City Water Technology
Capability Information

July 2015

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1 About City Water Technology

1.1 Background

Based in Sydney, Australia, City Water Technology (CWT) has been assisting the water and wastewater industry evolve to meet ever more stringent standards for reliable, high-quality drinking water and treated wastewater for 25 years. Our clients include water authorities, local councils, state and federal government bodies, private companies, law firms, and other consultancies.

The CWT team specialises in:

- process technology for water and wastewater treatment, and water delivery and;
- design and documentation of management systems.

Our core business activities include auditing and optimising water treatment plants, water treatment options studies, process design and component specification, desk-top, bench-scale and pilot-scale research, operator training, production of operations manuals and design and advice on management systems.

Our achievements include:

- conducting process reviews or plant audits for over 120 water treatment plants;
- preparing detailed concept designs for approximately 50 new water treatment plants;
- carrying out or contributing to the detailed design and specification of around 30 WTPs. These WTPs have ranged from direct filtration, DAFF and conventional treatment to high technology plants including membranes and/or ozone/ BAC or UV;
- commissioning more than 25 WTPs;
- involvement in twelve desalination plant investigations and associated research;
- involvement in numerous wastewater research design and auditing projects with particular expertise in tertiary treatment;
- preparing detailed operating manuals for at least 40 treatment facilities plus a large range of standard operating procedures and work instructions;
- authoring instructional documents, including published booklets providing guidance on filters, chemical dosing, coagulation, flocculation and clarification;
- employment by government authorities to write a generic WTP operating manual, management protocols for Giardia and Cryptosporidium and copper corrosion, fact sheets for the NHMRC Australian Drinking Water Guidelines and other research documents and now Health Based Targets as proposed new guidelines ; and
- designing and documenting water quality management systems conforming to the Australian Drinking Water Guidelines Framework for Management of Drinking Water Quality; and
- designing and documenting recycled water management systems conforming to the Australian Guidelines for Water Recycling; and
- publication of approximately 40 papers and 4 books on various subjects and contributions to the Australian Drinking Water Guidelines and Health Based targets.

1.2 Our Consulting Approach

Our consulting approach is simple – working *with* our clients as partners on a shared objective. This approach fosters ongoing feedback between all involved parties and facilitates a transparent and collaborative working relationship, the foundation for successful project outcomes.

Our project management structure emphasises the establishment of a clearly defined scope of works and methodology with our clients before engagement, which enables us to more accurately define the program and budget, verify progress against agreed upon milestones, and produce the required deliverables on time and to our client's expectations.

We ensure high client satisfaction through clear communication and technical reporting, a hallmark of our business. And, our size allows us to be flexible to our client's needs and capable of adapting to variations when they arise. This is a key feature of working with CWT and one which we are proud to promote.

1.3 Our Organisation

CWT employ 21 staff, including 15 engineers and 2 scientists. CWT establishes staffing requirements early during the project proposal stage to ensure the appropriate level of resources are maintained throughout the duration of the project. After breaking down a project scope into defined tasks based on our experience, we are then able to allocate specific staff members in relation to their availability and expertise.

CWT operates out of a central office located in Sydney to minimise costs. Depending on the nature of the project, the project scope, and the client's requirements, CWT staff assigned to a particular project maintain active communication via phone, email, and face-to-face meetings as required. CWT maintains its project workload at a manageable level to ensure assigned staff are available throughout the life of the project. This fosters active collaboration between CWT and the Client as well as ensuring that the project budget/ schedule are adhered to.

However, we frequently undertake consulting services on sites outside of Sydney, and are sometimes required to work on-site for durations from a few days to several months. This is considered normal within our sphere of services and staff are quite happy to perform their tasks in this manner.

We can set up local project offices if necessary. CWT project managers and the Client normally agree to terms such as accommodation, disbursements, and/ or allowances during the proposal stage. Any work that can be carried out from our office is usually the preferred arrangement as it minimises project costs.

1.4 Services Provided

CWT provides the following services in the fields of water, wastewater, and industrial waste treatment:

- Management Plans
- Management system design and documentation
- Technical review
- Project Management
- Specialist information and advice
- Specifications and documentation
- Plant audits
- Commissioning
- Jar testing
- Pilot plant design and testing
- Investigations

- Benchmarking
- Options reviews and developments
- Concept designs
- Detail designs
- Cost estimates
- Operating and maintenance manuals
- Operator training
- Environmental Impact Assessments and Review

2 Business Management System

CWT operates under a Business Management System, which is certified to the international standards for quality management (ISO 9001) and environmental management (ISO14001) as well as the Australian Standard for occupational health and safety management (AS 4801). CWT's Business Management System has been operating since 2001 and has been externally certified to ISO 9001 since 2003, to ISO 14001 since 2012 and to AS 4801 since 2014. The system has been developed to complement management functions and ensure quality, sustainability and the health and safety of our employees and contractors.

The CWT Business Management System sets out specific requirements for management of projects, which would be adhered to for any project undertaken. These requirements include:

- Confirmation of scope and approach with Client on engagement, with any agreed changes noted;
- Preparation of a Project Management Plan, identifying all tasks and responsibilities and the required project deliverables;
- Close liaison with the Client to confirm tasks are undertaken as required;
- Deliverables reviewed and approved by the Project Manager before release to the Client; and
- Delivery of each task and deliverable on the Project Management Plan verified and recorded.

Post-engagement modifications to the original scope of works (raised by CWT or the Client) are commonly encountered and are not typically difficult to resolve. Any changes in approach and/ or impacts on the original budget/ timeframe would be agreed and captured in written correspondence prior to moving forward.

Our Business Management System is continuously reassessed and modified in response to changes in factors such as market conditions, regulations, client expectations, available technologies, company size and staff characteristics.

2.1 Quality Management

At CWT, quality is both a goal and a method of continuous improvement. Our belief is that the real measure of a quality service is meeting or exceeding a client's expectations by providing deliverables to a high technical standard, within agreed deadlines and within budget constraints. As quality is directly related to client satisfaction, our Business Management System is constantly reviewed to ensure we are addressing areas for improvement and capturing valuable feedback.

We aim to achieve continuous improvement of our systems and our performance through the cycle of monitoring, evaluation and identification of potential improvements. We aim to optimise our business activities for the current conditions and also recognise that any organisation or system must continue to be

evaluated and re-optimised over time in response to changes in factors such as market conditions, regulations, client expectations, available technologies, company size and staff characteristics.

Our Business Management System requires us to carry out adequate planning at the commencement of a project, nominate experienced staff and allocate sufficient resources for the duration of the schedule, and conduct continued review of our performance against the Project Management Plan throughout the project. Ensuring the active participation of senior staff at all stages of the engagement is particularly emphasised at CWT.

In our experience, the most likely cause of poor quality is failure to follow defined procedures. This could result through a lack of training or by taking shortcuts to achieve tight deadlines. At CWT, we place significant emphasis on training each staff member on our quality procedures as well as the technical aspects of our work.

This training and skill development is then recorded for all technical staff in individual 'skill matrices' by supervising senior staff. These records show which staff can work supervised, unsupervised or manage different types of projects. We believe this approach ensures that staff have adequate skills and training to undertake their project roles for quality outcomes and in turn, reduces the risk of failing to meet both our, and our client's, expectations. Furthermore, we find detailed planning during the pre-engagement phase, as required and recorded in the Project Management Plan, helps to minimise the risk caused by tight schedules.

At CWT, we learn from both our successes, and our failures. We capture undesirable incidents, experiences, and/ or perceived potential problems on an 'Improvement Form'. This form is set up to guide the user through the processes of investigation and identification of any future corrective/ preventive actions. The outcomes of these actions are then reviewed, evaluated and later presented at our monthly management meetings with involve all available staff. This process ensures that our Business Management System is continuously improved to adequately support project quality performance, with the result that mistakes are learned from and potential problems are recognised by all staff.

2.2 Work Health & Safety

CWT's Business Management System includes the following written Work Health & Safety policies and procedures:

- BM010 Management for Quality, Safety and Environment
- BP011 Business Management Policy for Safety, Quality & Environment
- BM030 Risk Management
- BM040 Work from Home
- BM050 Work on Site
- BM060 Work in the Office and at CWT
- BM070 Work in the Laboratory
- BM080 Contractor Management
- HP210 Consultation
- HP220 Vaccination

- HP230 WHS Incident Reporting and Investigation
- HP240 Return to Work
- HP 250 Personal Protective Equipment

All new CWT staff are required to read and agree to these policies and procedures as part of our employee induction process.

Our policies relate to, and impact upon, all work carried out by CWT staff. Specific workplace health and safety risks depend upon whether our staff are working out of our Sydney office (which may involve use of our laboratory), or on location. When we work at a client's site, we are typically required to observe the policies set out by their safety systems. Our location, then, determines what actions, if any, are required. As a minimum, all staff working on the project will have signed and agreed to the Work Health & Safety policies and procedures listed above, will have been trained in office hazards and, if applicable, trained in laboratory and/or typical field hazards and provided with PPE. If working on site, CWT staff will also be required to comply with site-specific procedures set by the client's safety controller. PPE requirements will be agreed upon with the client before CWT staff leave for site work/ visits. As required by legislation, all CWT staff will be covered by Workers' Compensation insurance.

2.3 Environmental Management

Reflecting the principles of our employees, and recognising our ability to influence positive change for the environment, we have incorporated sustainability directly into our Business Management System policy statement with the following commitments:

- *"prevention of pollution and minimising our impact on the environment"*
- "*continuously improving health and safety, quality and environmental performance within a framework of sustainable development*".

These intentions are communicated to all staff along with regularly reviewed environmental objectives established as part of the policy. Our Business Management System appoints an Environmental Officer who is responsible for ensuring that the environmental aspects of the management system are implemented and maintained. They also have the responsibility of amending and reissuing environmental management documents and advising staff of the principles and applications of environmental management procedures. We adhere to our environmental policy on all projects we engage in for their duration.

3 Insurances

CWT is covered by all relevant insurance policies as detailed below:

- Professional Indemnity ($10,000,000);
- Public Liability ($20,000,000);
- Products Liability ($20,000,000)
- Workers Compensation;
- Property in Custody/ Control;

- Office/Building and Contents/Stock Damage/ Burglary;
- Business Interruption;
- Equipment Breakdown;
- Comprehensive car insurance on all company vehicles.

4 Previous Experience

4.1 Management Systems

City Water Technology has designed management systems to comply with the Australian Drinking Water Guidelines Framework for Management of Drinking Water Quality including the following:

- Drinking Water Management Systems for 12 regional NSW Councils (as listed in section 4.2)
- Gosford City Council Water Quality Management System
- Gosford Wastewater System Risk Management System (participation)
- Orange's Stormwater Harvesting Risk Management Systems (part of a team)
- Drinking Water Quality Management Plans for Mackay Region
- DWQMPs for Banana Shire

City Water Technology has designed management systems to comply with the Australian Guidelines for Water Recycling (AGWR) for Management of Recycled Water including the following

- Recycled Water Management Plans for Banana Shire
- Recycled Water Management Plans for Cabonne Shire
- Recycled Water Management Plans for Essential Water Broken Hill

City Water Technology consultants have extensive management system experience in:

- Business process analysis, documentation and re-engineering;
- Management system design (quality, OHS, environment, sustainability, risk, compliance, corporate governance, HACCP, ISO 22000, integrated systems)
- Audits, investigations and reviews
- Technical writing (tenders, policies, procedures, manuals, forms etc)
- Planning and coordinating certification to ISO 9001, ISO 14001, AS 4801, ISO 22000, and AS 4360;
- Business planning and strategy development
- Business improvement
- Workshop facilitation
- Development and presentation of training packages.

