is not guaranteed. The treatment process is currently very expensive and requires the further treatment and disposal of the reject brine.

Furthermore, until after 2030 there would be less than 600ML/ year available. It would not be viable to construct a small scale plant which could only be used intermittently when surplus effluent happened to be available.

E3 would involve using treated effluent to increase downstream flows in Blackmans Swamp Creek so that more upstream flows could be harvested. Again this is limited by the available supply and would not be substantially different to what is happening now. Other issues relate to the need for storage if the effluent is used to supplement during harvesting. Otherwise if it proposed as a constant release to make up for the increased volumetric extraction, it would provide an artificially permanent stream. Any discharge would also be subject to load based licence fees. Not enough information is known at this stage regarding what is best for the downstream aquatic ecosystem. An environmental flow study is currently being undertaken to determine how best to manage flows in the downstream creek system. This is considering the changes due to the raising of Suma Park Dam and stormwater harvesting. It is envisaged that this would inform how much harvesting can take place.

E4 considered the construction of a third water supply pipeline system dedicated to providing irrigation water to some parks and gardens. Even though this does not involve potable water use or even direct contact, health risks from indirect contact means that the water would need a high level of treatment and the capital cost of the additional reticulation system would give this option a prohibitively high cost per ML.

During wet weather, stormwater infiltrates or overflows into the sewerage system, resulting in excess flows which bypass some of the treatment processes. Option E5 looked at capturing these excess flows, treating them and feeding them into Suma Park Dam. This would require the same level of treatment as option E2 to be acceptable to regulators, would have to provide additional peak treatment capacity at the STP and would only yield about 80 to 150ML/year. This would make it more expensive per ML than option E2 and could therefore not be selected ahead of it.

Of the five effluent treatment options, only E2 was taken forward for more detailed evaluation although it is recognised that it cannot be considered until at least 2030 which means that it cannot contribute to the immediate yield increment target.

E2 – membrane treatment of effluent for indirect potable reuse after 2030 was carried forward for more detailed analysis. This would increase secure yield by 3,300ML per year.

a) Groundwater Sources

Council already had two bores installed which were extracting 75ML of groundwater which is fed into the raw water supply system.

One option (GW1) would be to pump more water from these and other existing bores. This had already been adopted as part of Council's Comprehensive Water Supply Management Strategy. This option was therefore shortlisted. Subsequent to the option evaluation which was undertaken, Council obtained a licence to operate this scheme so although it is discussed in the option evaluation, its actual operation is imminent.

Consideration was also given to sinking new bores in Orange basalt. This was option GW2. Basalt is too unpredictable as a groundwater source and it was not considered further.

All of the preceding groundwater options rely on rainfall and runoff naturally recharging the groundwater aquifers. An alternative is to manage the recharge of the aquifer by pumping excess water into it for later extraction. Option GW3 considered this and it is noted that it would be of limited benefit doing this if the water simply flowed out of the aquifer and was not available when needed. It has already been decided to trial managed aquifer recharge to better understand the capacity and behaviour of the local aquifer before it can be evaluated to augment the City's water supply. Even so, water for recharging the aquifer will need to be sourced from somewhere so an additional water supply would still be required with this option.

GW1 – increased pumping from existing bores – carried forward for more detailed investigation. This would increase secure yield by 350ML per year.

b) Stormwater Harvesting

The existing Blackmans Swamp Creek Stormwater Harvesting Scheme is the first stage of a three stage design. It is fully constructed but is currently only licensed to operate when Suma Park Reservoir drops below 50% capacity. Option SH0 is therefore to obtain approval for the scheme to operate when the Reservoir drops below 100% as it was originally designed. This option has been shortlisted and is referred to as Stage 1b in this report. It would increase secure yield by about 200ML per year.

SH1 is the second stage of the Blackmans Swamp Creek Stormwater Harvesting Scheme and consists of an off line wetland storage and changes to the pumps and operation of the main pump station from Stage 1. This would harvest stormwater from existing development and was therefore shortlisted. It would increase secure yield by 900ML per year

The third stage of the Blackmans Swamp Creek (BSC) Stormwater Harvesting Scheme is SH2 and requires a much larger harvesting weir at the location of the existing harvesting weir and additional pumping, treatment and transfer capacity.

Since this option was shortlisted the Draft Water Sharing Plan (WSP) for the Macquarie Bogan Unregulated and Alluvial Water Sources (NSW Office of Water, 2011) was placed on exhibition and it applies to the Summer Hill Creek water source. Clause 54(2) states:

A water supply work approval must not be granted or amended to authorise a new in-river dam in the following water sources:

(v) Summerhill Creek Water Source

This means that the proposed larger harvesting weir for BSC Stage 3 (SH2) could not be approved unless Ministerial approval was obtained. Other advice suggests that it would require an amendment to the WSP.

While these are significant impediments to approval, they do not necessarily mean that approval cannot be obtained. As this option would provide an additional 1,000ML per year of secure yield it was shortlisted for further consideration but it needs to be recognised that it may not be able to deliver this yield in the short term because of these significant approval challenges.

Option SH3 would involve further harvesting of stormwater on Blackmans Swamp Creek and Rifle Range Creek south of the railway line upstream of the existing urban areas. This could realise a secure yield increase of 200 to 400ML per year if the catchments were fully developed with urban infrastructure but much less under their current development. It was determined that this option would be more appropriately developed when those catchments are subdivided and the stormwater harvesting could be integrated with all of the other infrastructure works. It was therefore not considered further.

SH0, SH1 and SH2 – Blackmans Swamp Creek Stormwater Harvesting Scheme stages 1b, 2 and 3 respectively were carried forward for more detailed investigation.

c) Surface Water Sources

There are six surface water harvesting options within the Macquarie River catchment which were identified.

It should be noted that Chifley Dam, which is further upstream in the Macquarie catchment, was not considered as a source of water for Orange as it is required to meet the future secure yield of Bathurst. The Centroc Water Security Study determined that it was not feasible to run a pipeline from Chifley Dam to Orange.

Option SW1 is raising Suma Park Dam. As already explained, the full supply level in the reservoir can be increased by no more than 1m otherwise the structural integrity of the dam would be compromised. If the full supply level is increased by 1m at the same time then secure yield would be increased by 100 to 200ML per year. However, through the approval and licensing process, the current environmental flow rules for Suma Park Dam may be changed. If the change requires more environmental flow release, then the additional 100 to 200ML per year secure yield gained by raising the full supply level may be lost. As noted previously, there is an environmental flow study currently underway for Blackmans Swamp Creek which will inform this process.

Lake Canobolas is a small lake which is solely used for recreation. Option SW2 considered extracting water from the existing reservoir which would deliver about 100ML per year in additional secure yield but would significantly impact on its use as a recreational lake. It was therefore not carried forward.

Option SW3 is a 37km long pipeline from the Macquarie River north of the city. This would be able to add significant additional yield. It was initially assessed to be able to deliver an increment of 1,600ML per year but more detailed investigations revealed that up to 2,700ML per year could be delivered. A Macquarie River pipeline was therefore shortlisted.

Similarly, Option SW4 is a pipeline from Burrendong Dam which could add significant additional yield of 3,400ML per year so it too was shortlisted.

Option SW5 which involves a dam on Mulyan Creek could add a more modest secure yield increment (400ML/year) and it too was shortlisted.

There is existing water infrastructure at Cadia Mine which in theory would become available when the mine ceases operations. This was option SW6 but was not shortlisted because it is unlikely to be available until after 2030.

SW1 – Raised Suma Park Dam was carried forward for more detailed investigation.

SW3 – Macquarie Pipeline was carried forward for more detailed investigation.

SW4 – Burrendong Pipeline was carried forward for more detailed investigation.

SW5 – Mulyan Creek Dam was carried forward for more detailed investigation.

d) Regional Water Supplies

These involve interbasin transfers of surface waters from catchments other than the Macquarie.

Option R1 would be for Central Tablelands Water to augment the existing Lake Rowlands to a 26,500ML reservoir to supply water to a number of towns including Orange. This is a project which has been identified and subject to detailed investigation by the Central NSW Regional Organisation of Councils and was therefore shortlisted.

A review of the secure yield for Lake Rowlands was completed by NSW Water Solutions (November 2011) which showed that it would have a yield considerably lower than initially anticipated. Orange City Council concluded that when climate change risks are taken into consideration, there would not be sufficient secure yield available even with the enlarged dam, to provide secure water supply options for Orange.

Molong Creek Dam is another existing dam which was investigated as means of supplementing Orange's water supply. This was option R2. The dam's existing yield is fully committed with current demand so it has no capacity to supply Orange and was therefore not shortlisted.

R1 – Lake Rowlands was carried forward for more detailed investigation but was subsequently found to be unable to supply water to Orange.

e) Other Sources

Other options were also considered. For example, there are mines which have intercepted groundwater aquifers and provide ready access to these water supplies.

Option O1 is Lucknow Mine but its low secure yield of about 100ML per year, possible arsenic contamination and the high risk of mine collapse meant that it was not shortlisted.

Browns Creek Mine (Option O2) would provide a substantially greater secure yield at approximately 1,000ML per year but would have a high cost per ML increase in yield, could possibly impact on surrounding groundwater tables and existing water licence holders and has potential water quality issues. It was therefore not shortlisted

Option O3 is water carting which is a very expensive option which is only used as a last resort. This was not shortlisted.

Desilting Spring Creek Dam's storage could increase its capacity by 150ML (Option O4). An assessment was undertaken when Spring Creek Reservoir was lowered for dam upgrade works. This showed that this would have an insignificant impact on secure yield and that there would be significant logistical issues. Given these issues it was decided at the time not to go through the environmental approvals process. It would be even more expensive to do now because the dam is full. This option was therefore not shortlisted.

4 SELECTION OF PREFERRED OPTION

4.1 SHORTLISTED OPTIONS

Detailed descriptions of each of the shortlisted options can be found in Appendix B and are summarised in Table 9 with their key features.

The increment in secure yield delivered by each of the options ranges between 300ML per year and 3,400ML per year and they range from having no direct financial cost to costing nearly $100 million. This results in costs per additional ML secure yield of between $0 and more than $12,000.

4.2 OPTION EVALUATION

Council's 2009 Comprehensive Water Supply Management Strategy committed Council to:

- the identification of the need for further sources to meet growth and improve yield, reliability and security
- Identification of local and regional sources to take the city forward several decades with an appropriate cushion/contingency

Many of the shortlisted options have been the subject of investigations and evaluations over many years. Some of these have been undertaken by Council and some by others such as Centroc.

This section summarises the results of those investigations and how they have been used in evaluation and the selection of a preferred water supply strategy.

4.2.1 Multi-Criteria Analysis

a) Evaluation Criteria

Orange City Council has been progressing with the development of an Integrated Water Cycle Management (IWCM) Evaluation Study for the City. IWCM helps local water utilities manage urban water services collectively, not as individual components, saving resources and improving services to ratepayers.

IWCM is a structured process which the NSW Office of Water requires councils to follow. As part of the process a Project Reference Group is established to input community objectives into the IWCM process.

Three PRG meetings were held between May 2007 and November 2011 as part of Orange Council's IWCM process. The second and third meetings included a session in which participants provided inputs into a multi-criteria analysis of options for water supply augmentation for Orange.

Four groups of evaluation criteria were considered:

- Environmental
- Social
- Governance
- Economic

One of the options which Orange City Council committed to investigate as part of its Comprehensive Water Supply Management Strategy was a pipeline from the Macquarie River.

The NSW Government established a Taskforce for the Macquarie Orange Pipeline Project. The Taskforce is comprised of representatives from the relevant Australian and NSW Government Agencies including:

- Department of Premier and Cabinet (Chair)
- Australian Department of Sustainability, Environment, Water, Population and Communities
- Office of Environment and Heritage
- Department of Primary Industries (NSW Office of Water, NSW Fisheries and Forests NSW)
- Division of Crown Lands
- Department of Planning and Infrastructure
- Cabonne Council
- Orange City Council

In December 2011 the Taskforce met to participate in a multi-criteria analysis workshop to evaluate water supply options for Orange. The details of this workshop and the option evaluations undertaken in it are found in Molino Stewart (2012).

Table 9: Brief Description of Shortlisted Options

ID	Name	Secure Yield Increase (ML/year)	Capital Cost ($m)	Operating Cost ($m/year)	NPV over 50 years ($m 2010)	Features	Issues
D1	More frequent and longer restrictions	300	Nil	Nil	Nil	• 10/5/10 rule	• Community acceptance • Departure from Government best practice guideline • Equality between communities ·
RW1	Rainwater tanks	300	64.9	Nil	45.6	• 10,000 L rainwater tank system connected for outdoor and toilet use for 10,179 households • Installed progressively by council over period of 10 years	• Level of household uptake • Water quality risks
E2	IPR 2: Membrane system treating 10ML/day	3,300	57.9	4.3	105.7	• Membrane treatment plant with zero liquid discharge • Pump and pipeline system to transfer treated effluent to Suma Park Dam	• Effluent not currently available due to contract with Cadia Mines – unlikely before 2030 • Less than 10ML/day expected to be produced before 2025. • Water quality risk assessment • Approvals/licensing process • Community acceptance • Additional Council resources required due to higher level technology

ID	Name	Secure Yield Increase (ML/year)	Capital Cost ($m)	Operating Cost ($m/year)	NPV over 50 years ($m 2010)	Features	Issues
GW1	Increased pumping from existing bores	350	0.25	0.285	4.5	• Showground Bore (Gw803930) • Depot Bore (80BL24578) • Shearing Shed Bore (Gw049705) • Bore 5 (Gw049541) • Pipeline From Clifton Grove Bores To Suma Park Reservoir • Pipeline from Showground and Depot bores to Suma Park Reservoir	• Water quality risks • Licensed in March 2012 after some of the option evaluation work had been undertaken • Now operational
SH0	Blackmans Swamp Creek Stage 1b	200	nil	0.86	1.3	• Harvesting when Suma Park Reservoir is less than 100%	• Licensing • investigating Impact on flow regimes in Blackmans Swamp Creek and Summer Hill Creek • Water Quality Risk Assessment
SH1	Blackmans Swamp Creek Stage 2	900	5.71	0.32	10.8	• Off-line wetland upstream of the harvest weir • Controlled outlet from the wetland to the creek • Replacement of one existing pump from the existing main harvesting pump station with an 80 L/s pump	• Licensing • investigating Impact on flow regimes in Blackmans Swamp Creek and Summer Hill Creek • Does not promote diversity of water resources • Water quality risk assessment

ID	Name	Secure Yield Increase (ML/year)	Capital Cost ($m)	Operating Cost ($m/year)	NPV over 50 years ($m 2010)	Features	Issues
SH2	Blackmans Swamp Creek Stage 3	1,000	11.49	0.23	15.7	• Off-line wetland upstream of the harvest weir (stage 2) • Installation of low flow harvest pumps at the main harvesting pump station (stage 2) • Larger harvest weir across the creek • New access road to the Sewage Treatment Plant off Astill Drive • Upgrade to the existing batch pond treatment system and associated pump stations, including a packaged treatment plant for settling and filtration. • Duplication of the rising main from the batch ponds to Suma Park Reservoirand upgrade to the transfer pump station • Modification to power and control systems	• Current issues with obtaining permanent licence • Impact on creek system • Does not promote diversity of water resources • Water quality risk assessment – may be too much stormwater • Draft Water Sharing Plan would prohibit this unless special approval is given
SW1	Raised Suma Park Dam	100-200	3.55	Nil	3.6	• Increase height of dam wall to increase full supply level in reservoir by 1m	• This would trigger review of environmental flow release rules which may result in a nil sum gain in secure yield.

ID	Name	Secure Yield Increase (ML/year)	Capital Cost ($m)	Operating Cost ($m/year)	NPV over 50 years ($m 2010)	Features	Issues
SW3 *SW3G (with Govt grant)*	Macquarie River pipeline – Low Supply	1,600	47.00 (8.8 with Govt. grant)	0.54	46.9	• Preliminary river flow modelling • Extraction pump station on the Macquarie River north of Orange • Pipeline to connect the river pump station to Suma Park Reservoir • Booster pump stations and balance tanks along the pipeline route	• Macquarie River hydrology • No river extraction in low flow conditions • Operation to prevent significant impact • EA process • Water quality risk assessment
SW3HS *SW3HS (with Govt grant)*	Macquarie River pipeline – High Supply	2,700	47.00 (8.8 with Govt. grant)	0.728	49.1	• February 2012 river flow modelling • Extraction pump station on the Macquarie River north of Orange • Pipeline to connect the river pump station to Suma Park Reservoir • Booster pump stations and balance tanks along the pipeline route	• Macquarie River hydrology • No river extraction in low flow conditions • Operation to prevent significant impact • EA process • Water quality risk assessment

ID	Name	Secure Yield Increase (ML/year)	Capital Cost ($m)	Operating Cost ($m/year)	NPV over 50 years ($m 2010)	Features	Issues
SW4	Burrendong pipeline	3,400	102.69	1.35	89.3	• A pump station located downstream of the dam • Pipeline from pump station to Suma Park Reservoir(~ 78 km) • Booster pump stations and balance tanks along the pipeline route	• Need to obtain high security licence under WSP • Potential regional solution (Macquarie/Lachlan connection) • EA process • Land ownership along pipeline route
SW5	Mulyan Creek Dam	430	43.16	0.15	35.5	• 25 to 30 m high dam wall • Pipeline to Suma Park Reservoir • Environmental flows based on the 80/20 rule	• Environmental approvals • Land ownership • Low yield
R1	Lake Rowlands	972*	84.50	0.58	80.3	• Enlargement of Lake Rowlands Dam (Orange contributing 21% of capital costs) • Pipeline and transfer system	• Revised secure yield estimates currently indicate sufficient water is not available to make this a viable option • Environmental approval process for a new dam could be protracted • Management of regional water scheme

* this was a preliminary estimate used in the evaluations. In late 2011 investigations revealed that Lake Rowlands is not able to supply any water to Orange

This workshop considered all of the shortlisted options with the exception of Blackmans Swamp Stage 1b which was considered to be an option which would be approved subject to conditions which are currently being negotiated.

