THE RIVERLAND PROJECT – 10 NEW WATER TREATMENT PLANTS IN SOUTH AUSTRALIA

Paper Presented by :

Neil Palmer &
Phil de Groot

Authors:

Neil Palmer, *Water Quality Manager*
Phil de Groot, *Process Controller*

North West Water - SA

61st Annual Water Industry Engineers and Operators' Conference
Civic Centre - Shepparton
2 and 3 September, 1998

TEN NEW WATER TREATMENT PLANTS IN SOUTH AUSTRALIA - THE RIVERLAND PROJECT

Neil Palmer, *Water Quality Manager*, North West Water
Phil de Groot, *Process Controller*, North West Water

ABSTRACT

The Riverland Water Treatment Project in South Australia consists of ten new water treatment plants worth $115 million. The plants are being constructed and operated by Riverland Water, a joint venture company owned by United Utilities Australia (trading as North West Water), AMP and Bechtel, as a Build - Own - Operate - Transfer (BOOT) project.

The plants vary in size from 4 to 90 ML/d and are designed to treat Murray water of turbidity up to 410 NTU and colour up to 120 HU. When completed in 1999, they will supply filtered water to over 100,000 people along the River Murray and in the Adelaide Hills, Barossa Valley, Lower North and Yorke Peninsula. Unit processes include rapid mixing, flocculation, clarification by tube settlers, dual media rapid gravity filtration, fluoridation and disinfection with monochloramine (4 plants) or chlorine (6 plants). The plants contain an innovative design feature for taste and odour control using powdered activated carbon dosing into contact tanks at the head of the plant. They are also believed to be the first plants in Australia using "sludge suckers" for sludge removal.

This paper describes aspects of the commissioning and operation of the Riverland Water Treatment Project and shares experience gained from rapid successive commissioning of a number of plants.

KEY WORDS

Riverland, water treatment, BOOT, River Murray, commissioning, operation

1.0 INTRODUCTION

1.1 Riverland Water

Riverland Water is a company established for the specific purpose of building, owning and operating ten water filtration plants which comprise the Riverland Water Treatment Project in South Australia. Over the 28 year life of the project, the assets will be progressively transferred to the client, the South Australian Water Corporation (SA Water). Process design was carried out in the UK by Bechtel. Baulderstone Hornibrook Engineering (BHE) is the Detailed Design and Construct (DD&C) contractor who subcontracted detailed engineering design to CMPS&F. Plant operation is being undertaken directly by North West Water. The planned construction period is just over two years and the total capital value of the project is $115 million.