4.2 Risk Management and Management Plans

CWT are, or have been, involved in risk management evaluations and developing management plans for:

Risk-Based Drinking Water Management Systems for Utilities in Regional NSW (for NSW Health)

CWT, with Risk Edge, has completed the development of Drinking Water Management Systems (DWMSs) for several NSW regional councils as part of a program conducted by NSW Health. These DWMSs cover 32 potable water supply schemes as follows:

- Balranald Shire Council (Balranald and Euston)
- Carrathool Shire Council (Carrathool, Goolgowi-Merriwagga and Hillston)
- Corowa Shire Council (Corowa, Mulwala and Howlong)
- Cowra Shire Council (Central Tablelands, Cowra, and Wyangala)
- Gunnedah Shire Council (Curlewis, Gunnedah, Mullaley and Tambar Springs).
- Hay Shire Council (Hay)
- Murrumbidgee Shire Council (Coleambally and Darlington Point)
- Tumut Shire Council (Tumut/ Adelong/ Cloverdale-Morgans Reserve, Batlow, Talbingo, Brungle)
- Wakool Shire Council (Barham, Tooleybuc, Koraleigh, Moulamein, Wakool and Murray Downs)
- Wentworth Shire Council (Gol Gol, Pooncarie, and Wentworth)
- Wyong Shire Council (Wyong)

The water supply systems have included:

- Bore and surface water sources;
- Various treatment processes including membrane, DAFF and conventional treatment;
- Bulk treated water supplies;
- Dual reticulation systems.

In developing each DWMS, CWT and Risk Edge have facilitated risk assessment workshops to assess the risks from catchment to consumer. A Critical Control Point (CCP) workshop was also conducted with each utility to develop CCPs to ensure that unsafe water is not released into the distribution systems and that it is protected from contamination during distribution. The outcomes of these workshops, data analysis and document review are used to prepare the DWMS document and associated critical procedures including CCP response procedures.

NSW Health has subsequently engaged CWT to provide process support to several additional Councils and assist with implementation of their DWMS.

Review of draft site-based management plans for three WTPs and STP for Mackay Regional Council (QLD)

CWT is currently assisting MRC to review three of their draft site-based management plans for Nebo Road (Mackay) WTP, Mirani STP (including pumping stations) and Sarina WTP. The purpose of a site-based management plan is to describe how activities are managed to minimise the effect on the surrounding environment. The review is undertaken to improve the existing documents for quality assurance and legislative compliance with Section 319 of the Environmental Protection Act.

North Queensland Bulk Ports Corporation - Port of Mackay

CWT was engaged to develop a Drinking Water Quality Management Plan for the Port of Mackay site that is managed by NQBP. CWT facilitated a risk assessment workshop to assess the risks from catchment to

consumer and consider possible CCPs. The outcomes of this workshop, data analysis and document review were then used to prepare a Drinking Water Quality Management Plan based on the Framework and complying with the Water Supply (Safety and Reliability) Act 2008, which has been approved by the water supply regulator. Critical documents including Standard Operating procedures, a Drinking Water Incident and Emergency Management Plan, and Drinking Water Incident Response Procedures, were also developed to assist NQBP in achieving compliance.

Port Macquarie-Hastings Council Drinking Water Management System

CWT developed a risk-based drinking water management system (including drinking water quality risk assessment and critical control point analysis) for Port Macquarie-Hastings Council's five drinking water supply systems.

Banana Shire water supply systems

CWT have carried out risk management evaluations and workshops and have developed Drinking Water Quality Management Plans (DWQMPs) for the water supply systems of the Banana Shire including: Biloela, Moura, Theodore and Baralaba systems. Critical Control Point analysis was also included.

Mackay Region water supply systems

CWT have carried out risk management evaluations and workshops and critical control point workshops and have developed DWQMPs for the water supply systems of the Mackay Region including: Mackay, Sarina, Mirani, Marian, Midge Point, Bloomsbury and other systems. CWT also carried out separate risk management workshops and developed concept designs for the augmentation of Mackay's Nebo Road WTP.

Banana Shire Council Recycled Water Management

CWT conducted risk management evaluations and workshops and have developed Recycled Water Management Plans (RWMPs) for the recycled water schemes of Biloela, Moura, Theodore and Taroom. These plans include irrigation management plans, site based management plans, end user agreements and CCP procedures, audit and annual report schedules and incident reporting procedures.

Cabonne Shire Council Recycled Water Management

CWT conducted risk assessment workshops and developed a Recycled Water Management Plan (RWMP) and CCP procedures for the recycled water schemes of Molong STP and Manildra STP. Manildra STP was a part of the Four Towns Sewerage Scheme providing new reticulated sewerage and treatment to replace septic tank systems, and the effluent is reused for crop irrigation at the neighbouring farm. The effluent from the Molong STP is used for dust suppression for Council's roads projects.

Essential Water Broken Hill Recycled Water Management

CWT conducted risk assessment workshops and developed a Recycled Water Management Plan (RWMP) and CCP procedures for the White Leeds wetland project that receives effluent from Broken Hill.

Orange Urban Water Recycling Program

CWT provided technical expertise in the award winning Blackmans Swamp Creek Urban Stormwater Recycling project. We were involved in risk assessment and management and technical resolution from the concept stage through design, construction, commissioning and operation.

Tweed Shire Water Supply System

CWT provided technical expertise in the development of the drinking water quality management program (by Water Futures) and participated in the risk assessment and management process.

Gosford Information and Water Quality Management Systems

CWT provided technical expertise in the development of the drinking water quality management system (by Water Futures) and then worked with Gosford City Council in developing an updated Information Management System. CWT continues to assist Council in updating the documentation required under this system, associated with catchment management, water treatment operation and reticulation management. CWT also investigated poor water quality issues and assisted in Council's Water Quality 2010 project.

Gosford Wastewater System

CWT provided technical expertise in the wastewater system risk assessment as part of a management program (by Water Futures).

Gosford Wyong Mardi to Mangrove Link

CWT conducted a risk management evaluation and workshop for the augmented water supply system for Wyong (pumping of storm event water from Wyong river) leading to recommended risk amelioration tasks.

Canberra's Water Supply System

CWT worked for ACTEWAGL in providing technical expertise to risk management evaluation and workshops and developed concept designs for options to deliver additional water from the Murrumbidgee River system to Canberra's water supply system as a drought emergency supply.

4.3 Documents and Manuals

Apart from several technical publications of our own and the many reports we produce, CWT have been involved in the production of numerous technical reports for companies and government departments including the co-ordination of input from several departments or groups. Several relevant examples follow:

Fluoride Dosing Rollout Across South-East Queensland Region

CWT were engaged to prepare revised Operations Manuals, SOPs and Work Instructions related to recently installed fluoride dosing systems. As part of this work, CWT also conducted operator training.

Subsequently, CWT was engaged to prepare documentation and train operators for each of the new "Stage 2" fluoride plants in the South-East Queensland region. In total, CWT's work on this project spanned 25 WTPs and two system types (sodium fluorosilicate bulk bag dry feed systems and sodium fluoride saturator systems).

Documentation at Gosford

Documentation of Gosford's water system to meet ADWG Water Quality Management Framework. Subsequently CWT also provided documentation (SOPs and WIs) for the catchment to tap system including catchment, process, civil and electrical aspects.

O&M Manuals

Detailed operating and maintenance manuals for several treatment plants including detailed drawings, labeled photos and diagrams. Production of manuals as both word documents and web browsable documents with hyperlinks and pop-up diagrams.

- Baralaba WTP (conventional),
- Biloela WTP (conventional),
- Broken Hill WTP (conventional with UV),
- Casino WTP (conventional),
- Coen WTP (DAFF and membranes),
- Dromana Chlorination system,
- Ellendale WTP (membranes),
- Gibson Island AWTP (Actiflo, membranes and RO),
- Gold Coast Desalination (review),
- Gosford's Bores,
- Hobart's Bryn Estyn WTP (contact filtration and conventional treatment),
- Landers Shute WTP (conventional with ozone/BAC),
- Maffra WTP (conventional),
- Moura WTP (conventional),
- Sunset Strip WTP (membranes)
- Swansea WTP (DAFF),
- Theodore WTP (conventional),
- Wingecarribee WTP (DAFF),
- Winneke WTP Sludge System,
- Several pilot water treatment plants,
- Several pilot/ demonstration desalination and water recycling plants

SOPs

Preparing Standard Operating Procedures (SOPs) and Work Instructions (WIs) for:

- Amity Point WTP;
- Boonah- Kalbar WTP;
- Borumba Dam WTP;
- Curtis Island Water & Sewerage Infrastructure Project;
- Dunwich WTP;
- Esk WTP;
- Gosford's Somersby WTP;
- Kilcoy WTP;
- Linkwater (now Seqwater) – bulk water transport system ;

- Lowood WTP;
- Maleny STP – numbering system;
- North Stradbroke Island WTP;
- Orange's Icely Road WTP;
- Petrie WTP;
- Phillip Island's Ian Bartlett WTP;
- Point Lookout WTP.

Training Manuals

Training manuals/training were also included on some of the above projects or were done alone on:

- Glen Innes STP;
- Banana Shire STPs;
- Kyneton STP;
- Illawarra WRP;
- Toowoomba's Mt Kynoch WTP

Other Documentation

- Writing of a generic operations and maintenance manual for WTPs for distribution to all members of the Water Directorates (NSW and Queensland).
- Writing of the published booklets "Practical Guide to the Operation and Optimisation of Media Filters" and "Practical Guide to the Optimisation of Chemical Dosing, Coagulation, Flocculation and Clarification" and associated workshops around Australia.
- Writing of 36 fact sheets on chemicals used in water treatment for the Australian Drinking Water Guidelines for NHMRC.
- Environmental Management Plan for the Kurnell Desalination Plant
- Co-ordination of input from several government departments, writing sections of, editing and production of "The Management of *Giardia* and *Cryptosporidium* in Town Water Supplies - Protocols for Local Government Councils" for NSW Department of Land and Water Conservation.
- Obtaining information on corrosion problems from NSW Councils, developing corrosion control database and producing detailed published report and paper for conference presentation for NSW Department of Land and Water Conservation.
- Administration of wastewater research program (1996 - 2000) for NSW Department of Land and Water Conservation - evaluating progress and editing and producing final research reports. Main research projects included: Application of duckweed in treating municipal wastewater; Assessment of stormflows in sewerage systems; Algae control and removal from tertiary sewage treatment ponds; Effluent reuse for silviculture; Reuse of alum sludge; Tertiary Filtration; Review and editing of various reports including ocean and estuarine sewage outfall performance, constructed wetlands, effluent reuse and disposal. Published reports were produced for all of these projects.
- Significant contributions as specialist writers for bid documentation for several organisations.
- A booklet on Particle Counting Australia was written and produced by us for publication by Pacific Dynamics.
- Approximately 30 journal articles and conference papers have been published.

- Detailed concept design reports, evaluation reports, specific issues reports have been provided or contributed to for many WTPs throughout Australia and SE Asia.

4.4 Water Treatment Investigation and Design

Asbestos risk evaluation in raw water source and treatment options for Orange City Council

Assessment of risks associated with naturally occurring asbestos in the raw water catchment and asbestos in the drinking water supply. Investigation of treatment barriers available at the existing Icely road WTP at Orange and options for the disposal of sludge containing asbestos according to regulations in place.

Investigation on taste and odour issues in the Hobart drinking water supply for TasWater

CWT was engaged by TasWater to investigate significant taste and odour issues occurring in the Hobart reticulation system. The raw water source was found to contain important natural organic matter (NOM). Treatment options such as activated carbon systems were proposed for the removal of NOM. The options included Powdered Activated Carbon (PAC) dosing systems and Granular Activated Carbon (GAC) systems.