Furthermore, it included options within the Macquarie Pipeline option. It considered the originally estimated 1,600ML per year secure yield as well as a higher yield in the vicinity of 2,700ML. It also considered these two options fully funded by Orange City ratepayers through Orange City Council and options where a Federal and State Government Grant of $38.2m would pay for most of the project's capital cost.

The PRG evaluation criteria were used as a starting point to which were added the following additional criteria:

- Social
  - Opportunity for business to contribute to scheme costs
  - Impacts on availability of water to users outside the City
  - Equitability and acceptability
- Governance
  - Time to scheme being fully operational
  - Ability to commit to scheme in business model

The full list of environmental, social and governance (ESG) criteria used by the Taskforce are listed in Table 10.

Panel members then weighted these criteria based on their own individual consideration of the importance of each criterion in the decision making process. A weighting of 0 indicated that a criterion was irrelevant, 1 it was not very important, 2 it was of some importance, 3 it was moderately important, 4 it was quite important, 5 it was very important. From these weightings, minimum, mean and maximum weightings were calculated for each criterion. The results of these weightings are provided in Table 11

b) Multi-criteria analysis process

Panel members then reached consensus on the performance of each of the shortlisted options against each of the criteria. This was informed by the results of the various investigations, which are summarised for each option in Appendix B, as well as from their own knowledge of option performance where that was not covered in the options summaries.

Performance scores were generally given on a scale of 1 to 10 with 1 being the worst performance and 10 the best. While for some criteria assigned performance scores ranged from 1 to 10, for others the range was narrower. The economic criteria did not use a 1 to 10 scale but rather the net present capital and operating costs were used. The estimated performance scores for each option are also listed in Table 11.

The multi-criteria analyses were undertaken using the minimum, mean and maximum criteria weightings to see whether opinions about the importance of criteria made a significant difference to option rankings. Different multi-criteria analysis processes were also used to see whether the number of criteria and their grouping had an influence on option ranking.

Each process used the basic concept of weighted summation where option scores are multiplied by corresponding criteria weightings and the results summed for each option. The resulting weighted summation for each option then provided a relative ranking of options.

In the first weighted summation process all of the weightings within any one category (e.g. environmental) were summed and the scores for individual criteria divided by the sum. In this way a distribution of criteria weightings was developed which had the sum of all of the environmental criteria weightings adding to one and likewise the weightings for the social and governance criteria also added to one. Effectively this meant that in the evaluation there was a relative difference in the importance given to criteria within a group but as a whole environmental, social and governance criteria groups were given equal importance.

This process was run three times, using the minimum, mean and maximum weightings provided for each criterion. The results are shown in Table 12 and labelled ESG (environmental, social, governance).

Table 10: ESG Evaluation Criteria

Environmental Group	Description
Infrastructure footprint	This criterion rolls up the physical impacts on the environment: aquatic, terrestrial, heritage and land use (see protection of farming/horticulture). It considers the physical impact of doing the work.
Protection of water quality and flow values	How well does the scheme protect water quality? Impacts on flow regimes. This includes catchment management impacts.
Efficient use of water resource	Concept of cascading water use, water being used for appropriate use i.e. non-potable for industrial, outdoor use rather than potable. Using water that would otherwise be "wasted"
Enhancement of habitat values	Used as a measure of schemes that enhance habitat for example those that allow environmental flow release, constructed wetlands etc.
Carbon footprint/GHG	Requires calculation of carbon footprint for each option. Would limit this to power costs only and GHG calculation.
Resilience to climate change	To be assessed qualitatively. Impacts of climate change are location and system specific. Typically systems that have storage are more resilient compared to surface water systems. Deep groundwater extraction more resilient than shallow. If supply from river is guaranteed, it is more resilient than surface water systems. Effluent reuse resilient as using water already consumed.
Social Group	**Description**
Security and reliability of urban water service	Improvement in secure yield.
Equity and acceptability	Intergenerational and intragenerational equity. Includes concepts such as financial burden, cost effectiveness/affordability, (ovals vs. sporting fields etc.)
Aesthetics of water supply	Ability of the scheme to meet customer expectations for water supply.
Protect public health	Risk of scheme not providing water that is fit for purpose (i.e. Australian Drinking Water Guidelines for potable; reuse guidelines for non-potable). Also includes risk of water being used for wrong purpose i.e. non-potable for potable, raw for potable etc.
Change in TRB (typical residential bill)	Step change in TRB
Impacts on availability of water to users outside the City	How much water does the option take from other water users
Opportunity for business to contribute to scheme costs	To what extent can businesses contribute to scheme costs

Table 10 continued

Governance Group	Description
Management and control of water assets	Does Council maintain control of the scheme? Will outside factors influence operation of the scheme?
Level of service	How well does the scheme enhance the level of service?
Complexity of delivering scheme	Is the scheme capable of being implemented, is it realistic, what skills/capacity are required, legislative issues?
Capacity building	How well does the scheme help with community awareness of urban water issues/develop individual from consumer to participant?
Ability to commit to scheme in business model	Can the scheme cost be funded through the business model? Reflects prudent business management.
Time to Scheme being fully operational	How long does it take to become operational

Table 11: Taskforce Criteria Weightings and Option Scores

Criteria	Weighting			Option													
	Min	**Mean**	**Max**	**D1**	**SW4**	**SW5**	**SH2**	**RW1**	**E2**	**R1**	**SW3**	**SW3G**	**SW3HS**	**SW3HSG**	**SH1**	**SW1**	**GW1**
Infrastructure footprint	2	2.5	3	10	5	2	5	8	8	1	6	6	6	6	6	8	9
Protection of water quality and flow values	3	4	5	10	9	1	3	9	8	1	7	7	8	8	4	5	7
Efficient use of water resources	2	3.3	4	10	8	3	6	9	8	5	7	7	8	8	7	5	8
Enhancement of habitat values	1	2	3	5	3	1	3	5	5.5	2	3	3	3	3	5	1	3
Carbon footprint/GHG	2	2.7	3	10	1	8.1	8	10	1.4	3.8	3.5	3.5	3.5	3.5	7.6	10	5.1
Resilience to climate change	3	3.3	4	10	8	2	9	5	10	3	7	7	8	8	9	3	8
Security and reliability of urban water service	5	5	5	1	10	1.4	3	1	9.7	3	4.9	4.9	7.2	7.2	3.1	1	1.1
Aesthetics of water supply	1	3	4	10	9	8	9	9	7	9	7	7	7	7	9	9	8
Protect public health	4	4.8	5	10	9	8	8	6	7	8	9	9	9	9	8	9	7
Change in TRB (typical residential bill)	2	2.8	3	10	2.1	6.8	8.6	6.2	1	2.8	5.6	8.7	5.5	8.7	9.1	9.7	9.9
Opportunity for business to contribute to scheme costs	2	2.5	3	1	9	8	7	8	10	8	7	7	7	7	7	7	7
Impacts on availability of water to users outside the city	2	2.8	3	10	6	5	8	9	8	5	7	7	7	7	8	8	10
Equitability and acceptability	2	2.8	3	4	9	3	9	9	3	6	9	9	9	9	9	8	9
Management and control of water assets	2	2.8	4	10	8	10	8	1	9	5	9	9	9	9	8	9	9
Complexity of delivering scheme	3	3.8	4	9	6	1	5	8	3	3	5	5	5	5	5	7	7
Capacity building	2	3.2	5	10	5	5	7	9	8	5	5	5	5	5	8	5	5
Time to scheme being fully operational	1	2.5	3	10	7	5	5	7.5	1	4	9	9	9	9	7	9	9
Ability to commit to scheme in business model	2	3.5	4	10	5	3	6	3	3	2	10	10	10	10	9	10	10
NPV Capital Cost ($M)	4	4	4	0	76.5	33.9	12.2	42.2	54.9	73.9	41.4	8.0	43.3	9.9	6.0	3.1	0.3
NPV Operation and Maintenance ($M)	3	3.7	4	0	11.2	1.4	3.1	0	45.6	5.6	5.4	5.8	8.4	8.4	4.3	0	1.4

Table 12: Taskforce MCA Results

Evaluation Method	D1	E2	GW1	R1	RW1	SH1	SH2	SW1	SW3	SW3G	SW3HS	SW3HSG	SW4	SW5
ESG weighted summation - min weight	23.4	19.7	20.4	11.4	17.5	20.0	18.1	18.9	20.5	20.8	22.2	22.6	21.4	11.7
ESG weighted summation - mean weight	24.0	19.3	20.6	12.0	18.8	20.3	18.4	19.1	20.2	20.6	21.7	22.1	21.1	12.3
ESG weighted summation - max weight	24.1	19.4	20.7	12.2	19.0	20.3	18.4	19.2	20.1	20.4	21.4	21.8	21.1	12.4
Range of ESG rankings	**1**	**9**	**5/7**	**14**	**11/12**	**7/8**	**11/12**	**10**	**6/8**	**5/6**	**3**	**2**	**4**	**13**
QBL weighted summation - min weight	24537.0	0.2	12.5	0.1	0.4	1.9	1.2	6.1	0.4	1.5	0.4	1.2	0.2	0.3
QBL weighted summation - mean weight	24537.0	0.2	12.6	0.2	0.4	2.0	1.2	6.2	0.4	1.5	0.4	1.2	0.2	0.3
QBL weighted summation - max weight	24537.0	0.2	12.6	0.2	0.5	2.0	1.2	6.2	0.4	1.5	0.4	1.2	0.2	0.4
Range of QBL rankings	**1**	**12**	**2**	**12/13**	**8**	**4**	**6**	**3**	**8/9**	**5**	**8/10**	**6**	**12**	**8/11**
Simplified weighted summation - min weight	36.2	26.5	28.5	11.0	23.9	29.1	25.9	26.4	25.8	28.3	28.2	30.6	26.4	12.2
Simplified weighted summation - mean weight	51.4	33.7	39.5	15.7	34.7	40.4	35.3	36.8	35.0	37.8	37.7	40.5	35.5	16.5
Simplified weighted summation - max weight	61.2	40.3	45.5	18.4	41.5	47.5	41.0	41.9	40.2	43.0	43.2	46.0	41.1	19.2
Range of simplified weighted summation rankings	**1**	**11/12/7**	**4**	**14**	**8/10/12**	**2/3**	**9/10**	**7/8**	**11/12**	**5/6**	**5/6**	**2/3**	**8/9**	**13**

The capital costs and operating and maintenance costs of each option were estimated and reduced to a Net Present Value (NPV). The NPV is indicative of how much money would have to be provided now and invested to provide sufficient funds to build, operate and maintain the works over the life of the scheme. The use of NPV enables equitable comparison of schemes with low capital costs and high operating costs with those which have high capital costs and low operating costs.

The ESG Weighted Summation scores were then divided by the NPVs to arrive at a value for ESG/$m which enabled the options to be ranked taking into account environmental, social, governance and economic criteria. These are also shown in Table 12 for minimum, mean and maximum weightings and are labelled QBL (quadruple bottom line).

In addition, to test any possible bias resulting from giving equal weighting to the sum of each group of criteria, a simple weighted summation was carried out using the minimum, mean and maximum weightings but without grouping criteria. This process included the NPVs for capital cost and operating costs as two separate criteria. These results are also shown in Table 12 and are labelled Simplified.

c) Multi-criteria analysis results

The ESG analyses always ranked the first four options in the same order:

- D1 - longer water restrictions
- SW3HSG - Macquarie pipeline, high supply with a Government grant
- SW3HS - Macquarie pipeline high supply pipeline without the grant
- SW4 - Burrendong Dam pipeline.

Lake Rowlands was consistently the lowest ranked option with Mulyan Creek Dam only being ranked marginally higher.

This indicates that the rankings of the top four and bottom two options are not sensitive to the range of importance placed on the various criteria by the taskforce members. The other options were sensitive to weightings as their relative rankings shifted slightly depending on which set of weightings were used.

When the costs were applied to the ESG results to derive the QBL results, D1 continued to be consistently top ranked because it has no cost but some significant changes occurred in the rankings with:

- GW1 – groundwater bores always ranked second
- SW1 – Raised Suma Park Dam always ranked third
- SH1 - Blackmans Swamp Creek Stage 2 consistently ranked fourth
- SW3HSG – Macquarie pipeline high supply with grant ranked fifth
- SW3 – Macquarie pipeline with low supply with grant ranked sixth.

This suggests that these options deliver the best value for money and their rankings are not sensitive to the importance placed on the non-financial criteria.

Lake Rowlands was consistently the lowest ranked option in these analyses. The rankings of other options were sensitive to the importance placed on the various evaluation criteria.

When the simplified weighted summation results are considered:

- D1 was again consistently the highest ranked
- SW3 HS with the grant and SH1 were ranked either second or third depending on the weightings placed on evaluation criteria
- GW1 was always ranked fourth
- SW3 with the grant and SW3 HS without the grant were either fifth or sixth, depending on the weightings on the evaluation criteria.

This analysis ranked Lake Rowlands lowest and Mulyan Creek dam second lowest irrespective of the criteria weightings.

Consideration of the results from all of the various multi-criteria analyses reveals the following:

- D1 Longer Water Restrictions are the highest ranked in any analysis
- R1 Lake Rowlands and SW5 Mulyan Creek Dam are always very lowly ranked with scores much lower than other options
- SW3 Macquarie Pipeline always ranks higher with a grant than without a grant but the difference in performance scores is not very significant when economic criteria are excluded in ESG analysis

- SW3 the relative ranking between Macquarie Pipeline options with high and low supply is sensitive to the evaluation methodology but generally the low supply Macquarie pipeline without a subsidy is the lowest ranked of these four options
- E2 IPR membrane plant is generally lowly ranked, particularly when economic criteria are included
- GW1 groundwater bores is generally higher ranked or has a similar score to SH1 – Blackmans Swamp Stage 2
- Blackmans Swamp Stage 2 always ranks higher than Stage 3.
- RW1 Rainwater tanks are always in the bottom half of the rankings
- SW4 Burrendong Pipeline is generally in the bottom half of the rankings and is always more lowly ranked than SW3 Macquarie Pipeline High Supply.

a) Elimination of Options

Since the preceding analyses were completed, two things have happened.

Investigations have shown that Lake Rowlands is unable to supply any water to Orange. Since all of the analyses gave this option the lowest ranking when it was considered that it may be able to supply nearly 1,000ML of secure yield, it is clear that this option needs to be eliminated from any further consideration.

The second thing which occurred is that option GW1 was licensed in March 2012. The multi-criteria analyses confirm that this is an economically worthwhile option as it ranked highly in all of the analyses which included economic evaluation criteria.

It does not need to be considered further because it has been taken into account in the calculation of required yield increments discussed in Chapter 2.

4.3 JUSTIFICATION OF THE PREFERRED OPTION

4.3.1 Meeting Objectives

The objectives of the water supply augmentation project are:

- Meet best practice secure yield guidelines consistent with the 5/10/10 rule for the next 50 years
- Deliver a minimum of 2,700ML per year to meet expected demand to 2060
- Deliver a minimum of 1,000ML per year additional secure yield to close the immediately foreseeable gap between yield and demand
- Create a diversity of water supply sources which is resilient in times of drought
- Consist of components which can be delivered in the required timeframes
- Provide a strategy that can be adaptive to changes in demand/or yield if they are impacted by climate change

The various multi-criteria analyses which have been undertaken provide informative, relative rankings of options. However, options, or combinations of options need to meet the project objectives as a minimum.

a) Best Practice Yield Security

In all of the multi-criteria analyses Option D1, more frequent water restrictions, ranked highest particularly because it is an immediately implementable, zero cost option. However such an option can have hidden economic and social costs which are not picked up by such analyses. For example Orange is close to both Dubbo and Bathurst which have more secure water supplies and operate to the standard 5/10/10 rule for water restrictions.

Were Orange to adopt a rule which imposed restriction more frequently and for longer periods, it is possible that businesses and residents will find these other cities more attractive and Orange will not reach its economic growth potential. It could also be argued that it would be socially inequitable for Orange's residents and businesses to have to operate under more severe water restrictions than those in neighbouring cities.

Furthermore, this option can only close the gap between demand and secure yield by about 300ML per year and so will need to be combined with other options. One of the conditions of the funding grant offered by the State and Federal governments for the Macquarie River Pipeline is that Orange City Council adopts best practice. Were it to adopt anything less than the 5/10/10 rule it would be ineligible for grant funding.

It is for these reasons that Orange City Council has adopted the standard 5/10/10 rule and ability to meet that rule is one of the project objectives.

Since Option D1 is unable to meet that objective, it cannot form part of the water supply augmentation strategy.

b) Secure Yield Targets

The yield targets in the objectives must also be met. It has been assumed that Stage 1b of Blackmans Swamp Creek will be approved by 2013/14. Since it only requires a change in operating rules, it will be able to provide a yield increment of 200ML per year immediately it is approved.

This means that at further 2,500ML per year needs to be found to meet the 2,700ML per year target. It also means that 800ML per year needs to be able to be delivered as soon as possible.

i) Single Option

Of the shortlisted options, only the Macquarie River Pipeline with High Supply, the Burrendong Dam Pipeline and Indirect Potable Reuse with Membrane Effluent Treatment can meet the 2,500ML per year long term target on their own. Since the latter cannot be implemented until at least 2030, it cannot be considered as a single option but must follow other options.

Even the 800ML per year immediate target can only be met by these aforementioned single options or the Macquarie River Pipeline with Low Supply or Blackmans Swamp Stages 2 or 3. Since the latter can only be constructed after stages 1 and 2 are completed it cannot be considered as a single option. Blackmans Swamp Stage 2 is therefore the only additional sole means of closing the immediate yield shortfall but it would fall well short of the longer term target.

This means that for the options other than the Burrendong or Macquarie pipeline options, to be considered as part of the water augmentation strategy they have to be combined with other options to meet the required project target yield and, in most cases, just to meet the immediate yield gap.

ii) Option Combinations

If a combination of options is to be chosen then it is logical that the options should be implemented in order of their rankings from the multi-criteria analysis.

Following this logic, Raising Suma Park Dam would be the first option which should be implemented. This would deliver a maximum increment in secure yield of 200ML per year which is only 25% of the remaining immediate gap after Blackmans Swamp Stage 1b is operational.