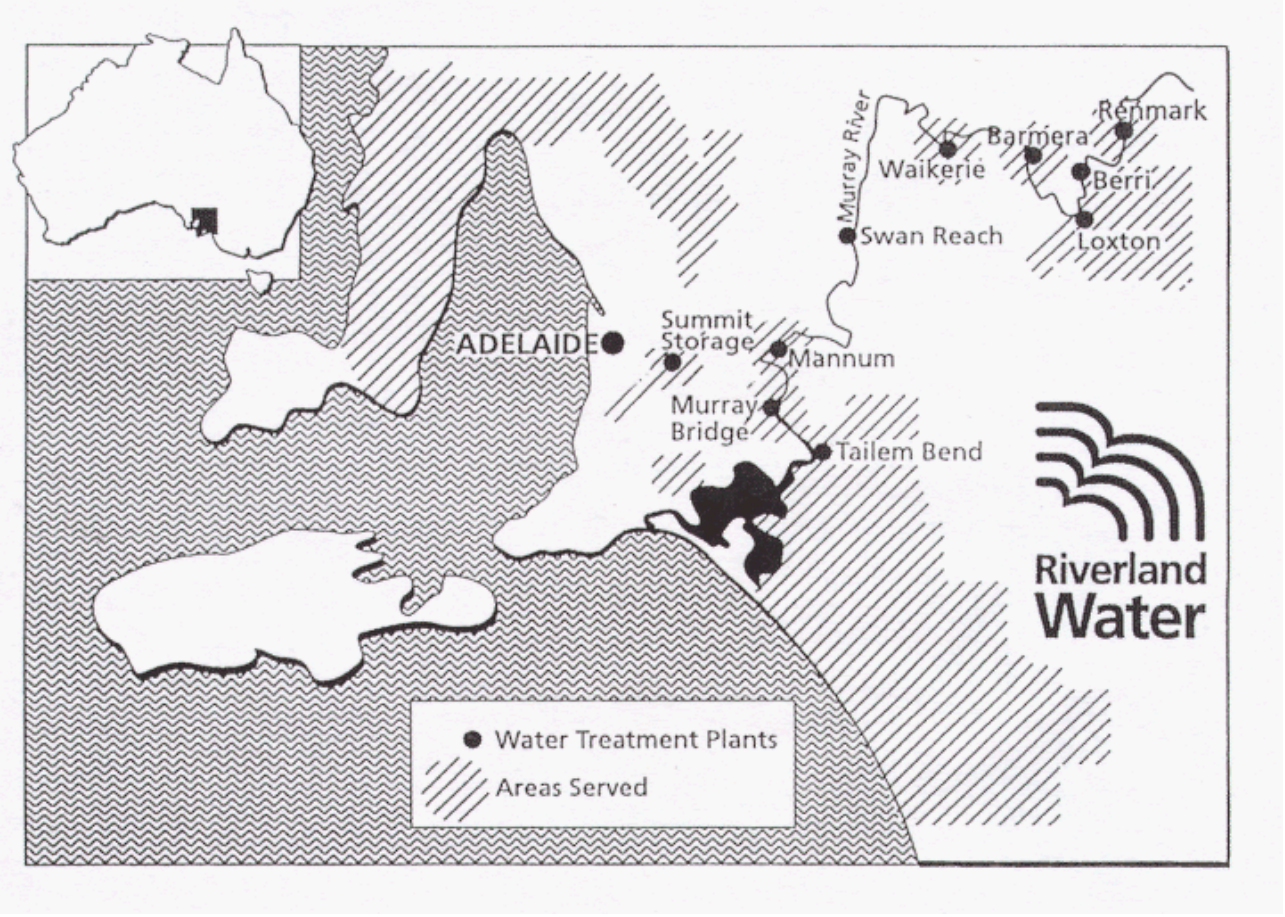
1.2 Plant Capacity and Location

The design capacities of the plants are shown in Table 1 and the location and areas served in Figure 1.

Table 1: ***Riverland Water Treatment Plant Design Capacities***

Water Treatment Plant	Maximum Flowrate ML/d
Tailem Bend	28
Murray Bridge	38
Summit Storage	71
Mannum	4.1
Swan Reach	90
Waikerie	4
Barmera	5
Loxton	14.5
Berri	8
Renmark	9

Figure 1: ***Location and Areas Served by Riverland Water Treatment Plants***



1.3 Water Quality

All the plants draw their raw water from the River Murray which is characterised by high turbidity, at times high colour, relatively high alkalinity and salinity and increasing frequency of algal blooms. The plants are designed to accept raw water with turbidity up to 410 NTU, colour up to 120 HU and algal cell counts of up to 500,00 per mL, are required to produce treated water with turbidity less than 0.5 NTU and colour less than 10 HU.

The treated water pH setpoint is determined by SA Water within a range of 7.5 to 8.0 for

chlorinated systems and 7.5 to 8.5 for chloraminated systems and communicated to North West Water for each plant. Similarly, SA Water determines disinfection setpoints for free and total chlorine residuals as appropriate. In addition, bacteriological samples must be free from total and faecal coliforms.

Limits are also set for aluminium, iron, manganese and trihalomethanes which are generally consistent with or lower than Australian Drinking Water Guidelines. Fluoride concentration is set by SA Water and is consistent with guidelines issued by the South Australian Health Commission. Treated water specifications for tastes and odours, hepatotoxins, MIB and geosmin have been foreshadowed in the agreement and will be fixed during the term of the contract.

1.4 The Water Treatment Process

Each plant is made up of similar unit processes including powdered activated carbon (PAC) dosing as required for taste and odour control, PAC contact tanks, coagulation, two stage rapid mixing, two stage flocculation, clarification with tube settlers, dual media rapid gravity filtration and disinfection using chlorine (for plants serving towns) or chloramine (for plants which have distribution systems with long residence times). The four larger plants have pH correction using hydrated lime with a sodium hydroxide trim, the smaller plants using sodium hydroxide alone.

Sludge is removed from the floor of the clarifiers using cable winched sludge suckers, each of which consist of a header pipe connected via a flexible hose to valved outlets on the side of the tank. All plants have sludge lagoons except Waikerie where site constraints dictated use of a thickener and a centrifuge.

Unit processes used in Summit WTP are shown in Table 2 and a basic process flow sheet for Summit is given in Figure 2.