12 ML/d Blackwater WTP Upgrade

CWT was approached by Central Highlands Regional Council to provide engineering services for the upgrade of Blackwater WTP. This work included the development of a Concept Design, P&IDs and layout drawings of pre-coagulation oxidant (potassium permanganate and/or chlorine), PAC chemical dosing system, Contact tank for iron/manganese oxidation and PAC adsorption processes, pre-filtration chlorine dosing arrangement (to function as part of coated media process for manganese removal), upgrade of WTP control system to achieve automatic backwashing triggers, ramping of WTP flow rates and improved chemical dosing control

55 ML/d Wagga Wagga WTP for Riverina Water County Council and NSW Public Works

CWT worked with KBR to prepare a concept design for the upgrade of Wagga Wagga WTP. The concept design included new clarifiers (two options allowed), dual media filters and chemical dosing systems and modification to the existing washwater handling system. CWT has subsequently been asked to be on a technical review panel for the detailed design phase.

4 ML/d Marian WTP for Mackay Water

CWT have been engaged to deliver this project from beginning to end. Options evaluation, concept design, EOI, technical specification and tender review have been completed. Following finalisation of the D&C Contract, CWT will continue to perform the role of owner's engineer and will assist in design review, HAZOP and commissioning.

6 ML/d Moura WTP for Banana Shire Council

CWT have completed options development and concept design for the staged upgrade of Moura WTP and are currently preparing a technical specification for Stage 1. The first stage of the upgrade is to include new PAC and potassium permanganate dosing systems, a raw water oxidation tank and a new washwater handling system.

Molong WTP Augmentation (2 ML/d) for Cabonne Shire Council

CWT has completed concept development, design review and specifications and continues to provide process advice as required.

720 ML/d Happy Valley and 273 ML/d Hope Valley WTPs for SAWater

CWT (with WTA and Hydrological) evaluated the filtration systems at each of these WTPs and provided options for refurbishments required to rehabilitate these filters. CWT was employed as an independent reviewer of the proposed design by SAWater/Aurecon.

232 ML/d Douglas WTP, Townsville for United Utilities (now TRILITY) Australia

CWT evaluated the performance of Modules 3 and 4 (direct filtration) components of the WTP and designed significant filter refurbishments in conjunction with Water Treatment Australia. CWT also reviewed and assisted in the optimisation of the WTP's wastewater system.

Broken Hill WTP (32 ML/d) for Country Energy (now Essential Energy)

CWT acted as owner's engineer for concept development, design review, specification, D&C tender review, Superintendent and commissioning of a proposed new WTP to replace the existing WTP. Pilot plant studies were included. O&M manuals were also developed.

Nebo Rd WTP Mackay (95 ML/d) for Mackay Water

CWT is assisting an alliance team as process concept designers and reviewers for the upgrading of the WTP to improve filter performance, wastewater treatment and to add additional processes to the WTP. Commissioning was also provided.

Northern Network Alliance

Process options development and concept design for proposed 215 ML/d Traveston WTP in conjunction with KBR.

Townsville - Douglas (250 ML/d), Toonpan (40 ML/d) and Northern (40 ML/d) WTPs

CWT carried out investigations and concept design for each of these three WTPs for Veolia/ Baulderstone Hornibrook's bid for the DBO contract for these WTPs.

Somersby WTP (140 ML/d) for Gosford City Council

CWT investigated water quality issues and developed and commissioned water treatment upgrades including pre-treatment lime/ carbon dioxide/ potassium permanganate and filter pre-chlorination systems.

Brisbane Caboolture Aquifer Alliance

CWT were design reviewers for this project which provided several new WTPs around Brisbane and on Bribie Island which will treat bore water for pumping into the reticulation.

Moura 6 ML/d WTP Audit and Manganese Investigations; Planning Reports and Operating and Maintenance Manuals for four WTPs for Banana Shire Council

CWT carried out an audit of the Biloela, Moura, Theodore and Baralaba WTPs and investigated several water quality issues especially high manganese concentrations in the treated water. Planning reports and O&M manuals have been written for each plant.

Coffs Harbour WTP for Coffs Harbour City Council

CWT acted as owner's engineer providing design review and technical advice for an alliance project for a proposed new 42 ML/d DAFF with UV WTP.

Landers Shute 140 ML/d WTP, Caloundra and Maroochydore, Qld, for Landers Shute Water Alliance/ Aquagen

CWT were part of a design team, developing concept design and reviewing detail design for a significant upgrade of the Landers Shute WTP to provide high quality water and to deal with taste and odour and algal toxin issues. Bruce Murray (CWT) was the lead process engineer for this project with assistance from other CWT staff for design and commissioning. CWT have also prepared the detailed, electronic operations and maintenance manuals for this project.

The 80 ML/d WTP was upgraded to 140 ML/d with pre-ozonation and post-ozonation with biological activated carbon (BAC) filters being added to a plant which includes manganese oxidation and corrosion control. The project received an Engineering Excellence Award (Qld, 2004).

Mt Stromlo 250 ML/d and Googong WTPs, ACT

CWT continue to act as process advisors to ACTEW and ACTEWAGL for the provision of treatment systems at 250 ML/d Mt Stromlo and Googong WTPs.

Proserpine (4.5 ML/d) and Beach (11.5 ML/d) WTPs with JWP for Whitsunday Shire Council

CWT provided the process designs for two direct filtration WTPs with manganese removal to treat bore water. Commissioning and operator training (with manual) has recently been completed by CWT.

Lake McDonald 46 ML/d WTP Noosa, Qld, for General Water Australia

CWT were part of Veolia Water's team who developed concept and detail design for a significant upgrade of the Noosa WTP to provide high quality water and to deal with taste and odour, manganese and algal toxin issues. Functional specifications and commissioning plans were also written by CWT for the WTP.

CWT carried out initial plant audit, jar testing, pilot plant investigations and plant trials to determine the concept design for the WTP. The concept design was developed to meet strict water quality requirements for manganese and taste and odour compounds. Manganese control included a three stage approach to meet a requirement of 0.01 mg/L Mn (dam destratification, potassium permanganate dosing and chlorination prior to manganese oxide coated media). Improved coagulation mixing was provided and polymer dosing was added to improve the performance of the clarifiers and increase the capacity of the WTP (with some hydraulic modifications). Ozonation and biological activated carbon filters were added for taste and odour and algal toxin control. CWT continues to work at this WTP on upgrading the sludge handling system.

Bendigo (126 ML/d), McCay (18 ML/d) and Kyneton (7.5 ML/d) WTPs Vic, for Bendigo Water Services

CWT staff worked as part of Veolia Water's team developing and costing various process options and subsequent concept and detail design for three microfiltration membrane with ozone/ BAC WTPs to provide high quality water and to deal with taste and odour/ algal toxin issues. Detailed design of the sludge and wastewater handling systems, equipment and chemical specifications and commissioning plans were also written by CWT. CWT staff were part of the commissioning team.

CWT was involved in upgrading the Bendigo WTP to provide new sludge handling systems and new PVDF membranes.

Molendinar (180 ML/d) and Mudgeeraba (70 ML/d) WTPs for Gold Coast Water

CWT carried out investigations and pilot plant testing for the upgrade of the Molendinar WTP (with HWA) to 180 ML/d. This work involved detailed pilot plant testing between 1995 and 1998 and with several reports produced during this period. This work lead to the design for the WTP upgrade.

CWT, with assistance from Water Treatment Australia, carried out a detailed review of operation and redesign of filter media and underdrains for the Molendinar filers in 2001. Subsequently this team carried out a similar review for the Mudgeeraba filters.

CWT carried out a review of alkali dosing options to minimise water corrosivity for the Molendinar WTP in 2002.

CWT acted as process designer for the upgrade of Mudgeeraba WTP (with JWP). This work included concept design for the upgrade and specification and design review. CWT also reviewed functional descriptions and commissioning plans (2003 to 2005).

CWT wrote operating and maintenance manuals and several workplace procedures for the new fluoridation plants for both Molendinar and Mudgeeraba WTPs and trained the operators in the operation of these plants (2009/10).

4 ML/d Swansea WTP (Tas) for Southern Water

CWT carried out commissioning and performance and capacity trials for this WTP in the absence of the WTP contractor – a result of contractual disputes.

WTPs and 8 Treatment Schemes (Tas) for Southern Water

CWT performed plant audits at 5 WTPs and 8 treatment schemes within the Southern Water network to identify and document areas of suboptimal performance and determine preferred costed options for improving plant performance to achieve ADWG.

Huonville WTP (Tas) for Southern Water

CWT is acting as owner's engineer for concept development, design review, specification, D&C tender review, and commissioning support of a new 9 ML/d DAFF WTP to add to the existing 4 ML/d WTP.

Ellendale WTP (Tas) for Southern Water

Trouble-shooting and auditing for a 0.1 ML/d WTP incorporating pressurised ultra-filtration modules. Advice regarding capacity upgrade of the plant was also provided.

Operations and Maintenance manuals have also been developed.

Bryn Estyn 160 ML/d WTP Hobart, Tas, for Hobart Regional Water Authority

CWT carried out a detailed audit, evaluation and optimisation of the WTP. CWT introduced a number of process improvements after plant trials enabling the satisfactory operation of a poorly operating, contact filtration plant including: supervision of filter media installation, design, specification, tender review and commissioning of new polymer system, design of coagulant mixing system, options study for pH adjustment and corrosion control, review of sludge handling system and design and monitoring of modifications to system. Electronic operation and maintenance manuals were also provided.

CWT managed an alliance of specialists to resolve, design and implement various upgrades required for Bryn Estyn WTP including: plant automation, pre-lime system, polymer system, new chlorination system and automatic monitoring system.

CWT developed concept design for future upgrades to the WTP including: refurbishment of the Stage 1 filters to replace underdrains and install new media along with automation of the filters. A concept design was also developed for upgrading the Stage 2 filters to DAFF.

Distillery Creek WTP(Tas) for Esk Water

CWT carried out an audit and evaluation of the Distillery Creek WTP and developed costed options for a new DAFF WTP.

Reatta Rd WTP (Tas) for Esk Water

CWT carried out an audit and evaluation of the Reatta Rd WTP (with Water treatment Australia and developed options for improved mixing and flocculation.

WTPs for Perth, Longford, Cressy, Ross, Campbell Town (Tas), for Northern Midlands with Hunter Water Australia

CWT carried out water treatment options studies, costings and site evaluations for these WTPs including a concept design for the DAFF Perth/ Longford WTP.

Audits of Tasmanian fluoride plants for Department of Health and Human Services

CWT audited and reported on the 50 fluoride plants of Tasmania including a detailed database of each plant. These audits were carried out twice (3 years apart)

Corrosivity Evaluation for Burnie WTP (Tas) for Burnie City Council

CWT carried out an evaluation of the corrosivity of the treated water from the WTP leading to recommendations for the addition of lime and carbon dioxide dosing systems.

Ampara WTP (17.5 ML/d), in Sri Lanka for Outokumpu

Bruce Murray was sent to the remote Ampara WTP as a treatment specialist for evaluation and issues resolution for a recently constructed DAFF plant.

Lane Cove Tunnel WTP (2.5 ML/d) with Parsons Brinckerhoff for Thiess/ John Holland Joint Venture

CWT have carried out jar tests, investigated treatment options and developed concept design and specification for treatment of groundwater, containing iron, manganese and contaminants.

Mudgee, NSW with Hunter Water Australia for Mudgee Council and NSW Public Works

CWT worked on concept design, design development and specification for a new conventional WTP including softening.

Coen WTP (0.5 ML/d), Qld, for Cook Shire Council

CWT worked on options development, specification, tender review, construction advice, commissioning, operations manual and radiation impact assessment for the Coen WTP. The WTP comprised coagulation, granular filtration and membrane filtration for the removal of algal toxins, arsenic, heavy metals and radioactive isotopes. DAF was later added for algae removal.

Prospect WTP, NSW (3,000 ML/d) for Sydney Water

This work comprised management of pilot and prototype plant research into leading edge technology in mixing, coagulation, filtration, particle counting, streaming current detection, on-line aluminium analysis, aluminium speciation and *Cryptosporidium* removal. The research work won two engineering excellence awards (NSW 1992 and Aust, 1994).