The next highest ranked option which could be combined with this would be Blackmans Swamp Creek Stage 2. This would add a further 900ML per year taking the total secure yield increment to 1,100ML per year. Although this would close the immediate gap, this combination would still deliver less than 50% of the required yield increment.

The completion of Blackmans Swamp Creek Stage 3 and the installation of rainwater tanks would increase the secure yield increment to a total of 2,400ML per year. Thus raising Suma Park Dam, completing all three stages of Blackmans Swamp Creek and installing rainwater tanks would all have to be done to get close to the secure yield increment target.

Since the low supply Macquarie pipeline ranked higher than Blackmans Swamp Creek Stage 3 and rainwater tanks in many of the analyses it would be possible to create a scheme where this provided the required yield increment in addition to that provided by Suma Park Dam and Blackmans Swamp Creek stages 1b and 2. This scheme would provide a secure yield increment of 2,700ML per year. However, the Macquarie Pipeline with low supply would involve the same infrastructure as the high supply option; it would simply be operated less frequently. Thus this option would effectively be construction of the high supply Macquarie Pipeline after Blackmans Swamp Creek Stage 2 but with lower operating costs over the planning timeframe.

The only remaining option not considered in this combination is Mulyan Creek Dam. However, as this was consistently the second lowest ranked option it would have to be the last option considered in any such strategy. At best it could be built instead of installing the rainwater tanks in which case the combined option would increase yield by 2,530ML per year.

If effluent reuse is to form part of the longer term strategy after 2030, then a 2,000ML per year increment in secure yield needs to be provided in the interim. This would require Suma Park Dam to be raised and Blackmans Swamp Creek Stages 2 and 3 to be completed.

iii) Schemes for Comparison

Table 13 summarises the schemes which would provide the necessary secure yield increment and the timing when each component would need to be installed. The year in each cell reflects when each component would need to be operational to provide a secure yield that is 10 years in front of the projected high growth demand (where possible). For completeness it includes the timing and yield delivered by the operation of Blackmans Swamp Creek Stage 1b.

None of the schemes listed in the table include the raising of Suma Park Dam since it would only be required as part of Scheme 5 to meet the minimum yield requirement. However, as it ranks highly amongst the options and it would be most cost effective to undertake the raising while the dam safety works are being undertaken, each scheme has been considered with and without Suma Park Dam raising in further analyses.

A further refinement was also made to the Burrendong Pipeline Option at this stage. It was reduced to a 2,800ML per year project so that it was more directly comparable to the Macquarie Pipeline Option. As with the Macquarie Pipeline, the capital costs remain the same irrespective of the annual secure yield but the operating costs reflect the amount of water which needs to be pumped each year to meet that secure yield.

In summary the Schemes are Blackmans Swamp Creek Stage 1b plus:

- Macquarie Pipeline (Scheme 1)
- Macquarie Pipeline followed by Blackmans Swamp Creek Stage 2 (Scheme 2)
- Blackmans Swamp Creek Stage 2 followed by Macquarie Pipeline (Scheme 3)
- Burrendong Pipeline without a State Government grant (Scheme 4A)
- Burrendong Pipeline with a State Government grant (Scheme 4B)
- Blackmans Swamp Creek Stages 2 and 3 followed by rainwater tanks (Scheme 5)
- Blackmans Swamp Creek Stages 2 and 3 followed by indirect potable reuse of membrane treated effluent (Scheme 6)
- Indirect potable reuse of membrane treated effluent (Scheme 7)
- Blackmans Swamp Creek Stage 2 followed by indirect potable reuse of membrane treated effluent (Scheme 8)

The column indicating grant funding availability is explained in the following section.

4.3.2 Value for Money

Each option has different construction, operating and maintenance costs and the increment in secure yield which they deliver varies. One way of determining value for money delivered by each option is to divide its total cost by the number of ML increment in secure yield it delivers to derive a figure of $/ML increment in secure yield.

This was done for each of the options and the results are compared in *Figure 8*. It took into account the timing of each scheme component and was based on a net present value (NPV) calculation over 50 years at a discount rate of 7%.

Effectively an NPV calculation estimates how much money would need to be invested now at 7% interest to have enough money to pay for the various capital works and annual operating and maintenance costs as they fall due over the next 50 years.

This shows that the Macquarie Pipeline with a grant and Stage 1b of Blackmans Swamp Creek would deliver the best value for money at $408/ML and $428/ML respectively. Stages 2 and 3 of Blackmans Swamp Creek would cost incrementally more at $812/ML and $1,061/ML delivered. The next most expensive would be raising Suma Park Dam at $1,202/ML and then the Macquarie Pipeline without a grant at $1,232/ML.

Table 13: Possible Schemes

Scheme	**Govt. Grant?**	**Blackmans Harvesting Stage 1b**	**Blackmans Harvesting Stage 2**	**Blackmans Harvesting Stage 3**	**Macquarie River Pipeline**	**Burrendong Pipeline**	**Rainwater Tanks**	**Indirect Potable Reuse**	**Extra Secure Yield Provided by Scheme ML/yr**	**Total Secure Yield ML/yr**
Scheme 1	Yes	2013/14		-	2014/15	-	-	-	3,000	7,650
Scheme 2	Yes	2013/14	2044/45	-	2014/15	-	-	-	3,900	8,550
Scheme 3	No	2013/14	2016/17	-	2018/19	-	-	-	3,900	8,550
Scheme 4A	No	2013/14	-	-	-	2015/16	-	-	3,000	7,750
Scheme 4B	Yes	2013/14	-	-	-	2015/16	-	-	3,000	7,750
Scheme 5	No	2013/14	2016/17	2021/22	-	-	2034/35	-	2,400	7,150
Scheme 6	No	2013/14	2016/17	2021/22	-	-	-	2030/31	5,400	10,150
Scheme 7	No	2013/14	-	-	-	-	-	2015/16	3,500	8,250
Scheme 8	No	2013/14	2016/17	-	-	-	-	2030/31	4,400	9,150

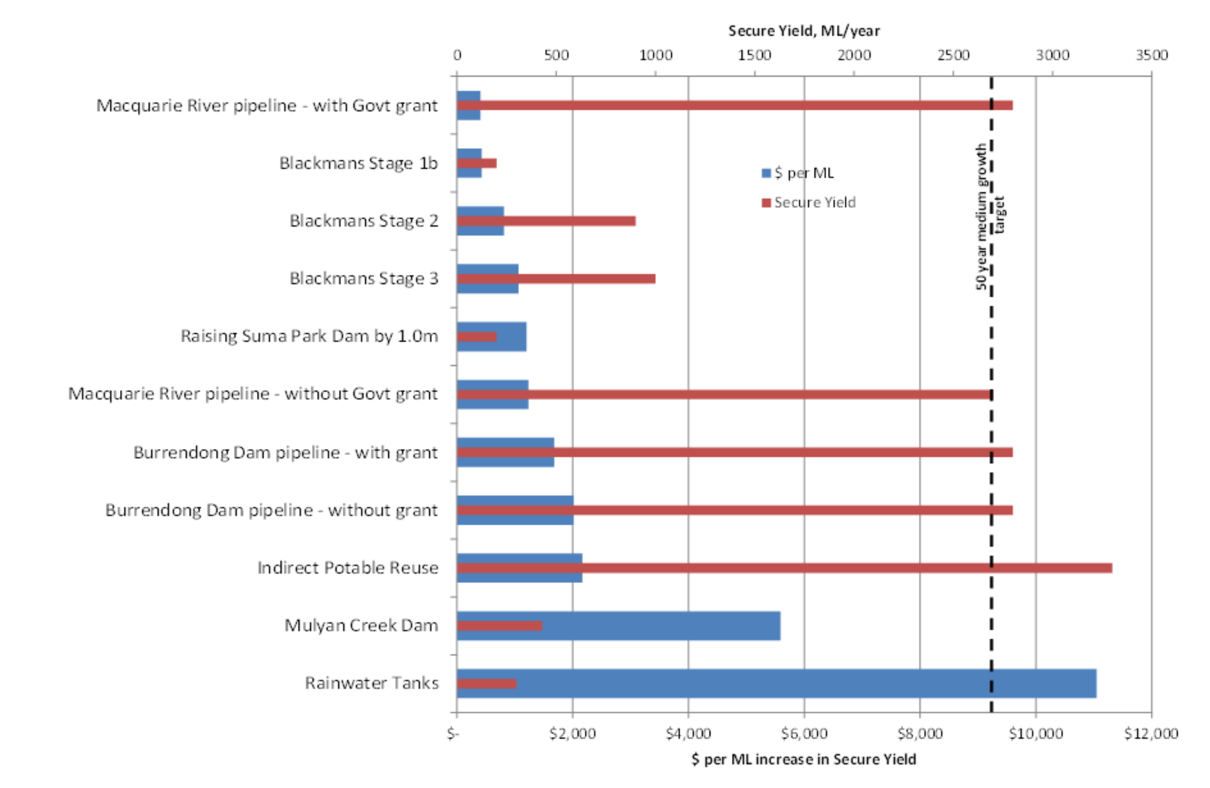

Figure 8: $/ML increase in secure yield

A pipeline from Burrendong Dam was assessed with and without an $18.2 million dollar State Government grant. It was considered that it may be possible to use the grant for this scheme given that it is drawing water from the Macquarie River just as the Macquarie Pipeline would. It was assumed that no Federal Government grant would be available for the Burrendong option. The Burrendong Pipeline would cost between $1,681/ML and $2,017/ML depending on whether or not the grant could be obtained.

Indirect potable reuse was assessed to cost about $2,168/ML, Mulyan Creek Dam $5,588/ML and Rainwater Tanks about $11,044/ML. The figures support the order in which options are proposed to be implemented in the various schemes set out in Section 4.3.1 with the best value for money options being implemented before those which would cost more for the increment in yield delivered.

4.3.3 Affordability

Another consideration in selecting a preferred option is to consider the affordability of the options. The schemes which can meet the required yield targets have different cost profiles and while each may deliver sufficient water, if it cannot be paid for it is not a practical option.

The NSW Office of Water uses the Typical Residential Bill (TRB) to compare the cost effectiveness of water supply utilities across the state so it is a useful method of comparing the affordability of different schemes. Figure 9 shows the increase in the TRB which would result from implementation of each of the schemes listed in Table 13.

The analyses include consideration of whether or not the Federal and State Government grant of $38.2m is available to fund the construction of the Macquarie River and whether the State Government Grant of $18.2m is available for Burrendong Dam. Clearly the provision of grants makes a significant difference to the affordability of schemes because this proportion of the scheme costs does not have to be passed on to customers.

It was assumed that Orange City Council would lose the State and Federal Government grant if the Macquarie pipeline project was delayed beyond 2014. This would mean that the grant would only be available for Schemes 1 and 2. Even though Scheme 3 includes the Macquarie Pipeline, the pipeline would not be required until 2018/19 and by then funding would not be available.

It was assumed that no Federal Government grant would be available for the Burrendong option (Scheme 4) and that the State Government Grant would only be available until 2014.

The various water supply schemes were evaluated using a Typical Residential Bill (TRB) analysis. This took into account the timing of each scheme component and was based on a net present value (NPV) calculation over 50 years at a discount rate of 7%.

The TRB analysis then estimates how much the typical residential dwelling would have to pay each year over and above what it currently pays for water to cover the cost of the additional water supply. It was assumed that there would be a 0.8% pa growth in the number of residential dwellings. The results are summarised in Figure 9. All results are in 2011/2012 dollars.

Each scheme was assessed with and without raising Suma Park Dam. Raising Suma Park Dam was assumed to add a further 150ML per year secure yield and was estimated to add $9 to the TRB for all options.

These analyses show that Scheme 1, the Macquarie Pipeline alone is the most affordable and would add about $53 to the TRB. Scheme 2, which would be Scheme 1 followed by Blackmans Swamp Creek Stage 2 in 2044/45 would add about $56 to the TRB.

However, should Blackmans Swamp Creek Stage 2 be constructed in advance of the Macquarie Pipeline, the TRB would increase by about $146. This highlights the value of the Federal and State Government Grants to scheme affordability.

Schemes 5 and 8, which respectively involve building Blackmans Swamp Creek Stage 3 with rainwater tanks and Indirect Potable Reuse, would be more affordable than Scheme 3. Scheme 5 would add $91 to the TRB and Scheme 8 $126.

Delaying Indirect Potable Reuse until after Stage 3 of Blackmans Swamp Creek (Scheme 6) would add $150 to the TRB.

Both Burrendong Pipeline schemes are quite expensive adding $212 to the TRB if a grant is available and $269 if it is not.

The most expensive option would be to undertake indirect potable reuse immediately. This would add about $288 per year to the TRB.

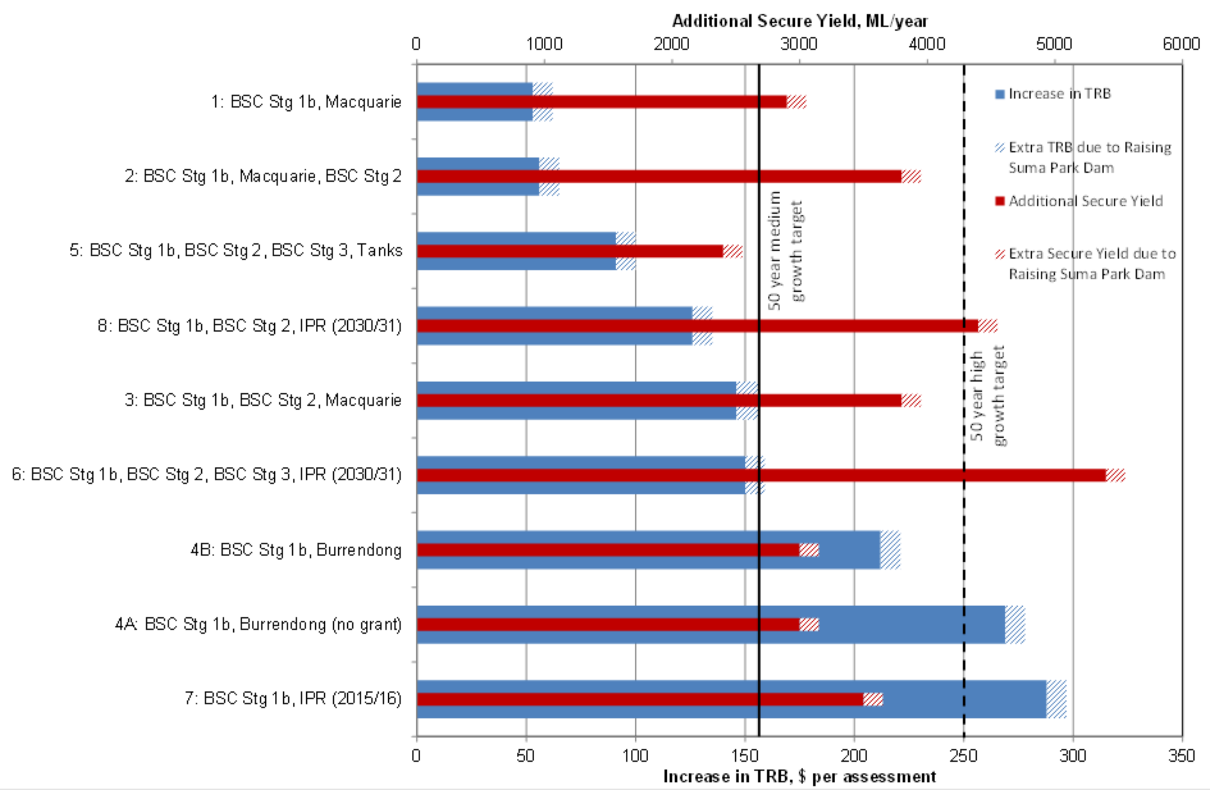

Figure 9: Average $ per annum increment on TRB

4.3.4 Preferred Option

The high yield Macquarie Pipeline option was ranked higher than the Burrendong Pipeline option in all of the multi criteria analyses where the two were both considered. When both are considered as 2,700 to 2,800ML per year schemes they have similar operating costs but the Macquarie Pipeline is about half the length and has less pumping stations and therefore has a significant lower capital cost.

Consequently the Macquarie Pipeline costs less per ML increase in secure yield and has a significant lesser impact on the TRB with or without the Federal and State Government grant. This suggests that it would always be preferable to proceed with the Macquarie Pipeline option over the Burrendong Pipeline option.

Of the schemes which involve a combination of options, all require the completion of Blackmans Swamp Creek Stage 2 as a minimum. This would have an impact on flows in Blackmans Swamp Creek and this is a matter of contention within the community which has delayed the implementation of Stage 1b.

These protracted negotiations over the past few years suggest that there is no certainty that approval will be given to Stage 2. Raising Suma Park Dam would also have implications for flows in Blackmans Swamp Creek. If Stage 2 does get approved and Suma Dam does get raised, it is possible that the environmental flow requirements imposed upon the schemes may mean that the increment in secure yield which they deliver could be lower than has been calculated and used in this report.

Assuming that these scheme components can go ahead, they need to be supplemented with other water supply components.

If they are to be supplemented with the Macquarie Pipeline it is cheaper to build the Macquarie Pipeline first because of the availability of the grant money. Once it is built, then Blackmans Swamp Creek Stage 2 would only be needed if the gap between yield and demand grows faster than the 2,700ML per year target over the next 50 years.

If Blackmans Swamp Creek Stage 3 is chosen as the increment to supplement Stage 2 then additional components will still be needed. Suma Park Dam raising and Rainwater Tanks would create Scheme 5 which would fall just short of the 50 year target yield. This however would be $26 per year less expensive on a TRB than Scheme 8 which would involve indirect potable reuse.

However, Scheme 8 is by far the least expensive of the Schemes involving indirect potable reuse.

Blackmans Swamp Creek Stage 3 out ranked Indirect Potable Reuse in all of the multi-criteria analyses and when the TRB is also considered it would also be preferable to implement Stage 3 ahead of Indirect Potable Reuse.

Approval for Stage 3 is likely to be very difficult to secure given the difficulties experienced in implementing stages 1b and 2 and the restrictions which would be imposed by the recently exhibit draft water sharing plan. However, there is also currently strong community and government resistance to indirect potable reuse so it would also be very difficult at this time to secure approval for such a scheme.