1.5 Plant Control

The treatment plants are all fully automatic with central operating and hot standby Allen Bradley PLCs and Citect Supervisory Control and Data Acquisition (SCADA) systems. Process Controllers have local and remote operator interfaces (desktop and laptop computers) to gain access to the SCADA system to respond to alarms, stop and start equipment in manual control, changeover duty and standby or change setpoints. The SCADA system for each plant is connected by ISDN links to Regional Reporting Centres at Murray Bridge and Berri which in turn link with the Adelaide office.

The contract with SA Water requires treated water to meet stringent water quality criteria with non compliance resulting in tariff reductions. Reporting and invoicing functions are computerised with data entry occurring either automatically from the SCADA or manually by Process Controllers.

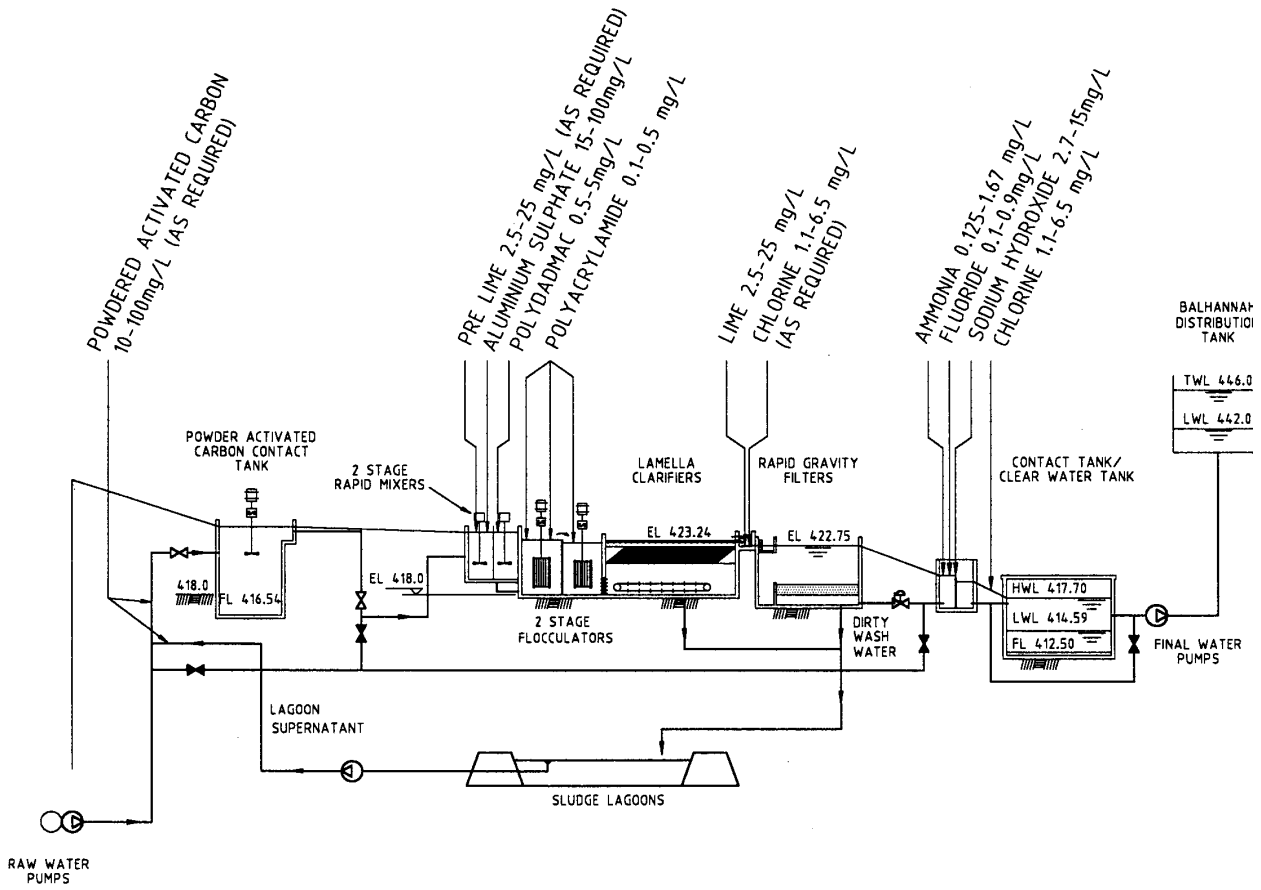
Table 2: *Unit Processes in Summit Water Treatment Plant*