4.5 Wastewater Treatment Investigations

In addition to the work detailed below CWT has carried out jar testing to determine dose requirements and/ or developed concept designs for chemical phosphorus removal for several WWTPs. We have also been involved in several NSW government research programs into improvement phosphorus and nitrogen removal systems.

Sludge Dewatering trials (for Degremont)

CWT is currently assisting Degremont to conduct sludge dewatering trials using the Dehydris Twist (TM) piston press technology. Site have included, to date: Luggage Point WWTP, Loganholme STP, and Oxley Creek STP. CWT's role includes: operation of the pilot plant, various sampling and analysis, process advice, commissioning assistance at the beginnings of trials, and decommissioning assistance at the ends of trials.

Toukley and Bateau Bay Recycled Water Scheme End Use Control Review (NSW)

CWT were engaged to undertake an investigation of the end user controls at the Wyong Shire Council's recycled water schemes for compliance with the Australian Guidelines for Water Recycling (AGWR). Central to implementation of the AGWR is developing understanding and managing the risks to public health and the environment. The work included participation to the inception meeting, preliminary gap analysis, preparation of questionnaire for irrigation stakeholders/end users, inspection of recycled water usage locations and preparation of audit report and associated recommendations.

East and South Lismore WWTPs for Richmond Valley Council

CWT was responsible for the preparation of a concept design for chemical phosphorus removal at the two plants.

Coraki WWTP for Richmond Valley Council

CWT performed jar tests and subsequent detailed options review for chemical dosing to control algae and reduce TSS levels in treated effluent.

Cowra WWTP for Cowra Shire Council

CWT was involved in a chemical phosphorus removal research program.

Application of Duckweed in Treating Municipal Wastewater

CWT managed the research team, which investigated the performance of a full-scale duckweed demonstration system. This work lead to a published paper for the Urban Water Research Association of Australia.

Bowral STP Odour Management Plan and wet weather overflow recommendations for Wingecarribee Council

CWT was involved in the preparation of an Odour Management Plan and odour mitigation strategies development for the Bowral STP. The plant receives large wet weather flows and needed to find ways to meet EPA licence requirements during those events.

Fly Camp Wastewater Treatment Plant Assessment for Chevron/Gorgon LNG project

CWT prepared an independent report on the ability of the existing de-commissioned plant to be refurbished so that it can be put back on line to treat 200,000L of raw sewage per day. The focus was on process issues and elements within the extended aeration plant.

Capacity Study for Chevron/Gorgon LNG project Bridging WWTP with Monadelphous

CWT was contracted to evaluate of process capacity of the Bridging MBR plant to determine how many staff can be accommodated at the camp. Recommendations for operation and monitoring were prepared as a part of the process overview.

Nauru Regional Processing Centre Water and Wastewater Treatment Plant Optimisation for Transfield Services

Evaluation and optimisation of the Sequencing Batch Reactor WWTP (Biological N and Chemical P removal) to ensure effluent can be reused for irrigating food crops. Additionally CWT assessed the disinfection of the water supply and recommend ways to ensure compliance with ADWG.

Sampling Campaign at Morpeth STP for Veolia Water Australia

Assistance was provided to the VWA bid for the Hunter Water Operations and Maintenance contract at the Morpeth STP. The Morpeth STP is a full BNR plant that struggles to meet its TN effluent limit and recommendations were sought as a part of the challenge question posed during the bid process. CWT assisted in preparation of a sampling schedule and points, JSEA's, installation of autosamplers, and all sampling and process observations for 3 weeks to inform the recommendations for process upgrades.

4.6 Water Treatment System Commissioning and Operation

The following treatment systems have been commissioned and/or operated by CWT:

- Mount Martha WRP - commissioning.
- Somers WRP – commissioning
- Packenham WRP - commissioning
- Crescent Head WTP - Operations
- Eastern WRP - commissioning.
- Eastern STP Upgrade - commissioning.
- Sarina WTP – Operations
- Christchurch Emergency Desalination Plant – commissioning and operator training.
- Nebo Rd WTP upgrade (Mackay) – commissioning and plant operation.
- Broken Hill WTP – commissioning.
- Winneke WTP Upgrade (Melbourne) – commissioning management.

- Gibson Island WRP demonstration plant – commissioning and operation.
- 4 x Murray River WTPs – commissioning.
- Melbourne desalination pilot plants – commissioning and operation.
- Sydney desalination pilot plants – commissioning and operation.
- Perth desalination pilot plants – commissioning and operation.
- Gold Coast desalination pilot plant – commissioning and operation.
- Pimpama Chemical Dosing Facility.
- Chambers Flat Chemical Dosing Facility.
- Landers Shute WTP (Sunshine Coast) – commissioning team.

4.7 Plant Audits

CWT has investigated and audited many WTPs leading to improved operations in most cases including:

In New South Wales

UTILITIES IN REGIONAL NSW (FOR NSW HEALTH)

As part of a program conducted by NSW Health, CWT has audited numerous water treatment plant utilities, identifying process and operational issues for several NSW regional councils. The company has offered assistance with plant, chlorination and fluoridation systems evaluation and optimisation, jar testing investigation, development of operating procedures, preventive management plans for manganese, algae & cyanobacteria. This work covered 29 potable water supply systems as follows:

- Bombala Council (Bombala WTP and fluoride, and Delegate supply system)
- Central Darling Shire Council (Wilcannia, White Cliffs and Ivanhoe WTPs)
- Cowra Shire Council (Wyangala WTP)
- Forbes Shire Council (Forbes WTP - audit and operating procedures)
- Gunnedah Shire Council (Gunnedah fluoridation system)
- Kempsey Shire Council (Kempsey & Lower Macleay and Willawarrin Schemes)
- Leeton Shire Council (Murrami WTP - audit and jar testing)
- Mid Western Regional Council (Rylstone, Mudgee and Gulgong WTPs)
- Moree Plains Shire Council (Boggabilla and Mungindi WTPs - manganese management plan and algae & cyanobacteria preventive management plan)
- Murrumbidgee Shire Council (Colleambally and Darlington Point supply systems)
- Narrandera Shire Council (Narrandera WTP)
- Snowy River Shire Council (Dalgety WTP, Jindabyne, Jindabyne Barry Way, East Jindabyne/ Berrydale, Kalkite, Adaminaby and Eucumbene Cove supply systems)
- Warrumbungle Shire Council (Coonabarabran and Mendooran WTPs)
- Yass Valley Council (Yass WTP)

OTHER AUDITS CONDUCTED BY CWT IN NSW INCLUDED:

- Molong, Cowra, Gosford, Illawarra, Orange (2 WTPs), Wyong, Woronora, and Sunset Strip;

In Queensland

UTILITIES IN REGIONAL QLD (FOR QLD WATER DIRECTORATE)

CWT has reviewed several water treatment plant utilities as part of a program launched by the Qld Water Directorate. The company has offered assistance with WTPs, proposing recommendations for process and operations optimisation. This project was conducted in partnership with Hydrological Pty Ltd and covered 16 potable water supply systems as follows:

- Barcaldine Regional Council (Alpha, Balcardine and Jericho WTPs)
- Barcoo Shire Council (Jundah, Stonehenge and Windorah WTPs)
- Cherbourg Aboriginal Shire Council (Cherbourg WTP)
- Longreach Regional Council (Ilfracombe, Isisford, Longreach and Yaraka WTPs)
- South Burnett Regional Council (Blackbutt, Gordonbrook (Kingaroy), Murgon, Proston and Wondai WTPs)

OTHER AUDITS CONDUCTED BY CWT IN QUEENSLAND INCLUDED:

- Moura, Biloela, Baralaba, Theodore, Cooktown, Windorah, Jundah, Stonehenge, Townsville, Charters Towers, Gold Coast (Molendinar and Mudgeeraba), Brisbane (sludge systems of 3 WTPs), Landers Shute, Noosa, Toowoomba, Hervey Bay;
- CWT has also conducted process audits on the following plants, for Seqwater in conjunction with MJM Environmental:
    - Boonah-Kalbar, Canungra, South Maclean.

In the ACT

- Mt Stromlo and Googong WTPs;

In Tasmania

- Ellendale, Burnie, Hobart, Boyer, Huonville, Reatta Rd, Distillery Ck, Donnellys Road, Dover, Geeveston, Prosser, Triabunna, Oatlands, and Bothwell;
- CWT audited and reported on the 50 fluoride plants of Tasmania including a detailed database of each plant.

In Victoria

- Murchison, Tatura, Tocumwal, Traralgon, Tarago, Bonnie Doon, Mafra, Mirboo North, Winneke, and Shepparton;

In South Australia

- Hope Valley and Happy Valley.

4.8 Bench and Pilot Plant Studies

Detailed bench and/ or pilot plant studies have been or are being carried out for:

- Broken Hill, Cascades, Coffs Harbour, Grahamstown, Greaves Ck, Greystanes Quarry (Parsons Brinckerhoff), Gosford, Illawarra, Lane Cove tunnel (Parsons Brinckerhoff), Lithgow, Liverpool and Quakers Hill (STPs), Macarthur, Moss Vale Drill Site (Parsons Brinckerhoff), Prospect, Quakers Hill, Sydney (desalination), Sydney LPG Cavern (Parsons Brinckerhoff), Woronora, NSW;
- Brisbane, Coen, Warwick, Charters Towers, Kilkivan, Hervey Bay, Toowoomba, Gold Coast, Noosa, Landers Shute, Pine Rivers, Proserpine QLD;

- Shepparton, Bendigo, Ballarat, Bright, Traralgon, Erica, Rawson VIC;
- Mt Stromlo, Googong, Molongolo ACT;
- Launceston, Hobart, Tasmania

The pilot processes tested during the above studies have included:

- Conventional treatment
- Contact and direct filtration
- Dissolved Air Flotation
- Filtration only (for evaluation of different filter media configurations)
- Oxidation with coated media and chemical oxidants
- Ozone-BAC process
- Membrane processes
- Actiflo wastewater treatment process
- Desalination;
- Wastewater treatment
- Groundwater treatment studies.

In some cases, pilot plant study results prepared by CWT have been used as the basis for published technical papers.

CWT has designed, specified and in some cases constructed pilot plants for the following treatment processes:

- Oxidation/ filtration process for reduced turbidity and manganese removal (Illawarra WTP, NSW and Noosa WTP, Qld)
- Contact/direct filtration process (Mt Stromlo WTP, ACT)
- Ozone- BAC process (Bendigo, Vic and Noosa, Qld)
- pH control, oxidation and direct filtration process (Illawarra, NSW).

4.9 Ground Water Management and Treatment

Brackish Groundwater Treatment for Small Communities for National Water Commission

CWT worked with NSW Public Works and others to study and cost brackish water treatment as a viable option for small and remote communities including evaluating existing systems (2011).

North West MetroLink Rail Project for Parsons Brinckerhoff

CWT advised PB in water quality management and likely treatment for the proposed tunnels (2008).

Lane Cove Tunnel for Parsons Brinckerhoff

CWT assisted PB in developing groundwater quality management in the tunnel, mains cleaning and iron bacteria minimisation and treatment of the groundwater and cleaning water. This work included concept design and specification and costing of a water treatment plant. (2005/06)

Transgrid Tunnel for Walter Construction Group

CWT completed investigations into iron and iron bacteria problems associated with tunnel groundwater leading to modifications to the installed treatment system. Sampling and analysis was also carried out (2004).

CrossCity Tunnel for SKM and Downer Engineering

Water treatment and testing. Two stages of jar testing were carried out to better define treatment parameters and sampling and testing was carried out to monitor water quality variations and salinity through the tunnel system (2003/04). Further evaluation of the WTP and discharge issues was subsequently carried out (2005/06).

Springvale and Clarence Coal Mines, Lithgow, NSW

Options investigation into removal of manganese and other contamination from mine water (2003/04).