In the multi criteria analyses the relative ranking of Blackmans Swamp Stage 3 and the Macquarie pipeline varied depending on the weightings given to evaluation criteria, the analysis method used, the yield supplied by the pipeline and whether a grant was available for the pipeline or not. However, the pipeline always ranked higher than the other options which would have to be combined with Blackmans Swamp Creek Stage 3 to deliver the required yield.

The TRB analysis also shows that the Macquarie Pipeline with the grant would be much more affordable than schemes involving Blackmans Swamp Creek Stage 3. The Macquarie pipeline with a grant also provides the best value for money per ML increment in secure yield.

Given the uncertainties around Blackmans Swamp Creeks stages 2 and 3, and the lesser impacts on TRB by constructing the Macquarie Pipeline while the Federal and State Grant is available, the Macquarie Pipeline option is the preferred option for meeting Orange's future water supply needs.

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APPENDIX A

DEMAND MANAGEMENT ASSUMPTIONS

Assessment of Future Water Demand

Model

The DEUS Demand Management Decision Support System (DSS) version S1.1 was used by Geolyse Pty Ltd to provide a water production demand forecast and evaluation of demand management measures.

Demand Forecast

Baseline Demand

Baseline demand forecast assumes no demand side management measures are in place. It provides a worse case demand scenario.

Impact of Demand Management Measures

Following on from the outcomes of the historical water production and baseline consumption analysis, a number of demand management measures built into the DSS model were evaluated to assess their impact on total and peak water demand.

Three combinations of demand management measures were assessed using the DSS model (refer **Table 1**). As described below, each combination builds on the previous level. The assumptions for each level of demand management are summarised in **Table 2**.

Peak Day Water Production

The peak day water demand is calculated in the DSS model using a peak to average ratio derived from actual water production data. The daily water production data shows that the peak day to climate corrected daily demand ratio is approximately 2.2:1 for Orange and 2.1:1 for Lucknow and Spring Hill.

Table 1 – Demand Management Scenario Levels

Level	Description	Options included in the DSS model
1	Low level demand management	Baseline[(1)] plus: National water efficient labelling scheme (WELS) Community education programs Residential showerhead retrofit program Fixture code – taps and showers on all new developments; this represents the fixture efficiency component required by BASIX Non-residential water audits
2	Medium level demand management = Business as Usual	Level 1 plus: Alternative water supply to dual reticulation area Permanent water conservation measures
3	High level demand management	Level 2 plus: Conservation pricing for residential users

(1) The adopted baseline per capita water demand accounts for water savings achieved through Council's leak and pressure reduction program completed in 2009. Therefore no demand management scenario included the loss management option available in DSS.

Table 2 – Demand Management Options and Assumptions

Option	Assumptions (1)	
	Market Penetration	**Potable Water Savings**
Implementation of national water efficient labelling scheme (WELS) 2005 saw the introduction of a mandatory Water Efficiency Labelling Scheme (WELS) for toilets, washing machines, shower roses, taps, urinals and dishwashers.	Assumed to impact on residential customers only; increase the uptake of efficient washing machines by 5% and low flow showerheads by 15%. No impact assumed on toilets because the level of participation in the existing voluntary scheme is high.	Based on average use reductions of: 20% for taps; 30% for dishwashers; 30% for washing machines; and 30% for efficient showerheads.
Community education programs Council would provide materials, training and technical assistance to implement a comprehensive ongoing community education program.	20% of all customers in each category influenced by the community education effort.	Water savings vary dependent on the customer category and end use.
Residential showerhead retrofit program Upon request, a Council approved plumber would install a retrofit kit in existing single family residential housing. The kit would include a low-flow shower head.	15% of customers over a three year period.	Based on average use volumes for each type of shower; and 5% of participants in the program are free-riders.

Table 2 – Demand Management Options and Assumptions

Option	Assumptions[1]	
	Market Penetration	**Potable Water Savings**
Fixture code – taps and showers on all new developments. The fixture efficiency component of the NSW Government BASIX program will be implemented.	90% of new residential accounts complying.	20% reduction in use in showers, taps and sinks and outdoor use.
Non-residential water audits This measure allows for water audits for non-residential customers.	10% of non-residential customers participating.	10% saving in non-leakage consumptions per customer 75% reduction in customer leakage - but saving only lasts two years
Dual Reticulation for New Subdivisions All new subdivisions to be fitted with dual reticulation systems with recycled water to be used for toilet flushing and irrigation.	Medium growth – 70% of all new residential developments. High growth – 45% of all new residential developments.	70% reduction in targeted end uses.

Table 2 – Demand Management Options and Assumptions

Option	Assumptions[1]	
	Market Penetration	**Potable Water Savings**
Permanent water conservation measures Council would introduce a water use regulation that would: prohibit irrigation during the times of the day with the highest evaporation; mandate the use of a trigger nozzle when washing cars; and prohibit irrigation that fell on hard surfaces or hosing down of footpaths or driveways.	50% of all customers would adhere to the regulation.	10% reduction in external use in participating customers.
Conservation pricing for residential users Council would introduce a water pricing policy that would increase the water consumption charge as water supplies dropped below critical levels.	All customers would be affected.	10% saving in external use 5% saving in internal use Price elasticity for external use is -0.2 Price elasticity for internal use is -0.05

Source: (1) DEUS (2006) with any modifications noted

APPENDIX B

OPTION DETAILS

Option SW3: Macquarie River Pipeline

Description

The option of a pipeline from the Macquarie River to Orange was first considered in the Centroc Water Security Study. This study recommended that, in the long term, Orange be connected via pipeline to the Central Tablelands Water system and supplied from an augmented Lake Rowlands dam. The option of a pipeline from the Macquarie River to Orange was not shortlisted as part of the preferred regional water security network as further information or investigation was required and better regional solutions were available. It was recommended that it be considered as a contingency action for emergency situations.

Council resolved in 2009 to continue investigation of the Macquarie River to Orange pipeline through completion of feasibility and concept studies. Council was successful in obtaining $38.2 million of Federal and State government funding to support the project. The Macquarie River pipeline option is currently the subject of ongoing engineering and environmental investigations as part of the design, assessment and approval process. This summary provides an overview of the Macquarie River pipeline system, its operation (as it is currently proposed) and an assessment of its impact on Orange's water security.

The Macquarie River pipeline is a technically straight forward water supply option. It involves:

- an extraction pump station on the Macquarie River north of Orange;
- a pipeline to connect the river pump station to Suma Park Reservoir (approximately 37 km); and
- booster pump stations and balance tanks along the pipeline route.

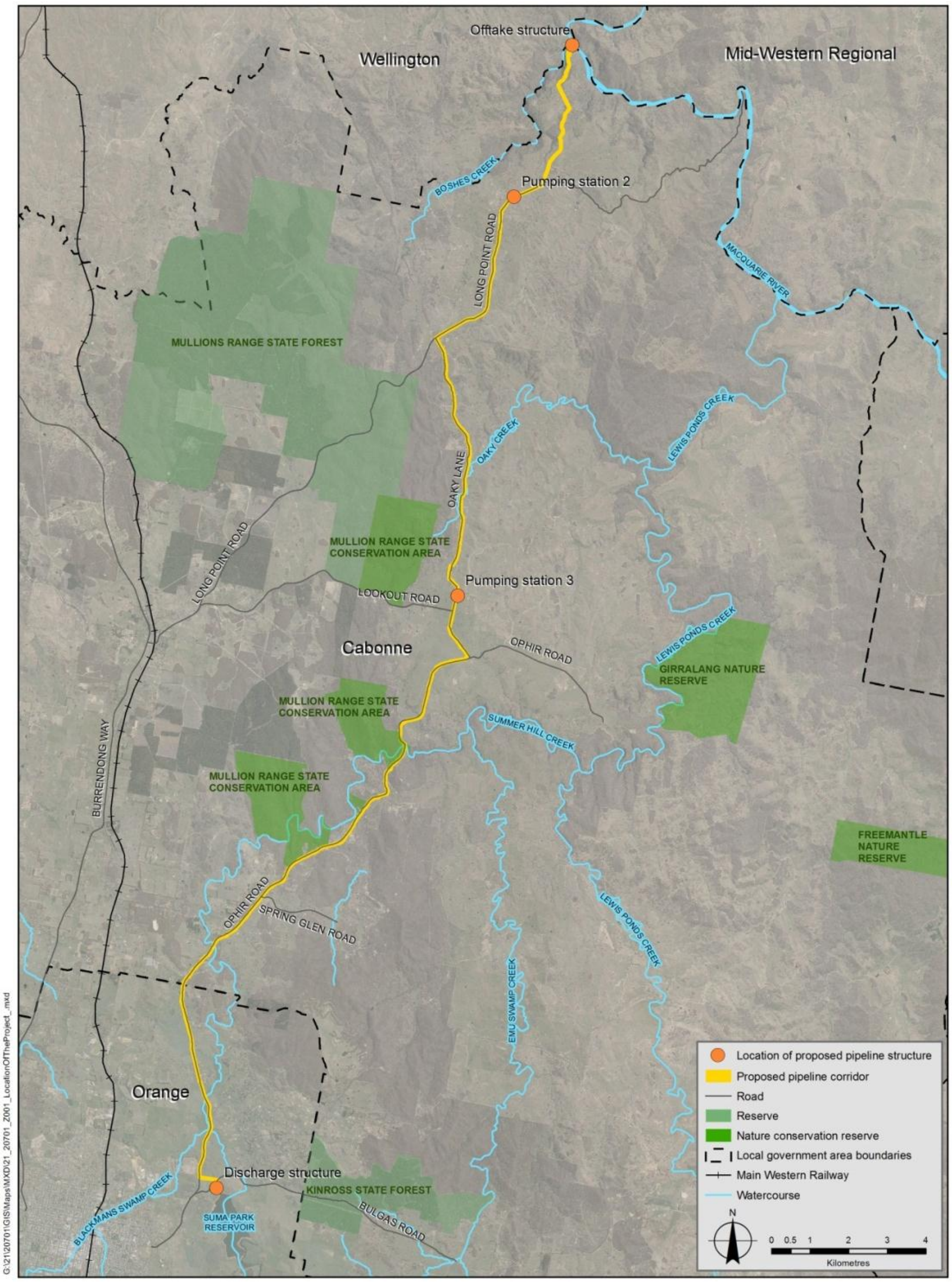
The approximate pipeline route connecting the Macquarie River to Suma Park Reservoir is shown overleaf. The estimated capital cost of this infrastructure is $47 million.

The Macquarie River has a catchment area of 7,249 km^2 to the proposed offtake point. Modelling of the catchment has been used to develop a long term flow series at the offtake point. This modelling has used available river flow data and has taken into consideration catchment interventions that have occurred over time including the construction of dams higher in the catchment, the development of urban centres, licenced river extractions and changing catchment conditions.

A summary is provided below.

Summary

Measure	Result
Capital cost, $	$47,000,000 ($8,800,000 with Govt. grants)
Operating cost, $/year	$736,801
NPV – capital cost ($2010)	$40,411,000 ($7,566,000 with Govt. grants)
NPV – operating cost ($2010)	$8,712,000
Potential increase in secure yield, ML/year	2,700
Capital costs, $/ML increase in secure yield	$1,014 ($190 with Govt. grants)
Operating costs, $/ML increase in secure yield	$219
Total cost, $/ML increase in secure yield	$1,232 ($408 with Govt. grants)
Change in TRB if adopted	$153 per assessment ($49 per assessment with Govt. grants)
Greenhouse Gas Emissions (operating power only)	2.18 tonnes CO_2e/ML
Issues to consider	• Macquarie River hydrology • Operation to prevent significant impact • Approval process • Water quality risk assessment
Likely timeframe to complete	2 to 3 years



Proposed Macquarie Pipeline route

The increase in secure yield provided by the proposed Macquarie River to Orange pipeline was assessed based on transferring 12 ML/day from the river to Suma Park Reservoir when the flow in the river is greater than 38 ML/day and the level in Suma Park Reservoir is less than 90%. Under these operational rules, the transfer of water from the Macquarie River increases the Orange water system secure yield by 2,700 ML/year. Modelling shows that under the proposed operating rules pumping occurs approximately 37% of the time, averaging 135 pump days per year. Of the 118 years modelled some extraction would have occurred in 116 of the years. Under this regime the average long term extraction from the river is 0.52% of the average annual flow. The maximum extraction from the river in any one day was calculated at 31.5% with the average extraction on pumping days being around 1.6% of flows in the river. The average annual extraction from the river is 1,616 ML/year, ranging from zero to 3,804 ML/year.

The commence to pump threshold of 38 ML/day was set to avoid pumping in low river flow conditions. Low flows are defined as those that occur for 80 percent of the time or more (80^{th} percentile flow). The 80^{th} percentile flow at the proposed offtake point was determined to be 22 ML/day. Therefore no river extraction would occur in low flow conditions.

Option SW1: Raising Suma Park Dam

Description

Suma Park Dam is located on Summer Hill Creek approximately 4 km east of Orange. It is the main water storage dam for Orange. Inflow to Suma Park Dam includes Gosling Creek (the overflow from Spring Creek Dam), Dairy Creek and Summer Hill Creek. The total catchment area upstream of the dam is 178.49 km^2.

Suma Park Reservoir was originally thought to have a capacity at Full Supply Level (FSL) of 18,100 ML. A bathymetric and spillway survey undertaken in 2010 revealed the volume at FSL is 17,290 ML.

Suma Park Dam is a prescribed dam under Schedule 1 of the *Dams Safety Act, 1978*. The spillway capacity does not meet required standards and a safety upgrade to the dam is planned. A concept design for the safety upgrade is being undertaken by consultants.

Following review of the concept design prepared for the Stage 1 upgrade works, Council commissioned an assessment of the technical, cost and program implications of raising the FSL of Suma Park Dam. This assessment examined the implications of a 1 m and 2 m increase in FSL which would provide the following volumes:

- 1 m raise 18,970 ML (an increase of 1,680 ML)
- 2 m raise 20,760 ML (an increase of 3,500 ML)

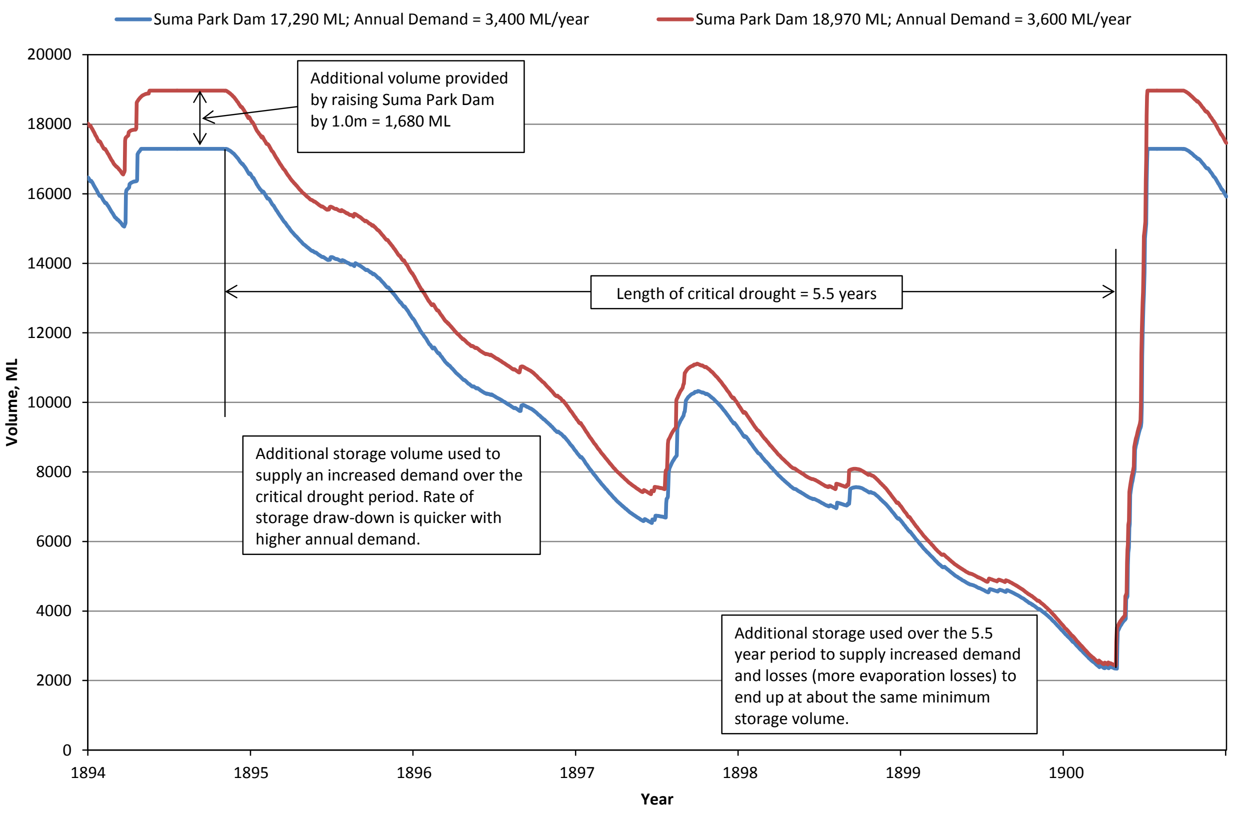
The assessment found that raising Suma Park Dam FSL by 1 m is a technically feasible option. However, a 2 m increase in FSL is not technically feasible due to excessive stress in the dam wall and no more than a 1 m increase should be considered for the dam.

Secure yield modelling based on the 5/10/10 rule showed that raising Suma Park Dam by 1 m above the current spillway level increases the secure yield for the system by 100 to 200 ML/year. This result applies to both the existing natural catchment and when additional water sources were being used to supplement the natural catchment inflow.

A 1 m raise in FSL does not have a significant impact on the secure yield. In fact, the dam would need to have a capacity of about 24,000 ML (an increase in FSL of 3.6m) to provide a secure yield that meets the current estimated unrestricted demand of 5,400 ML/year with the current inflow. The main reason for this is that the additional volume provided by raising the dam that is available at the start of a drought period is “used up” throughout the drought period by increased annual demand and additional evaporation losses. This is demonstrated on the graph overleaf. Therefore the additional volume is not available every year; it is used over the drought period when the storage is less than full.