4.10 Public and private swimming pool systems

Biloela Swimming Pools for Banana Shire Council

In December 2012 to January 2013, Biloela Aquatic Centre's 25 meter swimming pool was closed in response to issues with their existing filtration system.

City Water Technology was engaged by Banana Shire Council to review tender submissions for filter upgrades. The review analysed capacity, cost and technical considerations. The technical considerations included ease of installation, pumps, piping and valve requirements, Cleaning-In-Place/backwashing and water quality specification guarantees.

Together with this data, CWT performed various performance calculations with respect to flow, media volume and backwash requirements. These performance criteria were weighted against capital and operating costs. Recommendations were put forward for the eventual upgrade.

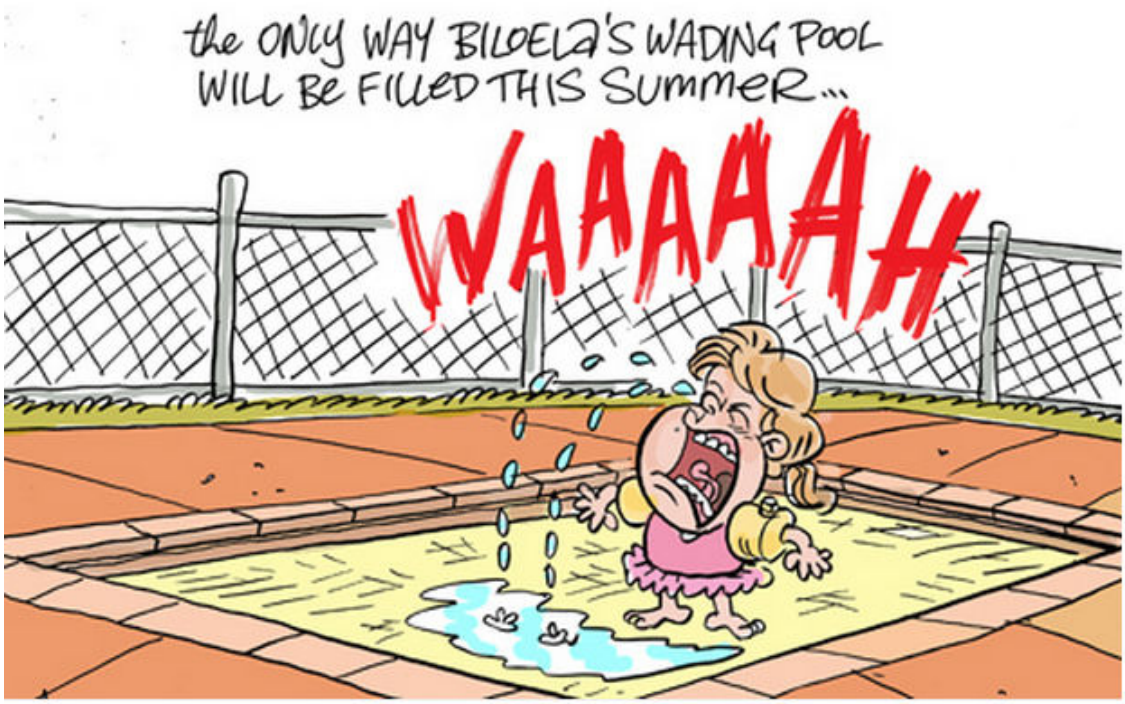

Figure 4-1 Excerpt from the Central Telegraph 31 Aug 2012

Various Swimming Pools for Sydney Region

Any surface in a pool or spa in contact with the water will have a film of bacteria which develops rapidly over a period of hours or days. The vast majority of the bacteria will be harmless, however, the greater the concentration of bacteria, the more likelihood there will be that some of the bacteria could be potentially dangerous.

CWT has worked with various chlorine and saltwater based swimming pools in the Sydney region and has catered recommendations for the management of their water quality through various treatment options including chlorine and UV disinfection and filtration.

Olympic Rowing Course for Penrith Lakes Development Corporation

Prior to the 2000 Sydney Olympics, CWT was engaged in the design of a destratification system for Middle Basin. The system included the sizing and costing of an aerator and auxillary equipment.

4.11 Desalination

125 ML/d Gold Coast Desalination WTP for Veolia Water Australia

CWT provided one month of onsite support leading the investigation into various process issues resulting from the frequent stop/ start operation of the WTP.

400 kL/d Emergency Christchurch Desalination WTP for United Water International

CWT assisted in the rapid set-up and commissioning of a package desalination plant installed as an emergency supply of potable water for the city following the February 2011 earthquake. Operator training was included.

400 ML/d Melbourne Desalination WTP for Bass Water

CWT assisted in the design review, documentation preparation, commissioning, and subsequent operation of several pilot plants, which compared two pre-treatment technologies (granular media vs. ultrafiltration). Each pre-treatment pilot contained a dedicated reverse osmosis system to assess and compare membrane performance.

125 ML/d Gold Coast Desalination WTP for Gold Coast Desalination Alliance

CWT assisted in the documentation preparation, commissioning, and subsequent operation of a pilot-scale reverse osmosis system that was used to investigate membrane performance using feed water from the full-scale WTP pre-treatment system.

250 ML/d Sydney Desalination WTP for Sydney Water

CWT assisted Veolia Water Australia to design and build a pilot plant located at Kurnell and have carried out commissioning and training on this and other pilot plant modules for this desalination project. CWT then provided commissioning expertise, supervision and operation for Sydney Water's studies for one year. Subsequently CWT were employed by the successful Blue Water JV to operate the pilot plant for a further 3 months and assist them in decommissioning it.

Brackish Groundwater Treatment for Small Communities for National Water Commission

CWT worked with NSW Public Works and others to study and cost brackish water treatment as a viable option for small and remote communities including evaluating existing systems.

Proposed 20 ML/d Central Coast Desalination WTP for Gosford/ Wyong Councils Water Authority

CWT staff were part of a team of owner's engineers investigating water quality data, treated water requirements, site selection, intake and discharge requirements and supervising/ reviewing the development of the concept design for a reverse osmosis desalination WTP producing 20 ML/d of treated water.

130 ML/d Perth Desalination WTP for Western Australian Water Authority

CWT supervised the installation and commissioning of a pilot plant and then operated it for input into design development of a reverse osmosis desalination WTP for Veolia Water Australia's design bid.

70 ML/d Burrup Desalination WTP for Western Australian Water Authority

CWT assisted SMEC in examining process problems associated with aspects of the desalination WTP.

Proposed RO Treatment for Wowan and Goovigen for Banana Shire Council, Qld

CWT provided a brief planning report on the suitability of RO technology for treating the bore water currently used by the communities and reviewed submissions from interested suppliers.

Eagle Hawk Hotel WTP (NSW) for Rydges Hotels (Selpam)

CWT carried out an investigation into treatment requirements, evaluated quotes and checked design and installed equipment and performance for a reverse osmosis treatment plant.

Hulhumale WTP, Maldives, for SMEC/John Wilson and Partners

CWT provided concept design, specification and drawings for a new desalination plant for drinking water supply on an island in the Maldives. The plant process included pre-treatment, reverse osmosis membrane filters and brine disposal.

4.12 Pipeline Water Quality Issues

Southern Regional Water Pipeline Alliance

CWT were engaged to resolve pH, disinfection and biofilm issues through system modelling for the Southern Regional Water pipeline connecting Brisbane and the Gold Coast. This work included laboratory analysis to determine chlorine and chloramine decay rates which was converted to algorithms for modelling residual decay and disinfection by-products and pH variations throughout the network. Process concept designs were also developed for chemical dosing stations including design risk workshops. CWT also provided detailed design review and commissioning assistance.

Subsequently CWT were engaged to carry out similar work for the Northern Pipeline Interconnector – stage 1 (Landers Shute to Brisbane).

Northern Network Alliance

CWT were engaged to carry out similar work for the Northern Pipeline Interconnector – stage 2. (Noosa to Landers Shute)

KBR

CWT assisted KBR in analysis for the Eastern Pipeline Interconnector

4.13 Ozone/ BAC

City Water Technology have gained considerable experience and a strong reputation in ozone and biological activated carbon systems.

The City Water Technology team has worked on the following ozone/ BAC systems:

Landers Shute WTP (140 ML/d) - process designers / commissioning

CWT were lead process engineers for this alliance project developing ozone/ BAC design with Veolia Water Australia/ Trailigaz and Water Treatment Australia. Commissioning of the ozone/ BAC system carried out and training and O&M manuals also provided.

CWT staff subsequently provided troubleshooting expertise to resolve issues associated with the ozone generators' power supply, cleaning, performance and operation.

Emigrant Ck WTP - pre-commissioning / troubleshooting

CWT were engaged by the ozone manufacturers (Wedeco/ Trailigaz) to check that the ozone system was ready for commissioning along with troubleshooting subsequent problems.

Aqua 2000 Project - Bendigo (126 ML/d), McCay (18 ML/d) and Kyneton (7.5 ML/d) WTPs - concept development/ design checking and specs / commissioning/ audit

CWT staff worked as part of a team developing and costing various process options and subsequent concept and detail design for three microfiltration membrane with ozone/ BAC WTPs to provide high quality water and to deal with taste and odour/ algal toxin issues. CWT staff were part of the commissioning team. A number of commissioning issues associated with activated carbon had to be resolved.

CWT audited the equipment and maintenance and operation of the ozone generation systems and provides ongoing advice when required.

CWT carried out concept design for the upgrade of the system membranes from polypropylene to PVDF including modified chemical dosing systems.

CWT wrote specifications for the upgrade of the Bendigo WTP associated with the provision of additional poorer quality raw water. The work included manganese oxidation, pH and alkalinity adjustment, upgraded wastewater and sludge handling systems.

Noosa WTP (46 ML/d) - investigation / concept design/ commissioning plans / audit

CWT carried out pilot plant testing to investigate requirements and develop concept design in conjunction with Veolia Water Australia, Water Treatment Australia and Trailigaz. A number of commissioning issues associated with activated carbon had to be resolved.

CWT audited the equipment and maintenance and operation of the ozone generation systems and provides ongoing advice when required.

Clunes WTP - Design review, commissioning / troubleshooting

CWT were engaged by the ozone manufacturers (Wedeco/ Trailigaz) to check the system design and to commission the plant along with troubleshooting subsequent problems.

Orange WTP - troubleshooting

CWT were engaged to investigate and evaluate issues associated with a problematic ozone/ BAC system for Orange City Council. Revised operation of the whole system was recommended and the activated carbon replaced. Ozone system modifications were also recommended.

Gerringong/ Gerroa WWTP - Audit

CWT carried out an audit of the WWTP's ozone system.

Waikato WTP (NZ)

CWT were employed as independent experts to evaluate granular activated carbon issues for this WTP and help resolve a contractual dispute.

Ozone System Engineer

CWT staff include an ex-Trailigaz engineer who has carried out troubleshooting / audits / servicing and commissioning for approximately 200 ozone plants worldwide.

Bendigo/Ballarat Ozone Operator Training

CWT were employed to produce and deliver a training presentation and accompanying reference material for the ozone plant operators at Veolia Water's Bendigo and Ballarat WTPs.

4.14 Taste and Odour and Algal Toxin Investigations

CWT has been involved in a number of studies into blue-green algae minimisation and water treatment requirements listed below.

- Casino WTP – investigation of organic contamination issues and upgrading of PAC system.
- Gosford organic contamination strategy leading to the design and specification for a PAC dosing system.
- CWT worked for Hunter Water Australia in assisting develop a detailed and comprehensive document "Grahamstown Organic Contamination Treatment Strategy Study". The study looked at factors affecting toxin production, guidelines, runoff, spillage and endocrine disruptors. It also looked at treatment options such as PAC dosing, GAC filter adsorbers, Ozone/BAC and nanofiltration.
- CWT worked with HWA in developing an organic contamination strategy for Toowoomba examining potential contamination from various cyanobacteria and other biota producing algal toxins and tastes and odours and addressed treatment options and a control strategy.
- Lake systems with algae growth or potential growth have also been investigated by CWT and measures taken to control and manage algae (Penrith Olympic Rowing Course, Penrith lakes Development, Lake Torrens, Adelaide, Coen Dam). Algae removal by dissolved air flotation was investigated and implemented for Coen WTP.

Ozone with Biological Activated Carbon (Ozone/BAC) facilities have been investigated and designed by CWT for Landers Shute, Noosa, Bendigo, McCay and Kyneton WTPs. We have also given advice on ozone/BAC for Emigrant Ck, Clunes, Image Flat and Orange WTPs.

Powdered activated carbon has been investigated for use at a number of WTPs examined.

4.15 Water Reclamation Plants

We have worked on the following water reclamation plants:

- Cronulla Water Reclamation Plant – independent review.
- Bundamba Advanced Water Reclamation Plant – several months of onsite process and troubleshooting support.
- Luggage Point Advanced Water Treatment Plant – carried out two independent reviews (before and after additional works done) of the physico-chemical process design of the pre-membrane treatment and wastewater treatment systems and subsequently again for the upgraded AWTP.
- Gibson Island Advanced Water Treatment Plant – jar testing of coagulation requirements, detailed Operating and Maintenance manuals and supervision/ operation of the demonstration plant.
- On design review team for Pimpama WRP.

4.16 Water Reuse

Our recent water reuse projects have included:

- CWT carried out an evaluation and risk assessment for Albury's recycled water system providing water to a neighbouring development.
- CWT provided technical process advice to the Pimpama (Gold Coast) recycled water project.
- CWT prepared guidelines for water reuse for multi-unit developments for DEUS, NSW.
- CWT were part of a bid by Barclay Mowlem/ ESI for the Sydney Water Factory.
- We have also examined the recycling of wastewater and its implications with respect to pathogens and algae at several WTPs including those at Casino, Coliban, Hobart, Noosa and Townsville.

4.17 Solids Contact Clarifiers

City Water Technology has been involved in the evaluation and performance optimisation of a number of solids contact clarifiers (upflow sludge blanket type clarifiers with sludge recirculation) including:

CWT recently monitored and reported on the performance of Hobart's 160 ML/d Bryn Estyn WTP over a two year period. The chemical doses, mixer speeds, solids concentrations and blowdown frequency and period were optimised in terms of supernatant quality for the two Infilco Accelator clarifiers during this time.

CWT worked with Esk water in optimising the performance of Launceston's 20 ML/d Reatta Rd WTP Accelator clarifiers. The chemical doses, mixer speeds, solids concentrations and blowdown frequency and period are being monitored with a view to performance optimisation. Band width between the two mixing zones can also be adjusted but this has not been carried out at this stage. Various other process parameters (coagulation, flocculation) and environmental conditions are also being monitored.

CWT evaluated and reported on the performance of Melbourne Water's 450 ML/d Winneke WTP solids contact clarifiers. Solids concentration data from several zones within the flocculation zone and other parameters and environmental conditions were monitored in order to determine optimum performance conditions and to evaluate performance differences between the clarifiers.

CWT have also carried out several plant audits of water treatment systems that include solids contact clarifiers and have been part of the design team for such clarifiers.

4.18 Filtration

Echuca WTP Filter upgrade work for Coliban Water

CWT were engaged by Water Infrastructure Group to supervise rehabilitation works for one media filter at the Echuca WTP. Filters were in poor conditions with mixed media profile and underdrain failures. Work included replacement of filter media, underdrains rehabilitation, assessment of backwashing systems and improved media design.

2 ML/d Molong WTP for Cabonne Shire Council

CWT carried out a detailed filter review at this plant and developed a list of prioritised tasks/ options to enable the filters to achieve the 2011 ADWG target for turbidity.

3 ML/d Rushworth WTP for Goulburn Valley Water

CWT (in conjunction with WTA) evaluated the filters and produced a report covering discussions with operators on historical performance, excavation of media from a section of the filter to allow inspection and removal of a filter nozzle, and inspection of the DAF equipment and backwash water supply.

16 ML/d Oakey Park WTP for Lithgow City Council

CWT (in conjunction with Hydrological) carried out a detailed filter review of this WTP and provided cost estimates for refurbishment options.

Biloela STP for Banana Shire Council

CWT evaluated and costed various replacement options for a set of two failed upflow sand filters – reinstating filters, new dual media gravity filters, installing disc filters in existing filter tanks, and worked with Council to prepare a new concept design. CWT went on to prepare tender documents and worked as owner's engineers following award of the D&C contract.

13 ML/d Tatura and 2 ML/d Murchison WTPs for Goulburn Valley Water

CWT (in conjunction with WTA and Hydrological) was engaged to carry out a detailed filter review at both plants and provide cost estimates for the recommended tasks/ options to enable the plant to achieve a filtered water turbidity target of less than 0.3 NTU (95%ile).

720 ML/d Happy Valley and 273 ML/d Hope Valley WTPs for SA Water

CWT (in conjunction with WTA and Hydrological) evaluated the filtration systems at each of these WTPs and provided options for refurbishments required to rehabilitate these filters.

Aurora, Whittlesea, Lilydale and Brushy Creek STPs for Yarra Valley Water

CWT (in conjunction with Hydrological) were engaged to carry out filter media condition assessments at each STP with the goal of assessing the status of the media, determining what refurbishments were required to ensure the filters could continue to meet YVW water quality targets across the full raw water profile, and development of a preferred approach, along with preliminary costing, for carrying out the refurbishment tasks.

Albury Water Filtration Plant - Plant A Filters for Albury City Council

CWT was engaged to assess the existing condition of the filter material for refurbishment where necessary and to provide recommendations regarding other actions where necessary.

Evaluation of Boonah-Kalbar WTP Filters for Seqwater

CWT (in conjunction with WTA) was engaged to carry out a review of the filter media and backwash regime at both plants and provide cost estimates for the recommended tasks/ options that were identified.

Lower Molongolo WQCC filter evaluation for ActewAGL

CWT carried out a detailed evaluation of the tertiary filters in order to minimise problems associated with filter nozzle blockage and to maximise phosphorous removal. A number of recommendations were made and are in the process of being implemented.

Molendinar (180 ML/d) and Mudgeeraba (70 ML/d) WTPs for Gold Coast Water.

CWT (in conjunction with WTA) evaluated and redesigned filter media and underdrains for both of these water treatment plants after a number of problems were identified with the filters.

Quakers Hill STP Tertiary Filters for Sydney Water

CWT carried out an evaluation of the performance of the Quakers Hill STP filters (particle counting evaluation). CWT subsequently worked with WTA in commissioning the upgraded tertiary filters including chemical dosing requirements, and filter performance evaluation.

Media Design and Selection

CWT have also been involved in filter media design and selection for a number of STP tertiary filters and WTPs.

4.19 Membranes for Water Treatment

The use of membranes for water treatment is increasing due to developments in technology, requirements for high quality water and increasing cost-effectiveness. CWT have been involved with the design, pilot testing and commissioning of processes incorporating membrane technologies.

Specific membrane technology projects have included:

- Sunset Strip WTP (NSW) – Trouble-shooting and auditing of a 5 L/s membrane WTP incorporating pressurized cross-flow membranes. Advice regarding pre-treatment options, control upgrades, and membrane repair/ replacement were also provided.
- Bendigo WTP (Vic) – Investigation/ costing of replacement of submerged MF polypropylene membranes with PVDF membranes.
- Ellendale WTP (Tas) – Trouble-shooting and auditing for a 0.1 ML/d WTP incorporating pressurized ultra-filtration modules. Advice regarding capacity upgrade of the plant was also provided;
- Coliban WTPs (Vic) – Concept design and operating issues resolution for two WTPs (18 and 7.5 ML/d) incorporating conventional microfiltration modules and one plant (126 ML/d) incorporating submerged microfiltration modules for production of very high quality drinking water. Commissioning assistance was also provided;
- Coliban PVP (Vic) – Operation and reporting for a 0.12 ML/d process verification plant (PVP) incorporating a membrane unit and various pre-treatment processes. Results of the testing were used to determine the optimum design parameters for membrane design, chemical cleaning and operation for the Coliban WTPs;
- Oberon WTP (NSW) – Assistance with design for tender for a 6.5 ML/d microfiltration plant. CWT provided specialist advice on pre/ post treatment processes combined with the microfiltration

modules, including oxidation of heavy metals, coagulation, flocculation, alkali dosing for pH correction, and algal removal.

- Coen and Laura WTPs (Qld) – Design, specification and tender review of WTPs including microfiltration membrane modules and pre/ post treatment for treatment of contaminated dam water. Also investigated suppliers for replacement membranes.

As well as the projects above, CWT have evaluated membrane technology as an option in a number of water treatment options studies for various water sources.

4.20 Destratification of Reservoirs

City Water Technology has also carried out studies into reservoirs and their water quality with a view to minimising manganese spikes and problems associated with nutrient levels and algal blooms including the following:

- Investigation into operation of destratification systems for Suma Park Dam (Orange, NSW)
- Destratification design for Lake Torrens, Adelaide SA (Adelaide City Council and Water Board)
- Investigation into and destratification of Lake MacDonald, QLD (Vivendi Water Australia)
- Investigation into and destratification of Coen Dam, QLD (Cook Shire Council)
- Investigation into and destratification of Lake Leslie in Warwick Shire, QLD (with Hunter Water Australia)
- Investigation into and destratification design for various lakes, QLD (Toowoomba Shire Council with Hunter Water Australia).

4.21 Iron and Manganese Removal

CWT have carried out or been involved in detailed research into iron and manganese removal at several WTPs including:

- South West Rocks, Orange, Gosford, Prospect, Illawarra, Woronora, Wyong, Macarthur WTPs, NSW
- Baralaba, Dysart, Mackay (Nebo Rd), Moura, Molendinar, Mudgeeraba, Toowoomba, Warwick, Douglas (Townsville), Howard (Hervey Bay), Noosa WTPs, Qld.

These plants use oxidation at elevated pHs, elevated pHs alone or chlorination prior to manganese oxide coated media for successful manganese removal. For some of the WTPs the research (often carried out in conjunction with other organisations) involved the analysis of manganese removal options in pilot plant testing leading to a preferred and optimised option.

Manganese issues have also been investigated for several coal mines around Lithgow, NSW.

Some specific examples include:

- *Dysart WTP Upgrade for Isaac Regional Council* Owners Engineer for the current upgrade of the WTP to deal with organics and manganese in the Mackenzie River. The upgrade has included improved monitoring and control, potassium permanganate oxidation, polymer dosing, upgraded filters with manganese oxide coated media and pre-filter chlorination.
- *Woronora (Sydney) Organics Removal Study for Veolia Water Australia*. CWT have just completed a pilot plant study which looked at optimising organics removal with consideration for manganese removal optimisation.

- *Gosford Clean Water Program 2010 for Gosford City Council.* CWT were part of a successful 2 year program of cleaning up organics and manganese laden water. Several treatment and reticulation issues were addressed including an extensive monitoring program, improved treatment especially with alkali and potassium permanganate dosing, and mains cleaning and flushing.
- *Illawarra WTP optimisation, NSW for Veolia Water Australia* Investigations into optimisation of manganese removal and WTP processes. The program looks at the effect of pH and chemical doses (enhanced coagulation) on both organics and manganese. Manganese removal enhancement was examined, dosing ozone, chlorine and/or potassium permanganate at various locations within the water treatment process at various pHs. Manganese removal at elevated pH without chemical oxidation is also being examined. The effect of these processes on various organic compounds and disinfection by-products is being investigated in conjunction with the Australian Water Quality Centre.
- *Molendinar WTP, Qld for Gold Coast City Council* Investigation into dirty water issues associated with manganese and biological growth through the reticulation leading to pilot plant testing and plant modifications to improve WTP performance.
- *Noosa, Qld, for Veolia Water Australia.* Investigations into manganese removal options in order to meet stringent manganese requirements of 0.01 mg/L. Dam destratification, potassium permanganate dosing and catalytic oxidation of manganese on coated media were found to be successful in combination to achieve these objectives. Investigations were also made into taste and odour control leading to the ozone/BAC process.