Summary

Measure	Result
Capital cost, $	$3,550,000
Operating cost, $/year	Nil
NPV – capital cost ($2010)	$3,550,000
NPV – operating cost ($2010)	Nil
Potential increase in secure yield, ML/year	100 to 200
Capital costs, $/ML increase in secure yield	$1,202 to $2,404
Operating costs, $/ML increase in secure yield	Nil
Total cost, $/ML increase in secure yield	$1,202 to $2,404
Change in TRB if adopted	$9 per assessment
GHG (operating power only)	Nil
Issues to consider	• Environmental approvals requiring an EIS • Licensing • Likelihood of change to environmental flow rules • Land ownership
Likely timeframe to complete	3 years



Example of how additional storage is used over a drought period

Option GW1: Bores

Description

Orange City Council has approval to extract 75 ML/year from the Showground bore. A second borehole has been developed nearby at the Council works depot and a Borehole Impact Management Plan (BIMP) prepared for these two boreholes indicates the following annual yields could be expected:

- Showground (GW803930) 113 ML/year
- Depot (80BL24578) 164 ML/year

Existing boreholes in the Clifton Grove area also provide a potential source of additional water. A pipeline has been installed to transfer water from these bores to Suma Park Reservoir. A BIMP prepared for these two boreholes indicates the following annual yields could be expected:

- Shearing Shed (GW049705) 158 ML/year
- Bore 5 (GW049541) 24 ML/year

The bores potentially supply around 450 ML/year which is estimated to equate to an increase in secure yield of 450 ML/year. It is estimated that the existing licence bore extraction would increase the secure yield by around 100 ML/year. Therefore increased extraction from the bore system could increase the secure yield by 350 ML/year.

NSW Office of Water has recently granted licences totalling 462 ML/year for these bores.

A summary of this option is provided below. Capital costs are associated with minor infrastructure works (connections) and additional testing.

Summary

Measure	Result
Capital cost, $	$250,000
Operating cost, $/year	$285,000
NPV – capital cost ($2010)	$316,000
NPV – operating cost ($2010)	$4,213,000
Potential increase in secure yield, ML/year	350
Capital costs, $/ML increase in secure yield	$61
Operating costs, $/ML increase in secure yield	$815
Total cost, $/ML increase in secure yield	$876
Change in TRB if adopted	$12 per assessment
Greenhouse Gas Emissions (operating power only)	1.35 tonnes CO_2e/ML
Issues to consider	• Water quality risks • Licensing (resolved March 2012)
Likely timeframe to complete	1 to 2 years

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Option SH0: Blackmans Harvesting Stage 1 Full Licence

Description

The current approval for the Blackmans Swamp Creek Stormwater Harvesting Scheme (BSCSHS) does not allow its use whenever Suma Park Reservoir is above 50% (Stage 1a). Obtaining a licence to use this harvesting scheme at times when Suma Park Reservoir is less than 100% (Stage 1b) increases the system harvest capacity and secure yield.

No capital works are required for this option; simply a change in operating rule.

Modelling of the Blackmans Swamp Creek stormwater harvesting scheme shows the following results for each stage. Stage 1b harvesting could increase secure yield by 200 ML/year. This increases the secure yield for Stage 1 from 900 to 1,100 ML/year (i.e. Stage 1a + Stage 1b).

STAGE	Average Volume Extracted from Blackmans Swamp Creek ML/year	Proportion of Average Annual Streamflow Extracted	Potential Increase in Secure Yield ML/year
Stage 1a	349	4%	900
Stage 1b	848	9%	200
Stage 2	1,679	17%	900
Stage 3	2,576	27%	1,000

Notes: (1) the average volume extracted from Blackmans Swamp Creek includes the holding pond. (2) the secure yield figures quoted above include the Ploughmans Creek harvesting scheme.

The average annual operating cost for the Stage 1 harvesting scheme operating on a 100% trigger is $594,000 per year (i.e. an increase of $86,000 per year above Stage 1a).

A summary of this option is provided below.

Summary

Measure	Result
Capital cost, $	nil
Operating cost, $/year	$86,000
NPV – capital cost ($2010)	nil
NPV – operating cost ($2010)	$1,265,000
Potential increase in secure yield, ML/year	200
Capital costs, $/ML increase in secure yield	nil
Operating costs, $/ML increase in secure yield	$428
Total cost, $/ML increase in secure yield	$428
Change in TRB if adopted	$3 per assessment
Greenhouse Gas Emissions (operating power only)	0.58 tonnes CO_2e/ML
Issues to consider	• Licensing • Impact on flow regimes in Blackmans Swamp Creek and Summer Hill Creek • Water quality risk assessment
Likely timeframe to complete	3 to 5 years

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Option SH1: Blackmans Harvesting Stage 2

Description

The Business as Usual (BAU) Scenario includes the construction of the Stage 2 Blackmans Swamp Creek stormwater harvesting system. The proposed Stage 2 harvesting scheme includes:

- an off-line wetland upstream of the harvest weir adjacent to the creek near the intersection of Jilba and Phillip Streets. The conceptual wetland provides 14 ML of permanent water (below normal water level) and 36 ML of air space (to spillway level) for harvesting;
- a controlled outlet from the wetland to the creek; and
- removal of one of the existing pumps from the existing main harvesting pump station (PS1) and installation of an 80 L/s pump.

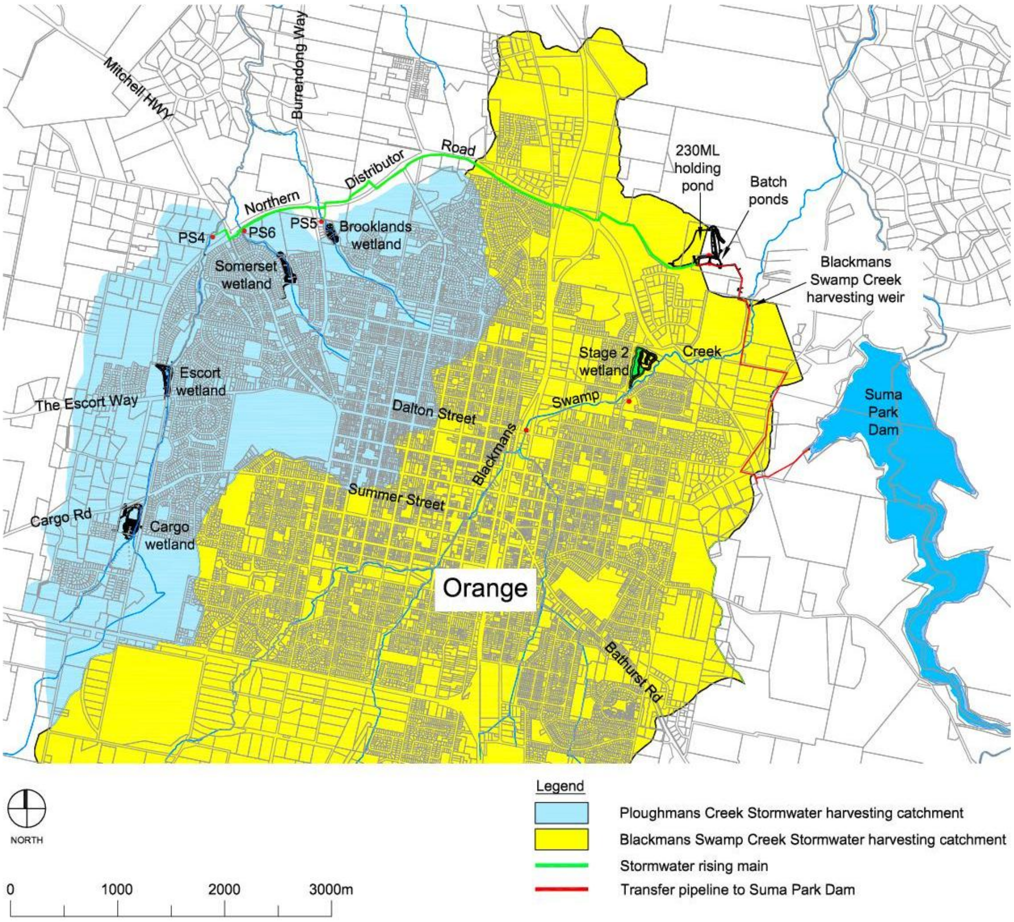
The location of the off-line wetland is shown overleaf. The Stage 2 harvesting scheme would operate in conjunction with Stage 1 as follows.

- Weirs would control flow into the off-line wetland. Low flows would continue along the creek and the wetland would be ephemeral, with the water level rising and falling in response to direct rainfall and evaporative losses. When flow in the creek reaches 100 L/s, water would start to divert into the wetland. The weirs would be set so that about 70% of the creek flow above 100 L/s is diverted to the wetland.
- The water level in the wetland would be controlled by an outlet box and pipe. An orifice control in the outlet box would limit discharge from the wetland to 100 L/s. As the water level in the wetland increases above the outlet box, a controlled release of 100 L/s would commence. This would combine with the bypass flow in the creek and move downstream to the harvest weir. If the wetland fills, excess flow would be released via a spillway to the creek.
- During a harvest event, the existing Stage 1 harvesting scheme would continue to operate with two 225 L/s pumps and the new 80 L/s pump operating at Pump Station 1 (PS1). The current Stage 1 operating triggers would apply (i.e. the pumps would start when the creek flow reaches 1,000 L/s).
- On the receding limb of the hydrograph, the main harvest pumps (at PS1) would ramp down and stop once the level in the weir pool falls to 0.5 m above the 300 mm diameter through pipe (as per current Stage 1 operating rules). At this stage, there would be a continued slow release from the upstream wetland providing a flow of about 100 L/s into the harvest weir pool. The 80 L/s pump would continue to draw water from the weir pool.
- The 80 L/s pump would continue to operate until the upstream wetland returns to its normal water level.

A summary of this option is provided below.

Summary

Measure	Result
Capital cost, $	$5,709,750
Operating cost, $/year	$324,000
NPV – capital cost ($2010)	$6,010,000
NPV – operating cost ($2010)	$4,780,000
Potential increase in secure yield, ML/year	900
Capital costs, $/ML increase in secure yield	$452
Operating costs, $/ML increase in secure yield	$360
Total cost, $/ML increase in secure yield	$812
Change in TRB if adopted	$30 per assessment
Greenhouse Gas Emissions (operating power only)	0.66 tonnes CO_2e/ML
Issues to consider	• Licensing • Impact on flow regimes in Blackmans Swamp Creek and Summer Hill Creek • Water quality risk assessment • Draft water sharing plan considerations
Likely timeframe to complete	4 to 6 years



OCC stormwater harvesting systems showing Stage 2 Blackmans Swamp Creek wetland

Modelling of the Blackmans Swamp Creek harvesting scheme shows the following results for each stage. Stage 2 harvesting could increase the secure yield of the Orange water supply system by 900 ML/year.

STAGE	Average Volume Extracted from Blackmans Swamp Creek ML/year	Proportion of Average Annual Streamflow Extracted	Potential Increase in Secure Yield ML/year
Stage 1a	349	4%	900
Stage 1b	848	9%	200
Stage 2	1,679	17%	900
Stage 3	2,576	27%	1,000

Notes: (1) the average volume extracted from Blackmans Swamp Creek includes the holding pond. (2) the secure yield figures quoted above include the Ploughmans Creek harvesting scheme.

Option D1: Longer and More Frequent Restriction Periods

Description

Secure Yield is the annual demand that can be supplied from a water supply system while satisfying the following conditions:

a) Duration of restrictions does not exceed 5% of the time;

b) Frequency of restrictions does not exceed 1 year in 10 on average; and

c) Severity of restrictions does not exceed 10%. Systems must be able to meet 90% of the unrestricted water demand (i.e. 10% average reduction in consumption due to water restrictions) through a repetition of the worst recorded drought, commencing with the storage drawn down to the level at which restrictions need to be imposed to satisfy a) and b) above.

This is referred to in the IWCM Evaluation Study as the 5/10/10 rule.

If the duration of restriction periods is increased and they occur more often, the secure yield for a system increases. This is because the community is accepting restrictions more often and for longer periods, which saves stored water.

The potential increase in secure yield gained by accepting longer and more frequent restrictions was examined assuming a 10/5/10 rule, that is:

a) Duration of restrictions does not exceed 10% of the time;

b) Frequency of restrictions does not exceed 1 year in 5 on average; and

c) Severity of restrictions does not exceed 10% (as above).

The increase in secure yield by adopting longer and more frequent restrictions is 300 ML/year.

It is considered that there would be no capital or operating costs for this option apart from community education which would be covered under existing budgets.

Summary

Measure	Result
Capital cost, $	Nil
Operating cost, $/year	Nil
NPV – capital cost	Nil
NPV – operating cost	Nil
Potential increase in secure yield, ML/year	300
Capital costs, $/ML increase in secure yield	Nil
Operating costs, $/ML increase in secure yield	Nil
Total cost, $/ML increase in secure yield	Nil
Change in TRB if adopted	Nil
GHG (operating power only)	Nil
Issues to consider	• Community acceptance • Departure from State Government Best Practice guideline • Equality between communities
Likely timeframe to complete	Immediate

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Option SW4: Burrendong Pipeline

Description

The option of a pipeline from Burrendong Dam was first considered in the Centroc Water Security Study. It was excluded from the short listed options in the regional study as it was considered to be not feasible and better alternatives were available (namely supplying water from the Lachlan system).

A pipeline from Burrendong Dam is a technically straight forward water supply option. It involves:

- A pump station located downstream of the dam (see below);
- A pipeline to connect the pump station to Suma Park Reservoir (approximately 78 km); and
- Booster pump stations and balance tanks along the pipeline route.

The off take point would need to be located on the downstream side of the dam to ensure that water could be extracted at all times (subject to licence conditions). If the extraction point was upstream of the dam wall (say at Mookerawa) there may be times when water could not be obtained due to low dam levels.

Burrendong Dam forms part of the regulated supply in the Macquarie River. An access licence would be required to extract water for town water supply. If this option was pursued, it would be preferably to obtain a high security licence rather than a general security licence that would be subject to allocation limitations. A high security allocation would need to be purchased on the open market. It is estimated that this could cost around $3,000 per ML.

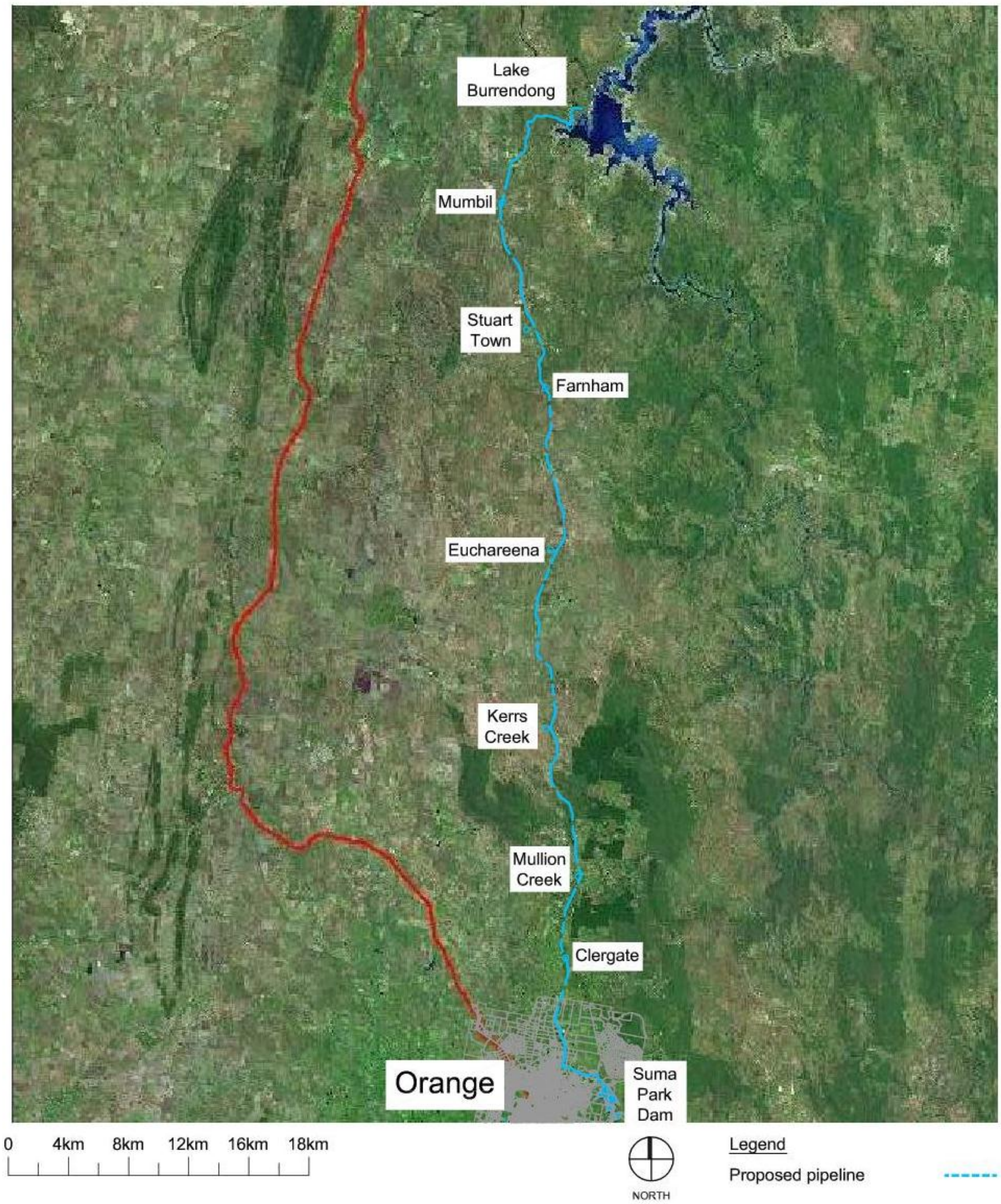
A suggested pipeline route connecting the Burrendong Dam to Suma Park Reservoir is shown overleaf. This route was selected to follow road and rail easements as much as possible. A conceptual transfer system was sized for a peak flow of 12.3 ML/day. This system would require 450 mm diameter DICL and 500 mm polyethylene pipeline and four pump stations with a total power demand of 1,657 kW.

The estimated capital cost of this infrastructure and approvals is $93.5 million. The purchase of an access licence would add to this cost depending on the volume obtained.

A pipeline from Burrendong Dam has significant capital costs. It is reasonable to suggest that if this option was used, sufficient licence allocation would be required to allow this system to provide a secure yield increase similar to the proposed Macquarie River to Orange pipeline project. It was further assumed that the Burrendong pipeline option could attract the same State Government grant ($18.2 million) as the Macquarie River pipeline project.

Summary

Measure	Result
Capital cost, $	$102,986,000 ($84,486,000 with grant)
Operating cost, $/year	$734,391
NPV – capital cost	$76,290,000 ($62,405,000 with grant)
NPV – operating cost	$7,099,000
Potential increase in secure yield, ML/year	2,800
Capital costs, $/ML increase in secure yield	$1,845 ($1,509 with grant)
Operating costs, $/ML increase in secure yield	$172
Total cost, $/ML increase in secure yield	$2,017 ($1,681 with grant)
Change in TRB if adopted	$256 per assessment ($213 per assessment with grant)
Greenhouse Gas Emissions (operating power only)	2.50 tonnes CO_2e/ML
Issues to consider	• Need to obtain high security licence • Potential regional solution (Macquarie/Lachlan connection) • EA process • Land ownership along pipeline route
Likely timeframe to complete	4 to 6 years



Suggested pipeline route from Burrendong Dam to Orange

Modelling determined that a 12.3 ML/day system transferring water whenever Suma Park Reservoir was less than 70% could provide an additional 2,800 ML/year in secure yield for Orange. The system was used in 82 years of the 118 years modelled. The long term average transfer for this system was 1,260 ML/year.

The estimated capital and operating costs of this option are shown above. The capital cost includes the purchase of 3,300 ML of high security access licence entitlement from the regulated water source.

Option SW5: Mulyan Creek Dam

Description

The option of a new water supply storage on Mulyan Creek west of Clergate was identified by a local resident. Conceptually, water captured by the storage would be transferred back to Suma Park Reservoir to supplement the Orange water supply.

The proposed site of the dam is located on Mulyan Creek approximately 3.5 km west of Clergate. The catchment area to the suggested dam site is approximately 38 km². It is predominately open grazing land with some forest areas along the catchment watershed. The catchment area and proposed dam location are shown overleaf.

Catchment modelling was used to generate a monthly stream flow data set for Mulyan Creek for the period 1890 to 2007. Catchment parameters were derived from the modelling undertaken for the Ploughman's Creek stormwater harvesting scheme assessment, which included generation of stream flows for sub catchments of the Bell River.

Construction of a new dam is likely to be subject to environmental flow requirements. The assessment therefore included an allowance for environmental flow based on the 80/20 rule (see overleaf). No allowance was made for other losses such as evaporation and seepage, or direct rainfall additions to the storage water surface.

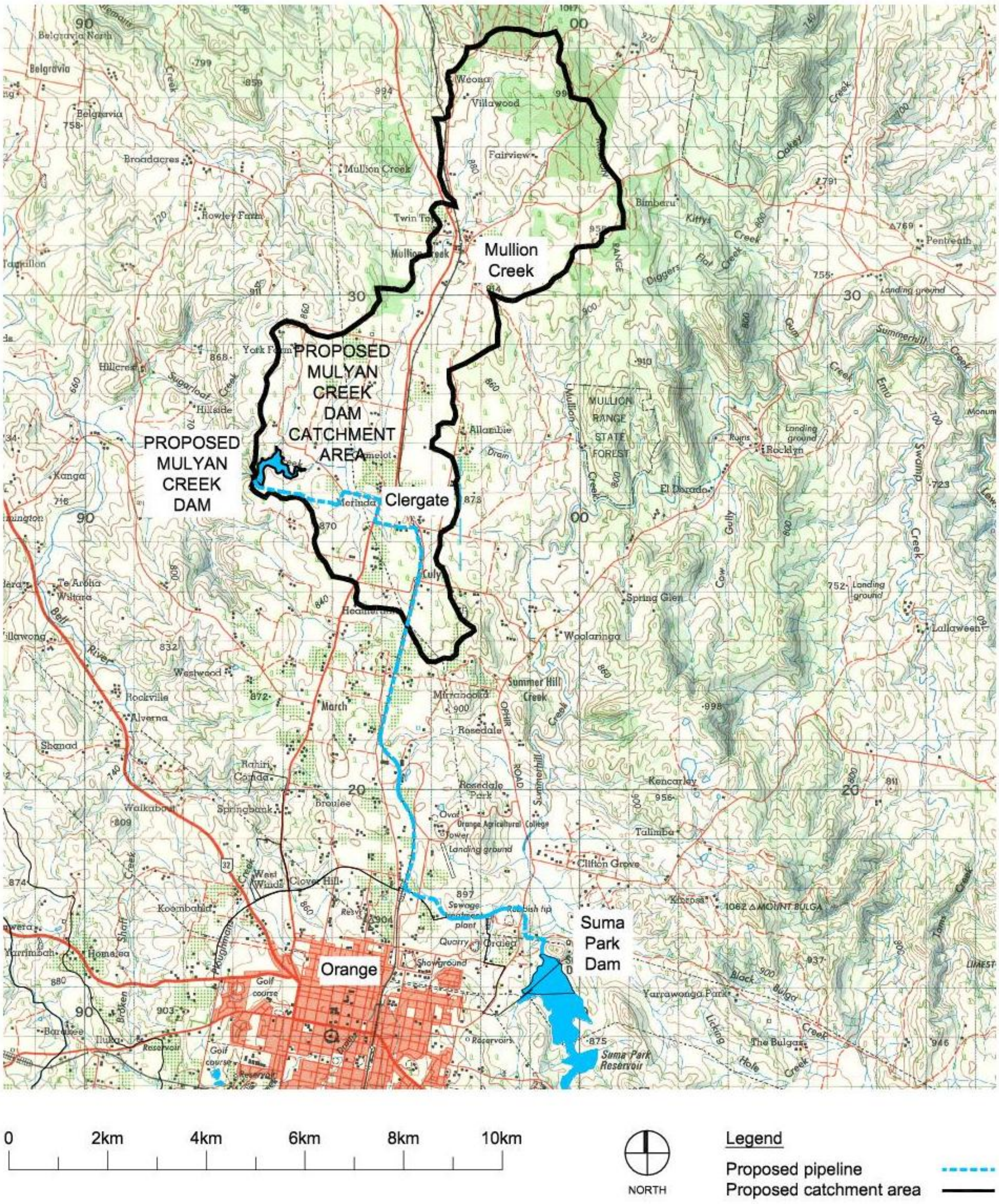
A mass curve analysis was used to generate a storage-demand relationship. This indicated that a storage of about 1,640 ML is required to supply an annual demand of 500 ML/year and a storage volume of 16,100 ML is required to supply an annual demand of 2,000 ML/year. In most cases the critical period was the Federation Drought.

A 25 to 30 m high dam wall at this location would create a storage with a volume of about 1,350 ML and surface area of about 22 ha. Based on this maximum volume, the potential annual demand provided by the storage would be around 430 ML/year.

The potential annual demand derived using this method is not the same as a secure yield value. It is the annual demand that could be supplied through the worst drought on record – in this case the Federation Drought. Secure yield is the annual demand that could be supplied through the worst drought on record, with the storage already starting from a drawn down condition. The secure yield criteria can be viewed as satisfying about a 1 in 1,000 year drought. Therefore the secure yield that could be provided from the conceptual Mulyan Creek dam system would be less than 430 ML/year; however this value was adopted as the annual supply from the dam for the purpose of this assessment.

Summary

Measure	Result
Capital cost, $	$43,163,000
Operating cost, $/year	$151,000
NPV – capital cost	$33,915,000
NPV – operating cost	$1,567,000
Potential increase in secure yield, ML/year	430
Capital costs, $/ML increase in secure yield	$5,341
Operating costs, $/ML increase in secure yield	$247
Total cost, $/ML increase in secure yield	$5,588
Change in TRB if adopted	$109 per assessment
Greenhouse Gas Emissions (operating power only)	0.52 tonnes CO_2e/ML
Issues to consider	• Environmental approvals • Land ownership • Low yield
Likely timeframe to complete	5 to 8 years



Conceptual Mulyan Creek Dam showing catchment and possible pipeline route

A conceptual pipeline alignment is shown above. It has a length of about 16 km and follows the rail easement for the majority of its length. A pipeline system to transfer up to 3 ML/day would need 280 mm diameter polyethylene pipe and a single pump station at the dam with a total power requirement of 85 kW.

Preliminary capital cost estimates for the dam and transfer system are $43.2 million; including $26.4 million for the dam, $15.3 million for the transfer system and $1.5 million for approvals.

80/20 Environmental Flow Rule:

The dam is fully transparent to all flows up to the 80th percentile flow, i.e. all inflows below the 80th percentile entering the dam will be passed through the dam. The dam is also 20% translucent for flows above the 80th percentile i.e. for all flows above the 80th percentile flow, 20% of the difference between the 80th percentile flow and the actual flow plus the 80th percentile flow is released.

Option SH3: Blackmans Harvesting Stage 3

Description

The Business as Usual (BAU) Scenario includes the construction of the Stage 2 Blackmans Swamp Creek stormwater harvesting system that would include:

- an upstream off-line wetland system; and
- installation of low flow harvest pumps at the main harvesting pump station.

Stage 3 would be the third (and final) expansion of the scheme. It would increase the harvest capacity of the scheme and would require construction of the following work:

- a larger harvest weir across the creek at the location of the existing harvest weir. The larger weir would have control gates to manage flow and would create an on-line weir pool of about 40 ML;
- a new access road to the Sewage Treatment Plant off Astill Drive;
- upgrade to the existing batch pond treatment system and associated pump stations to double its capacity to 300 L/s. This would include a packaged treatment plant for settling and filtration;
- duplication of the rising main from the batch ponds to Suma Park Reservoir and upgrade to the transfer pump station; and
- modification to power and control systems.

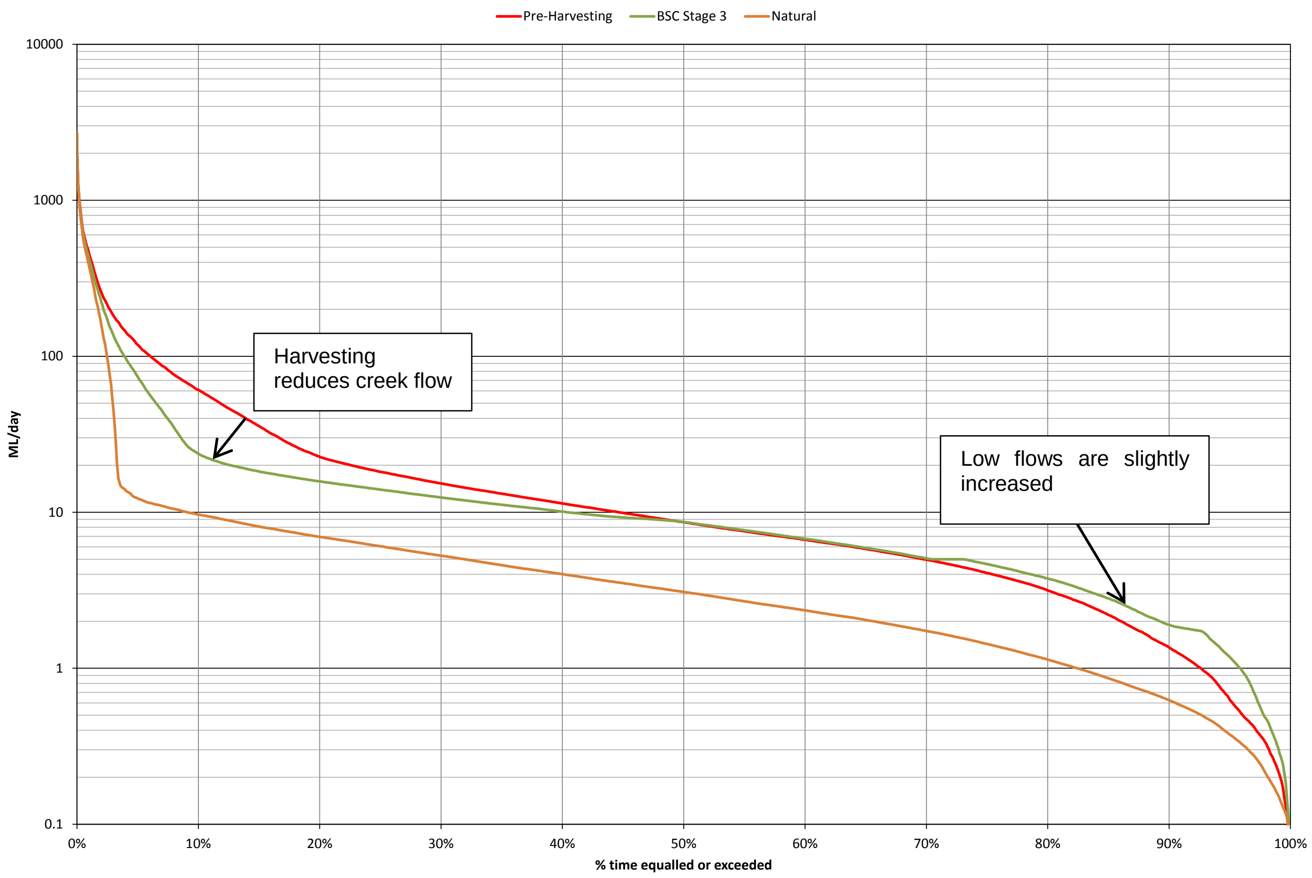
Modelling of the Blackmans Swamp Creek harvesting scheme shows the following results for each stage.

STAGE	Average Volume Extracted from Blackmans Swamp Creek ML/year	Proportion of Average Annual Streamflow Extracted	Potential Increase in Secure Yield ML/year
Stage 1a	349	4%	900
Stage 1b	848	9%	200
Stage 2	1,679	17%	900
Stage 3	2,576	27%	1,000

Notes: (1) the average volume extracted from Blackmans Swamp Creek includes the holding pond. (2) the secure yield figures quoted above include the Ploughmans Creek harvesting scheme.

Summary

Measure	Result
Capital cost, $	$11,489,000
Operating cost, $/year	$231,000
NPV – capital cost	$12,254,000
NPV – operating cost	$3,410,000
Potential increase in secure yield, ML/year	1,000
Capital costs, $/ML increase in secure yield	$830
Operating costs, $/ML increase in secure yield	$231
Total cost, $/ML increase in secure yield	$1,061
Change in TRB if adopted	$44 per assessment
Greenhouse Gas Emissions (operating power only)	0.55 tonnes CO_2e/ML
Issues to consider	• Current issues with obtaining permanent licence • Impact on creek system • Does not promote diversification of water resources • Water quality risk assessment – may be too much stormwater • Draft water sharing plan considerations
Likely timeframe to complete	6 to 8 years



Blackmans Swamp Creek modelled flow duration curve

Stage 3 harvesting could increase the secure yield by a further 1,000 ML/year. The volume extracted from Blackmans Swamp Creek represents a reasonably significant proportion of the average annual stream flow with flows above the median flow being reduced as shown on the flow duration curve above.

The flow duration above curves shows:

- the estimated natural stream flow (brown line). This was modelled by removing the impervious areas from the hydrology model;
- the pre-harvesting stream flow (red line) – this represents the developed catchment with no stormwater harvesting; and
- the flow downstream of the harvest weir under Stage 3 harvesting (green line).

The reduction in flow from the red line to the green line in the range 0% to 50% shows how stormwater harvesting would reduce these flows – this is indicated by the green line moving below the red line. The reduction in storm flows (those flows occurring less than 10% of the time) would benefit the downstream creek environment through reduced erosive forces. The harvesting does not reduce the stream flow below what is estimated to be the natural flow.

Proposed operating rules that would require the release of a base flow during harvesting have the effect of increasing low flows – which is indicated by the green line moving above the red line in the 70% to 100% range.

Option RW1: Rainwater Tanks

Description

Rainwater tanks provide a potential alternative water source and can reduce the demand on the mains water supply. There are a number of constraints which need to be considered to ensure that the most appropriate sized rainwater tank is installed. These include things such as rainfall, lot size, purpose of use and cost. Although larger rainwater tanks provide a greater capacity for storage and increased potential to reduce the demand on mains water, they are more expensive and may be restricted by planning controls and space. The effectiveness of larger rainwater tanks also becomes limited by the roof catchment area.

An analysis of rainwater tank systems was undertaken to:

- Assess the impact of a range of rainwater tank sizes on mains water consumption for a number of different water uses for an average household; and
- Estimate the annual water supply that could be provided by rainwater tanks

Orange City Council has a rainwater tank rebate policy in place (ST061) that has had a good take-up rate and provided many local residents extra financial incentives to install a rainwater tank. This rebate is the largest financial water saving incentive Council offers.

Rainwater tank modelling was undertaken to assess a number of different rainwater tank scenarios for an average house in the Orange area. Model scenarios were run using a variety of tank sizes and a combination of potential home rainwater uses as follows:

1. Outside use only – garden watering and car washing;
2. Outside use as well as internal toilet use; and
3. Outside use as well as internal toilet and washing machine cold water use.