4.22 Corrosion Issues

Areas of the east coast of mainland Australia typically have waters which are high in potential corrosivity. Such conditions can lead to problems in reticulation systems such as corrosion of metals and dissolution of lime, calcium carbonate and related compounds from cement linings of pipes and reservoirs. This, in turn, leads to water which is outside guidelines for pH, reduced disinfection efficiency, reduced life of pipelines, fittings and reservoirs and copper corrosion and dezincification of consumers' pipes.

City Water Technology have investigated the corrosion implications for particular raw water types and treatment processes at various WTP sites around Australia. This work has included the modelling of corrosivity parameters such as the calcium carbonate precipitation potential and Langelier Index, for which proprietary software is used.

CWT has been involved in concept and detail design and commissioning of lime/CO_2 systems.

Studies in which corrosion issues were addressed include:

- Somersby WTP, Gosford (NSW) – Design and Specification for lime and carbon dioxide dosing facilities.
- Lander's Shute WTP (Qld) – Lead process engineers for upgraded WTP including lime and carbon dioxide in the treatment process. Modelling was undertaken to find theoretical design doses for lime and carbon dioxide for the upgrade design;
- Gold Coast WTPs (Qld) – Review of corrosion issues and comparison of lime and caustic as alkali dosing options, with modelling of corrosivity parameters;
- Douglas WTP, Townsville (Qld) – Corrosion and pH correction options study, including a review of corrosion issues and of current and alternative alkali dosing options. Options were compared on cost and process issues;

- Coliban WTPs (Vic) – Concept design and operating issues resolution for three WTPs, including lime and carbon dioxide in the treatment processes. Modelling was undertaken before and after operation commenced to determine theoretical design doses and explore different dosing approaches. Commissioning assistance was also provided;
- Macarthur WTP (NSW) – Pilot study into the effects of lime dosing on final water quality in terms of corrosivity and turbidity;
- Bryn Estyn WTP (Tas) – Comparison and evaluation of alkali dosing options, including lime and carbon dioxide, with modelling of corrosivity parameters. Design and specification of lime system;
- Burnie WTP (Tas) – Corrosion control options study and report, including corrosion parameter modelling, lime carbon dioxide system concept design and costing;
- Northern Midlands (Tas) - Treatment and supply options report, including corrosion parameter modelling, comparison of treatment options and lime carbon dioxide system concept;
- Mt Stromlo WTP (ACT) - Options report, with study of corrosion issues and corrosion parameter modelling;

Other work relating to corrosion includes the compilation and analysis of a database of copper corrosion incidents for NSW Department of Land and Water Conservation. This project also involved the development of a report and paper entitled "Copper Corrosion in Country NSW: Survey and Management Strategies".

4.23 Sludge Handling

CWT have extensive experience in research and development and the design of sludge handling systems throughout Australia.

We have worked on sludge strategies and designs for several WTPs including, Coffs Harbour, in the Hunter Region (NSW), Illawarra, Woronora, Orchard Hills, Macarthur and Prospect (all in Sydney, NSW), Tea Gardens (NSW), Broken Hill, Mackay, Townsville (Qld), Noosa (Qld), Coen (Far North Qld). We have also completed strategies and concept designs for several proposed WTPs including Bendigo, Sandhurst, McCay and Kyneton (Vic), Northern Midlands, (Tas), Mt Stromlo (ACT), Mudgee (NSW), Baguio and Fort Bonifacio (Philippines), Maluan, (China) and various small plants around NSW.

Specific, recent sludge handling projects include:

- Determination of process requirements/ options for increased sludge production resulting from changes in raw water quality at Bendigo WTP (*for Veolia Water Australia*).
- Sludge management concept design for new Broken Hill WTP (*for Country Energy*).
- Process design for new wastewater/ sludge handling system for Mackay WTP (*for Mackay Water*).
- Determination of process requirements for upgrade of Canberra's Mt Stromlo WTP wastewater system (*for ACTEWAGL*).
- Review of options for upgrading of Gosford's sludge handling system (*for Gosford Council*).
- Review and process optimisation followed by process design of upgrade of sludge handling system for Noosa WTP (*for General Water Australia*).
- Audit of sludge systems and development of sludge handling strategies (with JWP) for Brisbane's 3 large WTPs (East and West Bank and North Pine WTPs) – detailed report.

- Concept design, specification and detail design, with a CWT/ OTVKruger design team, for wastewater handling/ sludge system (thickener and drying beds) for Sandhurst, McCay and Kyneton WTPs BOO projects (membrane filtration and ozone/ BAC) (*for Vivendi/ USFilter*).
- Two year research project into sludge system evaluation trials and development of management strategies for 180 ML/d Bryn Estyn WTP. Evaluation of sludge lagoons, underdraining of lagoons, sludge thickening, drying beds sludge transfer and trials of sludge as a cover material for a municipal tip *(with SEMF for Hobart Regional Water Authority).*
- Investigation into minimisation of risks associated with *Giardia* and *Cryptosporidium* in recycling supernatant from sludge handling systems for Illawarra and Woronora WTPs (*for General Water Australia*)
- Part of design team for design and specification of new sludge handling system (thickeners and centrifuges) for Douglas WTP (*with Hunter Water Australia and McIntyre and Associates for Townsville/ Thuringowa Water Board*).
- Evaluation and costing of sludge system options for Tea Gardens WTP (*for NSW Public Works*).
- Evaluation and costing of sludge system options for Orchard Hills WTP (*for Sydney Water*).
- Part of design team for design of new sludge handling system (centrifuges) for West Hornsby STP (*with Patterson Britton and Partners and Barclay Mowlem for Sydney Water*).

4.24 Computer-Based Tools

CWT has developed a number of computer-based tools to assist with and streamline various parts of water supply, including:

- O&M manuals in HTML format to allow web browsing (*for Banana Shire Council*).
- Water quality monitoring databases for both Gosford City Council and Banana Shire Council; BSC WQ database included automatic notification to managers when water quality excursions were recorded, and water quality summaries to feed into reports to the Queensland government.
- Process auditing tool, which compared WTP design and performance against various criteria to produce a colour map for use in prioritising asset management (*for Seqwater, in conjunction with MJM Environmental*).
- Water quality monitoring log sheet for Hill End National Parks & Wildlife Service. The log sheet included warnings when values were outside of WQ limits, automatically populated summary sheet and graphs for any given date range and links to related operating procedures and response plans.

5 Key Personnel

5.1 Bruce Murray, Managing Director

Bruce is a chartered professional engineer (CPEng) and registered professional engineer of Qld (RPEQ) and has over 30 years of engineering experience, principally in the fields of water and wastewater treatment. Bruce is renowned as a water treatment specialist and has been employed as an independent expert or to provide technical evidence on many occasions. He has been leading City Water Technology since its establishment in 1990, which currently has a staff of approx. 15 engineers and scientists.

Bruce has extensive experience in water treatment research, including award winning work in Australia. His principal expertise lies in: the application of treatment processes for the upgrading of existing treatment

plants, or for the development of new plants; the refinement of these processes by researching, investigating and further developing processes; and in writing reports and articles detailing the findings of these studies. He has been involved in all aspects of treatment plant process design and risk management.

Bruce has conducted water treatment process reviews or plant audits for over 60 water treatment plants in Australia, New Zealand and Sri Lanka and has prepared detailed concept designs for new water treatment plants for approximately 50 towns and cities in Australia, Philippines and China. He has contributed to detailed designs for several WTPs and has been employed as an independent expert for design review on many occasions. He has also commissioned a number of WTPs or components of WTPs.

He has also worked on approximately 35 industrial water and wastewater treatment plants in monitoring stream quality and volumes, plant evaluation, modification and augmentation or the concept design of new systems.

5.2 Kirsten Hulse, Senior Process Engineer

Kirsten has 18 years' experience in the fields of water and wastewater treatment engineering. A large part of her experience has been in water treatment process investigation and optimization, including options studies, auditing WTPs, concept design and technical specifications. Kirsten has experience with a wide range of WTP processes, including conventional treatment, direct/ contact filtration, membrane filtration, dissolved air flotation, oxidation, activated carbon adsorption, ozone-BAC, sludge thickening/ dewatering and various related chemical dosing systems.

Kirsten has completed design and specification projects for various water supply projects, including new WTPs and upgrades to existing WTPs. She has also prepared system management documents, quality system documents and a number of detailed operating and maintenance manuals for various WTPs around Australia.

Kirsten has been involved in and led process commissioning of several WTPs, including conventional treatment, granular media filtration, membranes and ozone/ BAC systems. She also has in-depth experience in jar testing, pilot testing and full-scale testing to investigate water treatment issues, including hands-on operation, pilot plant design and commissioning and management of testing projects.

Kirsten's water treatment experience includes dam destratification system design and corrosion control modelling/management. She has also worked on projects for the treatment of sewage and industrial wastewater and advanced water treatment for water recycling.

5.3 Leonie Huxedurp, Principal Environmental Scientist / Water Legislation & Policy Specialist

Leonie has over 27 years of experience in natural resources, including 22 years in the Australian water industry, working extensively with Sydney Water and numerous local water utilities while holding positions at the NSW Department of Energy Utilities and Sustainability (now NSW Office of Water), the NSW Environment Protection Authority and the former NSW Department of Land and Water Conservation.

Leonie's areas of expertise encompass risk assessment and planning for water recycling, approvals and assessment, environmental planning, water and wastewater operations, environmental regulation, biosolids and effluent management, guideline preparation, industry regulation, policy and legislation, licensing and regulatory compliance and best practice management of water and wastewater utilities.

Leonie has project managed a number of technical and policy projects and researched and written a number of reference and guidance materials in the water industry. Leonie has a strong background in the translation of technical and legal material into plain English.

Leonie brings to water utilities a wealth of expertise and knowledge in biosolids and effluent management including over 3 years of coordination of biosolids land application for Sydney Water's reuse program and a further 6 years of coordination of effluent and biosolids reuse management for NSW water utilities while employed at the NSW Department of Land and Water Conservation.

Leonie has had extensive input and involvement with the key documents underpinning the regulatory landscape for effluent and biosolids management. Leonie has written a reference book on biosolids management specifically targeted to NSW regional water utilities, contributed to the current NSW Biosolids Code of Practice and researched and re-drafted the current NSW Effluent Irrigation Guidelines. Leonie is widely published in this field and has presented internationally on biosolids management and water recycling.

Additionally, Leonie has over 14 years experience encompassing considerable technical expertise and knowledge in environmental impact assessment and legislative requirements for water utilities undertaking water and wastewater management projects.

For over 10 years Leonie also successfully participated in numerous intergovernmental / stakeholder liaison forums including advisor to water utilities regarding effluent and biosolids reuse.

Since working with CWT from 2006 Leonie has gained further experience in research, development and application of new and existing water and wastewater treatment process technologies. She has also been involved in environmental management strategies, development of operations and maintenance manuals, office greening strategies, communication strategies, policy development, scoping and issues papers.

5.4 Myo Min Cho, Senior Commissioning/ Process Engineer

Myo is a Chemical Engineer with 13 years' experience in water and wastewater treatment, as well as solid waste management. Myo's passion and expertise is focused particularly on the design and operation of water treatment equipment. Myo has been heavily involved in several significant design and commissioning projects, including the commissioning and performance optimisation of Mackay's Nebo Rd WTP upgrade, commissioning supervision of the Broken Hill's new Mica St WTP, and Gosford's new lime/ CO_2/ potassium permanganate dosing systems for the Somersby WTP upgrade. He has recently finalised an engagement as a commissioning engineer on the Eastern STP upgrade in Melbourne and has returned to Nebo Rd WTP in Mackay to continue commissioning and performance optimisation.