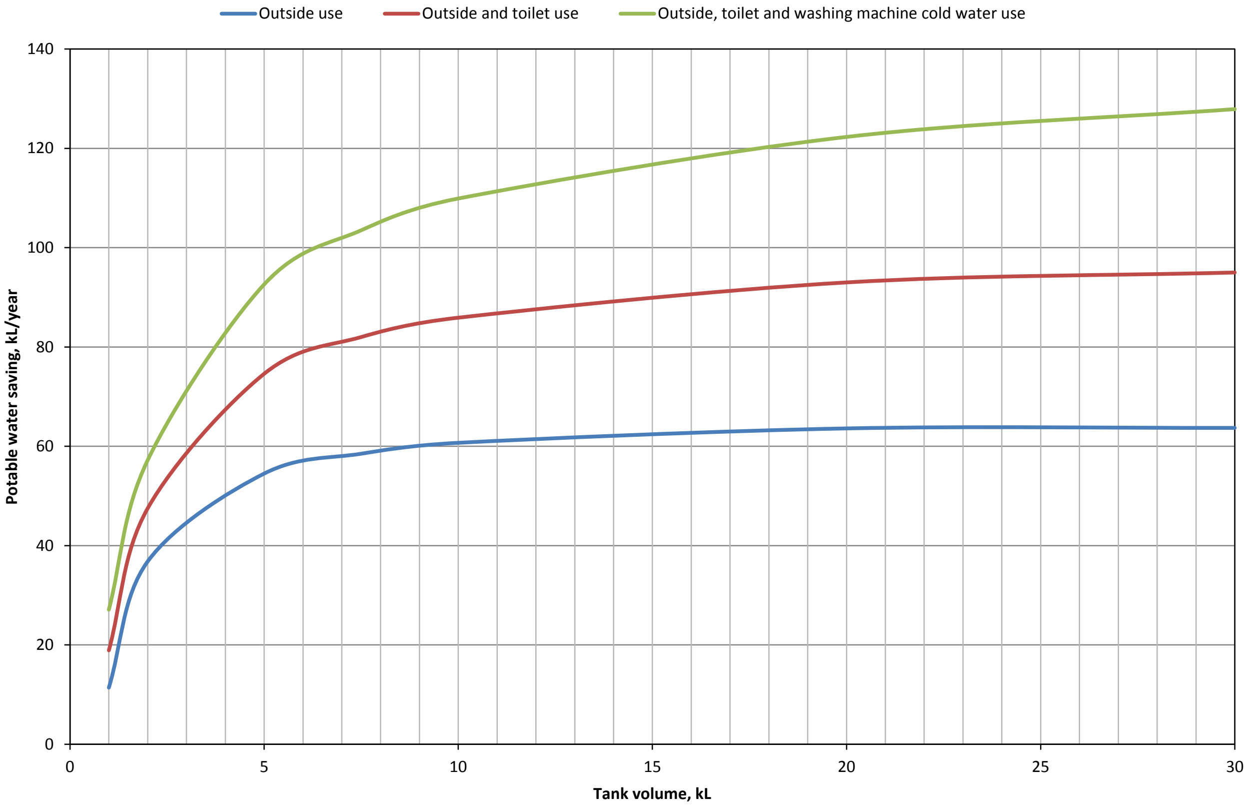
These three scenarios provide a good indication of the effectiveness of rainwater tanks under different use scenarios. Each scenario was assessed against seven different tank sizes ranging from 1,000 to 30,000 L to determine the benefit to potable water usage and average water bill saving. A 300 m^2 roof area was used in the modelling.

The graph overleaf illustrates the potential water saving for the three water use scenarios modelled for varying tank sizes. The average annual household potable water saving using a 10,000 L tank is:

- Scenario 1 60.7 kL/household/year
- Scenario 2 85.9 kL/household/year
- Scenario 3 109.9 kL/household/year

Summary

Measure	Result
Capital cost, $	$64,942,000
Operating cost, $/year	NIl
NPV – capital cost	$45,613,000
NPV – operating cost	Nil
Potential increase in secure yield, ML/year	300
Capital costs, $/ML increase in secure yield	$11,044
Operating costs, $/ML increase in secure yield	Nil
Total cost, $/ML increase in secure yield	$11,044
Change in TRB if adopted	$140 per assessment
Greenhouse Gas Emissions (operating power only)	negligible
Issues to consider	• Level of household uptake • Water quality risks • Low secure yield
Likely timeframe to complete	> 10 years



Rainwater tank analysis – potential household water saving

Financial analysis indicated that there is no financial benefit for households to install rainwater tanks. The cost of the water supplied from the rainwater tank system was greater than the current water usage charge of $1.60/kL for all scenarios modelled.

The number of residential assessments in 2010/2011 is 14,542. If 70% of households (10,179 households) installed a 10,000 L rainwater tank connected for outdoor and toilet use, the annual supply from all the tanks in an average year would be in the order of 874 ML. However this figure is not a secure yield as it is likely to be significantly lower in dry years. Furthermore, as rainwater tank systems would require potable top-up, they would be subject to water restrictions as the city's water storages are drawn down. In these periods rainwater tanks would mainly supply internal uses with an associated reduction in potable water saving. This would further reduce the benefit of rainwater tanks system on secure yield.

Given the above, it is considered that the secure yield from 10,179 rainwater tanks would be in the order of 200 to 300 ML/year. While beneficial, it is unlikely to impact on the need for and timing of other major water security works.

Given that there is no financial benefit for households to install rainwater tanks it is likely this option would need to be funded by Council to ensure high uptake. The average cost of installing a 10,000 L rainwater tank system connected for outdoor and toilet use (excluding the rebate) is $6,380. This equates to a total cost of $64.94 million for 10,179 households. Assuming the rainwater tanks are installed over a ten year period and the upper end of the secure yield increase, the cost is $11,044 per ML increase in secure yield.

Option E2: IPR 2: 10 ML/day Membrane Plant

Description

An option for future water supply is to develop an indirect potable reuse (IPR) scheme. This would entail advanced treatment of the municipal wastewater to a very high standard with this reclaimed water then being transferred to Suma Park Reservoir where it would mix with raw water. It would then be further treated in the water treatment plant (WTP) before distribution to the community.

The advanced treatment stage must address both the acute and chronic risks associated with introducing the reclaimed water into a drinking water supply.

A review of technology identified three possible treatment systems for an IPR scheme:

- Non-membrane – these systems use coagulation, filtration and disinfection;
- Membrane system without brine treatment – these systems use micro and reverse osmosis filtration and disinfection. The reject from the filtration process is discharged to the environment; and
- Membrane systems with brine treatment (zero liquid discharge system) – these systems treat the brine reject from the filtration process so that there is not discharge to the environment.

The volume of reclaimed water produced by the non-membrane plant is greater compared to the membrane systems due to the concentrate produced from the reverse osmosis (RO) in the membrane systems. The concentrate from RO, which can amount to 15% to 25% of the flow to the RO unit, requires disposal. It is generally disposed of to the ocean in the case of coastal cities while evaporation basins, deep well injection or concentration followed by crystallisation are considered for inland locations.

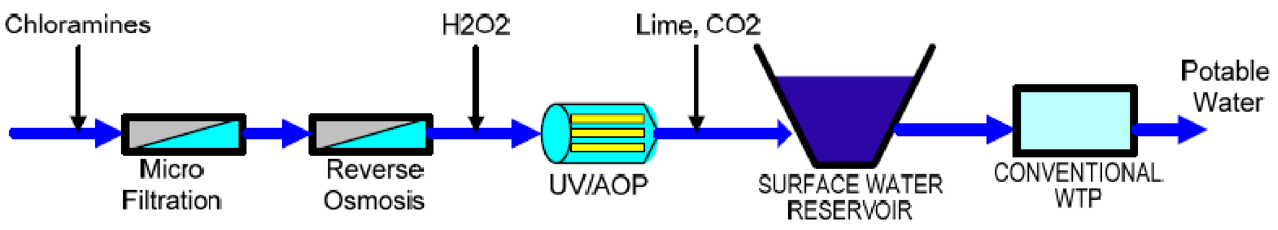
The third IPR treatment system above (membrane plus brine treatment) includes a zero liquid discharge treatment system to treat the concentrate from the RO unit. This would be required for Orange as there are no opportunities for deep well injection and evaporation systems would be very marginal due to climate.

The NSW Office of Water advised that they are unlikely to accept a non-membrane system if IPR was being considered as a long term water security option due to public health risks. Therefore the preferred options would be a membrane system.

A summary of this option is provided below. A membrane system treating 10 ML/day would deliver about 9.1 ML/day to Suma Park Reservoir. As this is a constant inflow, it would equate to an equivalent increase in secure yield. The treatment process for a membrane plant is shown overleaf.

Summary

Measure	Result
Capital cost, $	$57,860,000
Operating cost, $/year	$4,302,000
NPV – capital cost	$54,212,000
NPV – operating cost	$51,441,000
Potential increase in secure yield, ML/year	3,300
Capital costs, $/ML increase in secure yield	$1,112
Operating costs, $/ML increase in secure yield	$1,056
Total cost, $/ML increase in secure yield	$2,168
Change in TRB if adopted	$318 per assessment
Greenhouse Gas Emissions (operating power only)	2.40 tonnes CO_2e/ML
Issues to consider	• Effluent not currently available due to contract with Cadia Mines – unlikely before 2031 • Water quality risk assessment • Approvals/licensing process • Community acceptance • Additional Council resources required due to higher level technology
Likely timeframe to complete	5 to 8 years



Treatment train for IPR membrane plant

The works required would include:

- The IPR treatment plant ($55 million); and
- A pump and pipeline system to transfer treated effluent to Suma Park Reservoir ($2.86 million)

The annual operating costs for the membrane plant with zero liquid discharge are $3.9 million/year. Additional operating costs are required for the effluent transfer system estimated at $402,000/year.

Option R1: Lake Rowlands

Description

Central NSW Regional Organisation of Councils (Centroc) undertook a Water Security Study to investigate and recommend solutions to improve water security across 17 LGA's. The study included an audit of existing bulk water supply infrastructure (Component 1) and an assessment of options to improve water supply security (Component 2). Water demand forecasts were developed for each town for the next 50 years (until 2059). The forecasts took into account projected population growth, surface water and groundwater resources, climate sequence and climate change. The study identified that 29 towns were at risk, and required substantial water security improvements, Orange being one of these towns at risk.

It was determined that an integrated program of water conservation and demand management measures, coupled with new and upgraded water supply and storage infrastructure was required.

In terms of infrastructure, an augmented Lake Rowlands was the key to the Centroc recommended region-wide town water security strategy. In the immediate term, there is insufficient capacity in Lake Rowlands for it to play a significant regional water security role. Enlarging the dam to a capacity of 26,500 ML would increase the system secure yield and provide additional water to the regional network.

Coupled with the augmentation of Lake Rowlands was a series of pipeline connections to distribute water to Centroc centres. A pipeline to Orange was one of these connections.

The need to enlarge Lake Rowlands before adequate water could be available means that this is a longer term project (10 to 15 years).

Since the Centroc study, further secure yield assessment has been undertaken for Lake Rowlands. This estimate indicates that under a climate change scenario the secure yield from Lake Rowlands is 4,600 ML/year (see footnote). This much lower than the previous assessment of 8,000 ML/year. With the yield of the augmented Lake Rowlands significantly reduced it is difficult to determine the likely share of water that could be directed to Orange. For the purpose of this assessment it is assumed that Orange will be able to access 972 ML/year from Lake Rowlands. This is based on:

- a Lake Rowlands secure yield of 4,600 ML/year;
- Central Tablelands Water baseline demand of 2,750 ML/year, of which 400 ML/year is supplied by bores; and
- a commitment to supply Cowra with 1,278 ML/year in drought periods.

A summary of this option is provided below. It has been assumed that the annual water available for Orange would equate to an equivalent increase in secure yield.

Summary

Measure	Result
Capital cost, $	$84,500,000
Operating cost, $/year	$576,000
NPV – capital cost	$73,918,000
NPV – operating cost	$6,420,000
Potential increase in secure yield, ML/year	972
Capital costs, $/ML increase in secure yield	$5,150
Operating costs, $/ML increase in secure yield	$447
Total cost, $/ML increase in secure yield	$5,597
Change in TRB if adopted	$246 per assessment
Greenhouse Gas Emissions (operating power only)	1.72 tonnes CO_2e/ML
Issues to consider	• Revised secure yield estimates may indicate sufficient water is not available to make this a viable option • Environmental approval process for a new dam could be protracted • Management of regional water scheme
Likely timeframe to complete	10 to 15 years

It should be noted that the remaining water available (972 ML/year) is the water available to Forbes, Parkes and Orange. Therefore the assumption that Orange would have access to the full 972 ML/year is seen as the best possible outcome.

The capital costs assume:

- Orange contributes 21% of the dam capital costs (total estimated cost $150 million). This is Orange's share of the total estimate secure yield.
- Orange pays for the pipeline and transfer system (total estimate cost $53 million)

Operating costs assume a 300 kW pump system moving and average of 3.24 ML/day.

Footnote:

In early 2011 the Minister for Primary Industries, Katrina Hodgkinson instructed the New South Wales Office of Water (NOW) to undertake an independent review of the secure yield analysis of the augmented Lake Rowlands on the 5/10/10 rule and considering the Federation Drought. This will establish a uniform basis for secure yield calculations and so enable a more detailed assessment of options.

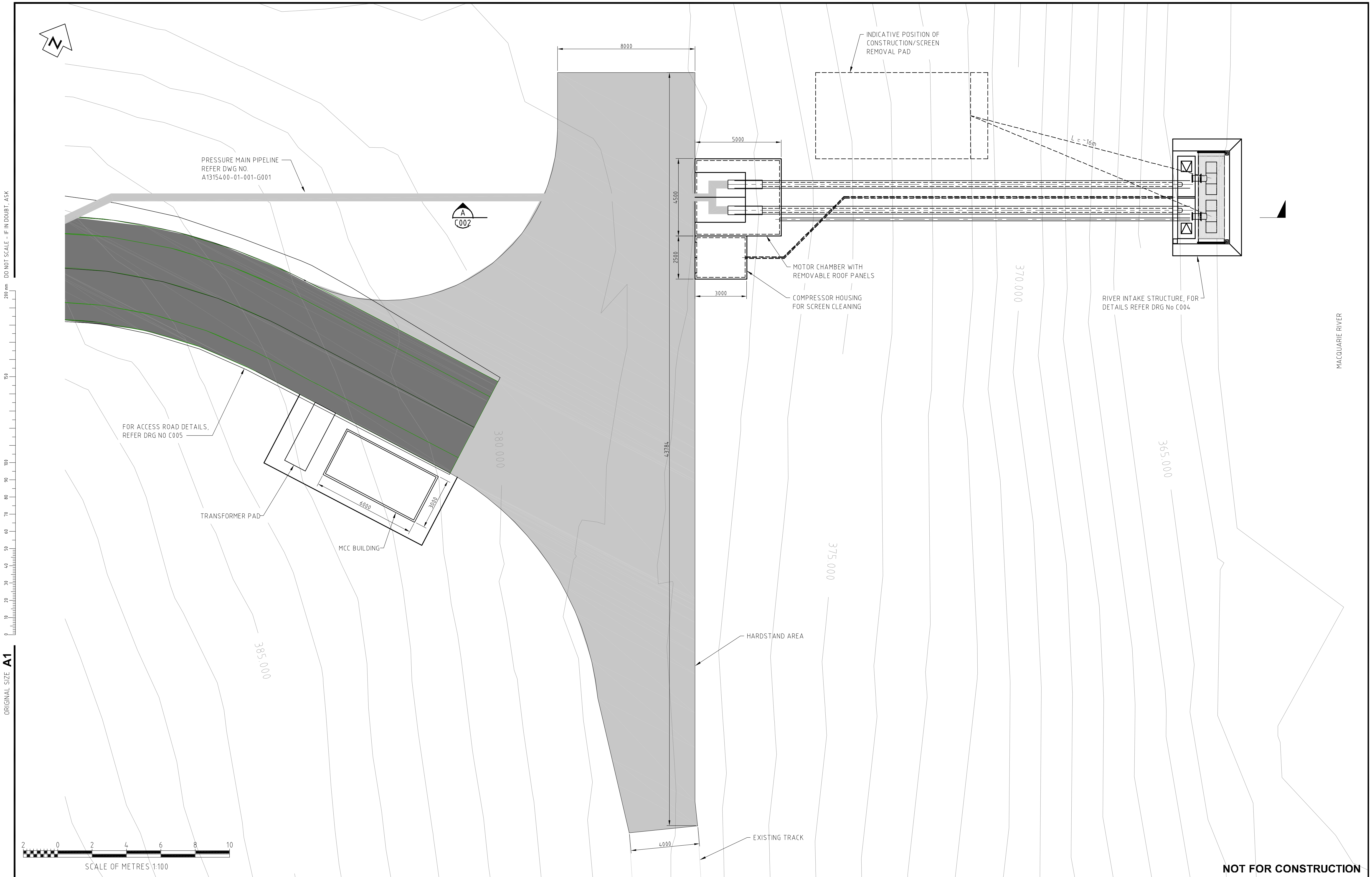
The Lake Rowlands yield study was completed in November 2011. This study indicates that under a climate change scenario the secure yield from Lake Rowlands is 3,150 ML/year, which is lower than the previous estimate of 4,600 ML/year.

This revised assessment indicates that there is unlikely to be significant "spare" secure yield to supply Orange, particularly when climate change is considered. Furthermore, the Draft Water Sharing Plan for Lachlan Unregulated and Alluvial Water Sources places limitations on water access entitlements.

This data was not available at the time of undertaking the comparison of options. Therefore the assessment is based on the previous secure yield of 4,600 ML/year.

Appendix C

Conceptual plans



NOT FOR CONSTRUCTION

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						DRAWN	S COYLE
						DRAWING CHECK	
						DESIGN CHECK	
						DESIGN REVIEW	
						APPROVED	NOT APPROVED
						PROF REGISTRATION:	

MWH

Client:

ORANGE
Australia's Colour City

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Civic Centre
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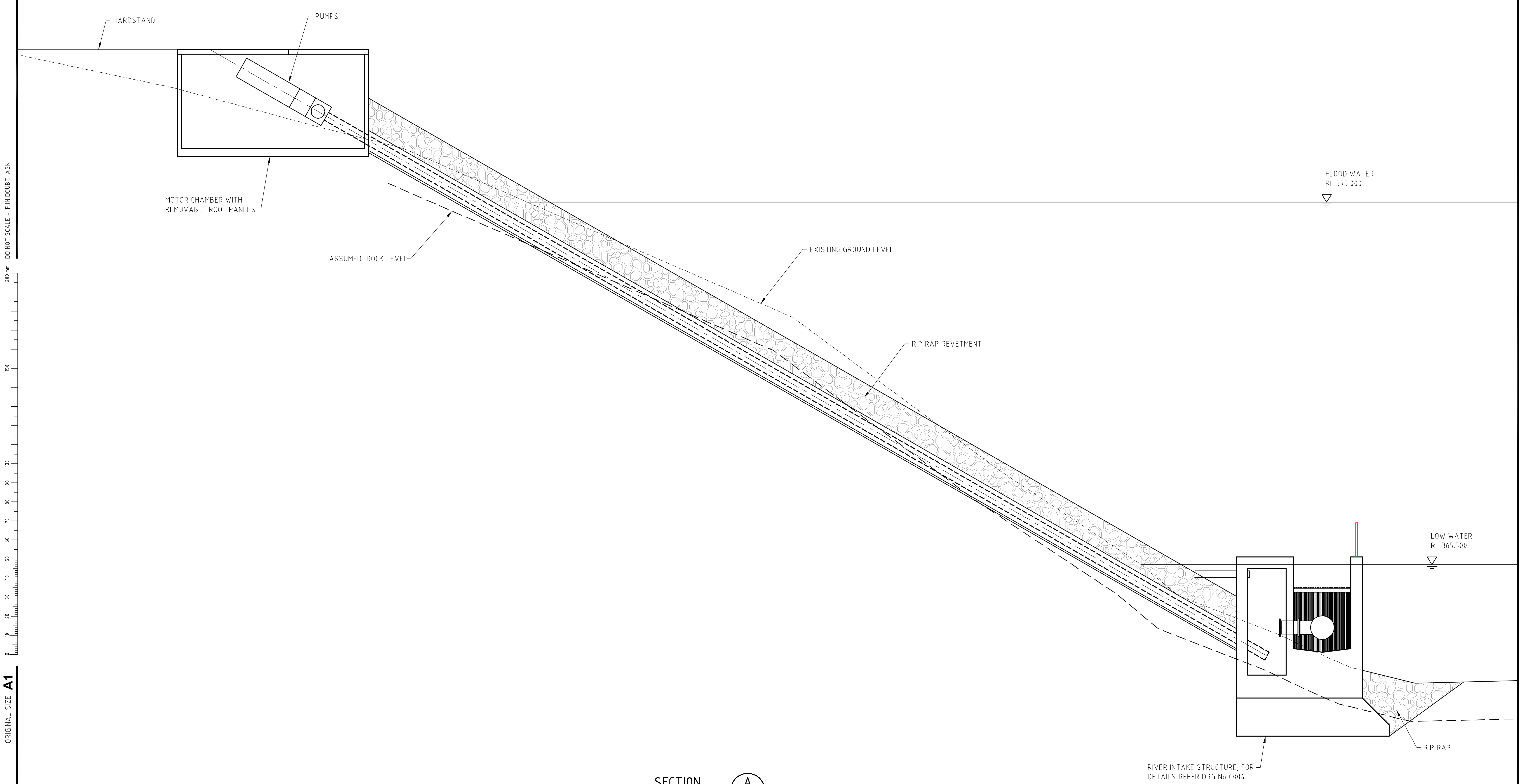
MACQUARIE RIVER PIPELINE
RIVER PUMP STATION

GENERAL ARRANGEMENT - PLAN

Status Stamp: FOR REVIEW
Date Stamp: 25.06.12
Coordinate System:
Scales: AS SHOWN
Datum:
Drawing No. A1324400-04-001-C001
Rev. A

ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK



SECTION A
SCALE 1 : 50
C002

SCALE OF METRES 1:50

NOT FOR CONSTRUCTION

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SURVEYED
DESIGNED
DRAWN S COYLE
DRAWING CHECK
DESIGN CHECK
DESIGN REVIEW
APPROVED **NOT APPROVED**
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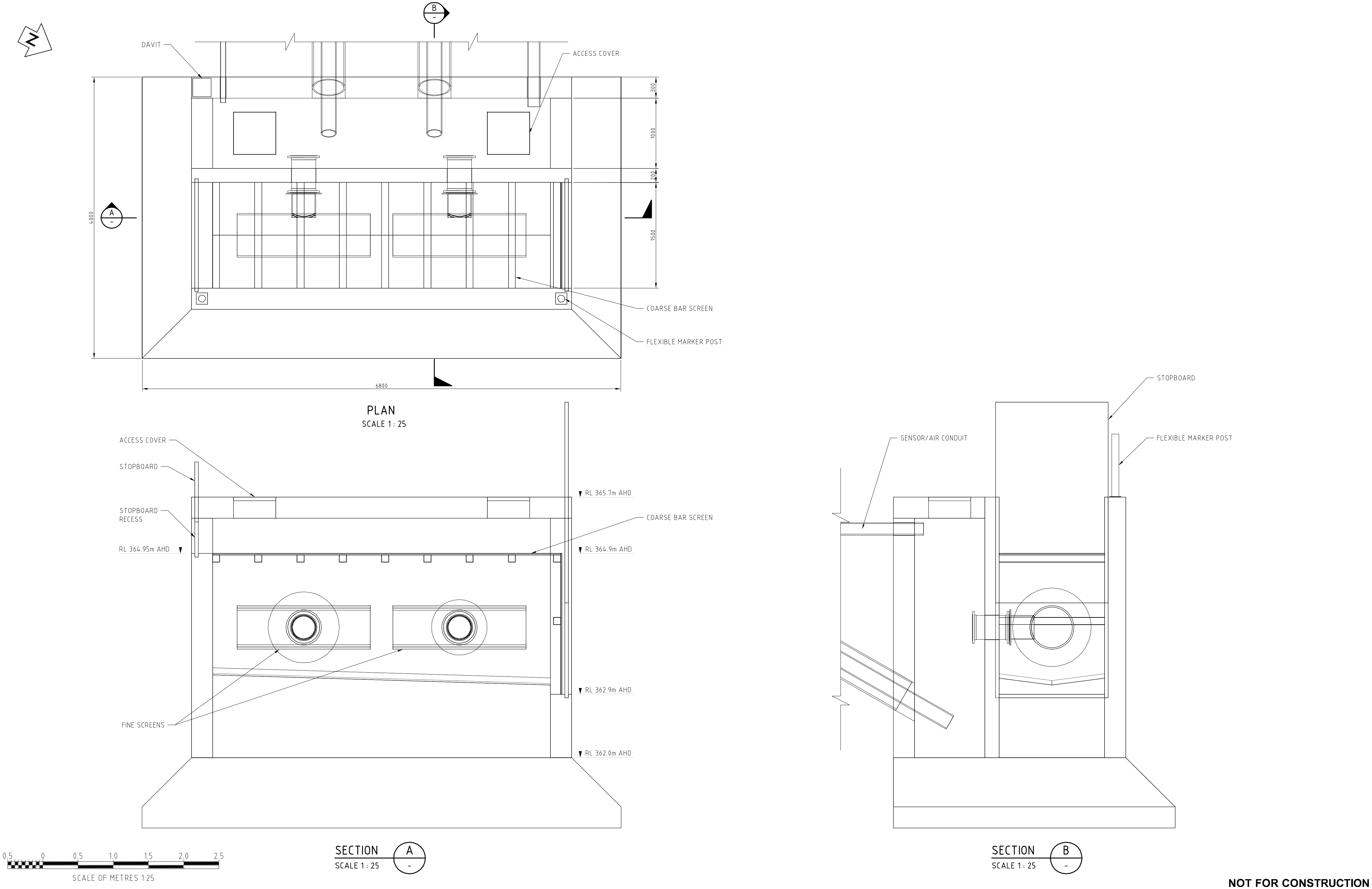
MACQUARIE RIVER PIPELINE
RIVER PUMP STATION

GENERAL ARRANGEMENT - SECTION - SHEET 1 OF 2

Status Stamp: **FOR REVIEW**
Date Stamp: **25.06.12**
Coordinate System:
Scales: AS SHOWN
Datum:
Drawing No. A1324400-04-001-C002
Rev. A



ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK

NOT FOR CONSTRUCTION

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SURVEYED		
DESIGNED		
DRAWN	L. CULLEN	JUNE 2012
DRAWING CHECK		
DESIGN CHECK		
DESIGN REVIEW		
APPROVED		
PROF REGISTRATION:		

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MACQUARIE RIVER PIPELINE
RIVER PUMP STATION

RIVER INTAKE STRUCTURE
GENERAL ARRANGEMENT

Status Stamp: FOR REVIEW

Date Stamp: 25.06.12

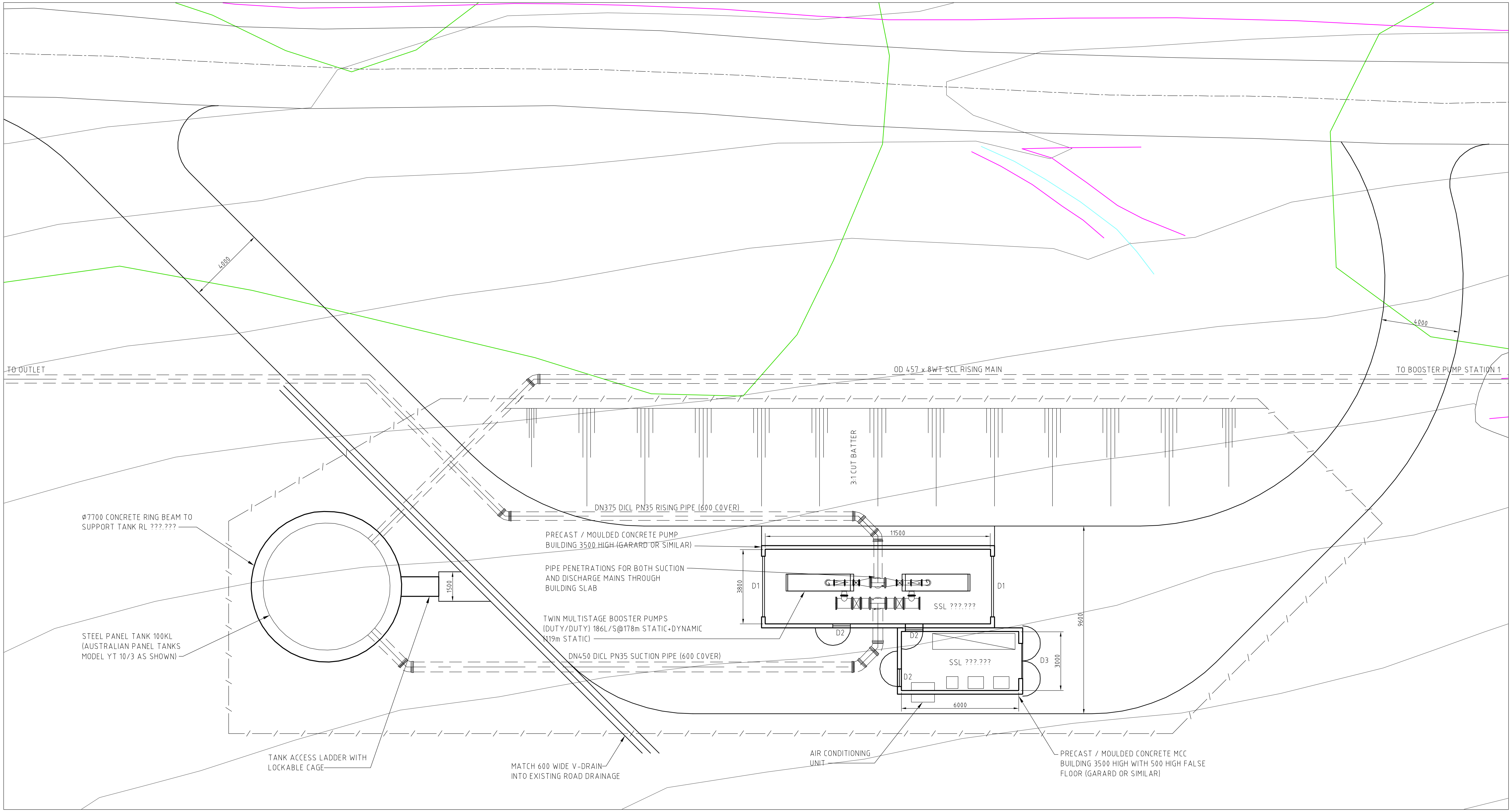
Coordinate System:

Scales: 1 : 25

Datum:

Drawing No.: A1324400-04-001-C004

Rev.: A



PLAN

SCALE 1 : 100

D1 - DENOTES ROLLER DOOR 3100 WIDE, 2750 CLEAR OPENING HEIGHT (BASED ON 3380 INTERNAL CEILING HEIGHT)

D2 - STANDARD 900 DOOR

D3 - 2 x 900 STANDARD DOORS

SCALE OF METRES 1:100

ORIGINAL SIZE A1 — DO NOT SCALE - IF IN DOUBT, ASK

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
A	ISSUED FOR 30% DESIGN REVIEW	SBC	JH	PC	27-06-12

SURVEYED
DESIGNED
DRAWN S COYLE
DRAWING CHECK
DESIGN CHECK
DESIGN REVIEW
APPROVED
PROF REGISTRATION

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MACQUARIE RIVER PIPELINE
BOOSTER PUMP STATION 2

GENERAL ARRANGEMENT

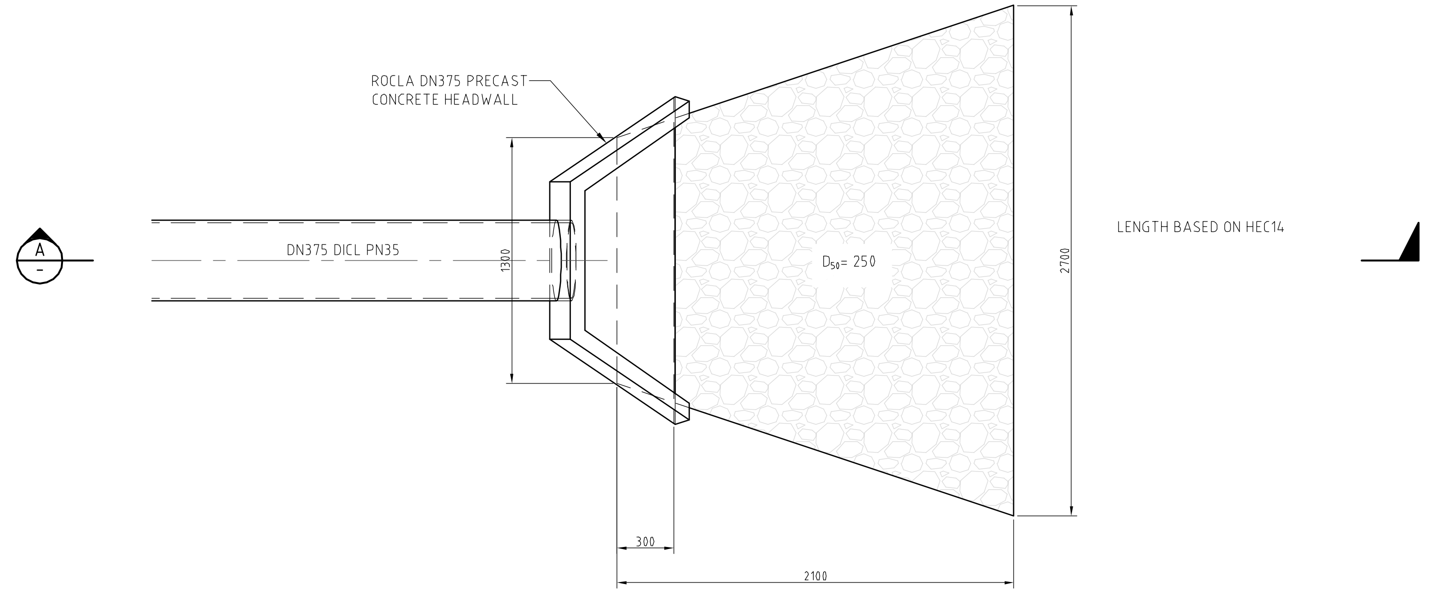
Status Stamp: **FOR REVIEW**

Date Stamp: **25.06.12**

Coordinate System:

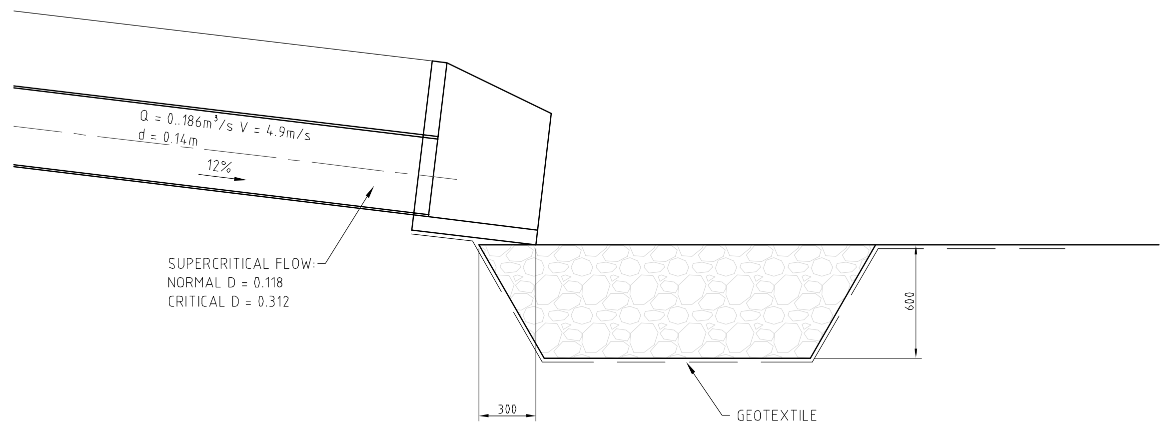
Scales: Datum:

Drawing No. A1324400-06-001-C001 Rev. A



SUMA PARK OUTLET PLAN

SCALE 1 : 20



SECTION A -

SCALE 1 : 20

0.4 0 0.4 0.8 1.2 1.6 2.0

SCALE OF METRES 1:20

ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE

SURVEYED	
DESIGNED	
DRAWN	SBC
DRAWING CHECK	
DESIGN CHECK	
DESIGN REVIEW	
APPROVED	NOT APPROVED
PROF REGISTRATION:	

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MACQUARIE RIVER PIPELINE
PRESSURE MAIN 3

SUMA PARK OUTLET
PLAN AND SECTION

Status Stamp: WORKING PLOT

Date Stamp:

Coordinate System:

Scales: Datum:

Drawing No. A1324400-03-001-C035 Rev. A