Myo has been involved in the operation and maintenance of several pilot plants for water treatment and desalination. He has also been significantly involved in the design and cost estimation of chemical dosing and fluoridation equipment. Myo has experience in troubleshooting, pilot plant design & testing, preparation of operations manuals, data analysis, jar testing and CAD drawings.

5.5 Gudny Palsdottir, Wastewater Engineer

Gudny has more than 10 years' experience in water and wastewater industry. Gudny has focused on the preparation of recycled water management plans for Queensland and New South Wales, as well as supporting documentation such as Risk Assessments, critical control point procedures, and operational

procedures. She recently assisted with the capacity study of the Barrow Island MBR for the Gorgon LNG project with Monadelphous, and process optimisation for Nauru RPC Water and Wastewater with Transfield.

Gudny's areas of expertise encompass recycled water planning, water and wastewater operations, process optimisation, wastewater biological nutrient reduction, environmental regulation, water recycling and efficiency, and irrigation end use. She is also listed as a Technical Professional under the Recycled Water Quality and Sewage Management categories of IPART's audit panel.

In 2011 she prepared an Odour Management Plan for the Bowral STP for Wingecarribee Shire Council that included capacity checks for installed equipment and recommendation to achieve best practice odour management according to NSW regulations.

Before joining CWT, Gudny worked as a proposals and process engineer for Hydro International PLC in the U.K. There she was involved in both industrial and municipal treatment works. Gudny has experience in laboratory work, continuous upflow sand filters, wastewater nitrification, commissioning of biological processes, troubleshooting, pilot plant design & testing, and data analysis. Gudny gained considerable experience in writing through her previous job and assisted project managers with the jobs she had previously prepared tenders for.

5.6 Kerry Francis, Senior Process Engineer

Kerry is a process engineer with over eight years of experience in the water industry. Her experience includes projects in: design and specification; investigation and optimisation; and, training and documentation. These projects have covered groundwater, surface water, desalination and municipal wastewater applications, and included a wide range of treatment processes, such as: conventional treatment; direct/ contact filtration; membrane filtration; oxidation; activated carbon adsorption; ozone-BAC; sludge dewatering; UV disinfection; and, various chemical dosing systems. Through this breadth and depth of experience, Kerry has developed a reputation for quality, thoroughness, and a desire to help people and projects to achieve their greatest potential.

Kerry has considerable experience in water treatment investigations and audits, for optimising, troubleshooting, and operational/ verification monitoring. Major projects have included: being Monitoring and Sampling Coordinator for Gosford City Council's Water Quality 2010 project; investigating rechlorination options for Mackay's northern region; and, coordinating site audits and management system implementation support for 14 WTPs. She has also developed various monitoring and investigation tools; notable projects include a process auditing template with automated scoring, and a water quality monitoring database with automated compliance reporting and exceedance notifications.

Kerry has assisted in the scoping, options development, design, and specification, of several WTPs, comprising both new plants and upgrades. Major projects have included: concept design for the new 4 ML/d Marian WTP; options review and concept design for the new 55 ML/d Wagga Wagga WTP; and, process design and specification advice for the new 440 kL/d East Sale RAAF Base WTP. She has also operated a number of pilot plants as part of design/ tender processes, including: confirming design for the Sydney Desalination Plant; informing the BassWater tender for the Victorian Desalination Plant; and, viability studies for the Degrémont Dehydris™ Twist dewatering process at Luggage Point STP, Loganholme WWTP, and Oxley Creek STP.

Kerry has developed operational and management documentation for over 25 water and wastewater supply systems through Queensland, New South Wales, and Victoria. These have included Drinking Water Management Systems (DWMSs) and Drinking Water Quality Management Plans (DWQMPs), Standard Operating Procedures (SOPs), service manuals, and operation and maintenance manuals. Major projects have included: SOPs for the new Curtis Island water and wastewater systems; DWMSs for five NSW councils; DWMS risk workshop facilitation for Hill End water supply system; and, a DWQMP and related documents, including a Water Quality Monitoring Plan, Drinking Water Incident and Emergency Management Plan, and critical SOPs, for the Port of Mackay. Kerry has also developed training documents for a number of plants, as well as training key staff in DWQMP for Port of Mackay, and training operators in laboratory procedures at the Sydney Desalination Plant.

5.7 Mathew Bennett, Senior Process Engineer

Mathew is an experienced process engineer with BE (Chemical, Hons I) and BSc (Chemistry and Geology) degrees and a diverse background spanning eleven years in, water treatment, FMCG, R&D, and pulp and paper.

Since joining CWT, Mathew has worked on a variety of project including: concept designs for plant upgrades and new water treatment plants, specifications for new and upgraded water treatment plants and supporting processes, preventative maintenance, process investigations, tender reviews, operational and commissioning support, drinking water management systems, and operational documentation. Mathew has completed projects for: Flow Systems, Hyder, National Parks & Wildlife Service, Mackay Regional Council, Veolia Water Australia, North East Water, NSW Health, SERWA, KBR, Seqwater, Banana Shire Council, ActewAGL, and Gippsland Water.

Before joining CWT, Mathew worked for the major companies Reckitt Benckiser and Visy Pulp and Paper.

Mathew has considerable experience with the design, optimisation, troubleshooting, and operation of most types of municipal and industrial water treatment processes such as, conventional and advanced water treatment plants, membranes, cooling towers, boilers, reverse osmosis, resins, and sequenced batch reactors.

From working in R&D, Mathew has also gained considerable design experience and is very familiar with the HAZOP process, piping and instrument diagrams, process flow diagrams, mass and energy balances, piping design, and process design.

In addition to his engineering experience, Mathew has extensive operational experience that he gained from working as a Production Engineer and Plant Operator in pulp and paper manufacturing.

5.8 Ryan Melville, Process Scientist

Ryan is a scientist with a BSc in Medical Microbiology and Immunology as well as a Masters of Environmental Engineering Management. Ryan has reviewed water treatment plant processes and laboratory testing procedures, assisting on preparing treatment plant concept designs, water management plans and operating and maintenance manuals, as well as the creation of internal reference materials. He has extensive experience in conducting both on-site and laboratory jar testing and written reports recommending courses of action for plant optimization at Dysart, Googong, Woronora, Proserpine, Bowen, Mt Crosby Westbank, Bororen, Benaraby, Horsham, Wingecarribee, Tarago, Broken Hill, Sunset Strip,

Mackay, Shepparton and Woronora WTPs as well as the Mt Martha and Somers RWTP, Glenfield STP, Cronulla WRP and the mining industry. He has conducted jar testing as part of concept design and upgrades for Miriam Vale, Icely Rd, Baralaba, Wagga Wagga, Molong, Taroom, East Nogoa, Marian and Moura WTPs and the Holsworthy MUR stormwater harvesting program. He has conducted laboratory research studies of organics formation and removal for the Woronora WFP and the Crescent Head bore supply. He has also provided training and demonstrations of jar testing methods to WTP operators at Ballarat and Broken Hill.

Ryan is experienced in laboratory work, conducting water quality testing and plant optimizing through jar tests and on-site testing. He is familiar with maintaining and developing QA systems and NATA accreditation and has a background in scientific and technical writing.

5.9 Audrey Knickerbocker, Process Engineer

Audrey is a process engineer with a BSc in Agricultural and Biological Engineering with a specialisation in Land and Water Resource Engineering. Since starting at CWT, she has been involved in process design and optimisation for several water supply projects. Her most recent work included several months of onsite plant recommissioning and operational documentation system design for two new advanced water reclamation facilities being delivered by the South East Regional Water Alliance (SERWA) in Victoria.

In addition, Audrey is currently assisting in the preparation of risk-based Drinking Water Management System documents for 24 water supply schemes in Tasmania, including the capture of risk assessment workshops, Critical Control Points (CCPs) identification and preparation of management system documentation. Audrey has also assisted in the development of drinking water management systems (DWMSs), including data analysis and risk workshop preparation, for four shire councils in NSW: Cowra, Port-Macquarie Wentworth and Wyong.

She has experience in the preparation of concept design and technical specification for multiple water treatment plants, including a new 2.2 ML/d conventional water treatment plant in Baralaba and chemical dosing and sludge handling upgrades to Moura water treatment plant (WTP), both for Banana Shire Council. She has also assisted in the technical specification and drawings for upgrades to Dysart WTP, for Isaac Regional Council, including filter refurbishment, new chemical dosing systems and new instrumentation and controls.

Audrey has experience in the preparation of technical drawings including process flow diagrams, piping and instrumentation diagrams, site layouts and general arrangements in AutoCAD. She recently drafted all necessary drawings for multiple projects in Banana Shire Council including Baralaba WTP, Moura WTP, and automation upgrades to Biloela and Theodore WTPs.

5.10 Claire Chatry, Process Scientist

Claire is a scientist experienced in the operation of small water treatment plants and pilot plants. She recently provided onsite operations support for Crescent Head WTP (Kempsey Shire Council) participating in the optimisation of the chloramine disinfection process. She also worked at Sarina WTP (Mackay Regional Council) where she provided secondment as an onsite operator at the 3ML/day conventional WTP for 15 months.

In addition to her onsite work, she developed documentation for WTPs including Standard Operating Procedures and Operation and Maintenance Manual.

She conducted a pilot plant testing at Woronora WTP examining optimised chemical dosing for the WTP under high organics raw water conditions.

Claire has also been involved in process investigations and concept design for several WTPs including data analysis, report writing, cost estimation and CAD drawings.

5.11 Jacquelyn Osborne, Process Engineer

Jacquelyn is a process engineer with a BE in Chemical and Biomolecular Engineering. Since starting at CWT she has been involved in a range of projects involving process design, data analysis, documentation and process optimisation.

She has experience in preparing concept designs and technical specifications for multiple water treatment plants and supply systems including upgrades to the 0.99 ML/d Miriam Vale conventional water treatment plant (for Gladstone Regional Council), a DAF pre-treatment system for 8 ML/d Dysart conventional water treatment plant (for Isaac Regional Council), and filter upgrades and refurbishments at Dysart WTP and Blackwater WTP.

Jacquelyn has recently finished working on site audits and reports for several water supply systems in regional NSW as part of the implementation stage of the Drinking Water Management System (DWMS) for NSW Department of Health. She is also assisting (as part of a team of technical advisers to Council) with the finalisation and commissioning checks for the Dysart WTP upgrade works, including options to address site storm water and drainage issues.

Jacquelyn has conducted environmental audits of a number of water and sewerage treatment plants on behalf of Veolia. She has also assisted with developing asset registers for several water and sewerage treatment plants for Banana Shire Council.

5.12 Jordan Murray, Process Engineer

Jordan is a process engineer with a BE in Environmental Engineering. Since starting at CWT he has been involved in a range of projects involving process design, data analysis, and documentation.

He has assisted in the preparation of Drinking Water Management Systems (DWMSs) and Drinking Water Quality Management Plans (DWQMPs) and associated documents. His work on these projects included: identifying critical control points; data analysis; developing Drinking Water Incident and Emergency Management Plans and developing a DWMS document that addresses the requirements of relevant legislation and of the *Framework for Management of Drinking Water Quality*, detailed in the *Australian Drinking Water Guidelines*.

He has developed water quality monitoring tools with the ability to include warnings when values were outside of WQ limits, generate automatically populated summary sheet and graphs for any given date range and links to related documents.

Jordan is currently working on site audits and reports for several water supply systems in regional NSW as part of the implementation stage of the Drinking Water Management System (DWMS) for NSW Department of Health. As part of this work, Jordan has been involved in fluoride dosing system inspections and gap analysis against *NSW Code of Practice for Fluoridation of Public Water Supplies*.

Jordan also has experience in the preparation of process flow diagrams, concept designs and technical specifications of chlorination systems.

Jordan has a keen interest in computing and technology and is looking to find ways to incorporate this into the Water Treatment Industry.