Unit Processes in Summit Water Treatment Plant	
ITEM	**UNITS**
Plant Type	Rapid Mixing Flocculation Inclined Tube Sedimentation Rapid Gravity Dual Media Filters
Process Capacity	71 ML/d
Detention Time and Design Capacity Rapid Mix Flocculation Sedimentation	 2 x 20 seconds 2 x 10 minutes 46 minutes
Number of Units Rapid Mix Flocculation Sedimentation Filters	 2 in series 2 x 2 in parallel 2 in parallel 4
Filtration Rate	12 m/h
Filter Media Sand Effective Size Uniformity Coefficient Coal Effective Size Uniformity Coefficient	 0.45 - 0.55 mm 1.45 1.0 - 1.1 mm 1.4
Sludge Lagoons Number Depth	 3 2 m
Chemical Dose Rates Alum Lime PAC LT35 LT22 Sodium Hydroxide Ammonia Chlorine Total Residual Chlorine Target Fluoride	 15 - 100 mg/L 2.5 - 25 mg/L 10 - 100 mg/L 0.5 - 5 mg/L 0.1 - 0.5 mg/L 2.7 - 15 mg/L 0.125 - 1.5 mg/L 1 - 5 mg/L 2.8 mg/L max 0.1 - 0.9 mg/L

1.6 Tastes and Odours

The control of tastes and odours and toxic compounds arising from an algal bloom is uncertain, so both parties to the contract have agreed to experimental work being conducted to determine the effectiveness of PAC on these compounds prior to fixing performance criteria. The use of PAC contact tanks is innovative and based on research carried out at SA Water's Australian Water Quality Centre in Adelaide.

Figure 2: *Process Flowsheet for Summit Water Treatment Plant*



1.7 Water Treatment Residuals

Water treatment residuals (sludge) include material from the clarifiers and from backwashing of filters. They are directed to sludge lagoons with provision for intermittent use and air drying. Following drying and removal, the sludge will be reused for agricultural purposes in accordance with guidelines issued by the SA Environment Protection Agency.

1.8 Human Resources

The Riverland Water operations consists of 16 full time staff including an Operations Manager and a graduate assistant (both located at Head Office) and 14 Process Controllers organised into flexible teams covering all of the plants. The Operations Organisation is shown in Table 1.3.

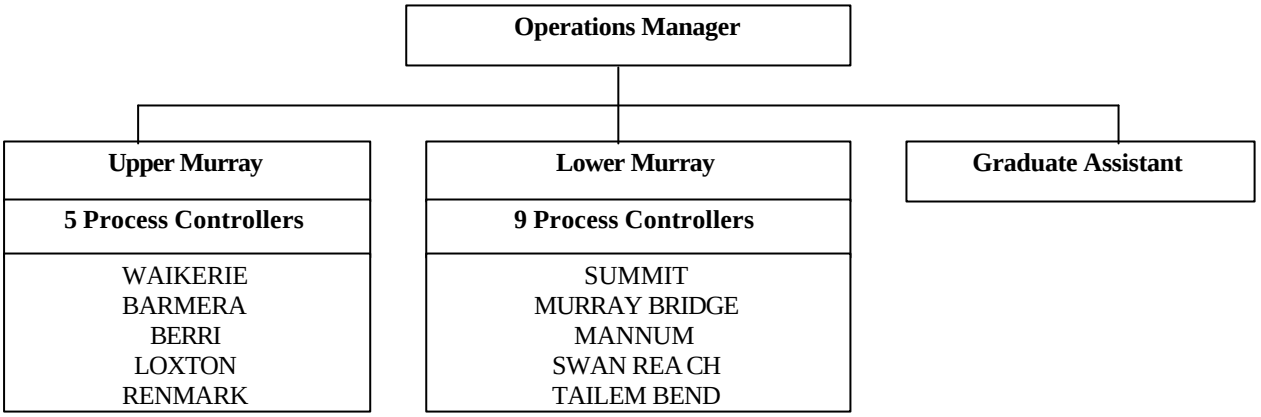
Support is also available from Adelaide Head Office for Human Resources, Administration and Finance, Asset Management, QA, Water Quality Management and the Environment.
Process Controllers are mostly trades qualified with additional training in water treatment operation.

They are salaried, provided with a vehicle and good communication equipment including a laptop computer for accessing the plant SCADA systems and are empowered to take responsibility for the operation of their water treatment plants in order to meet treated water specifications.

In addition to plant operation, they undertake first call maintenance and servicing with major or substantial routine activities being outsourced to contractors. The level of "ownership" of their plants is relatively high.

Process Controllers carry out basic laboratory testing under a quality control program from a NATA registered laboratory and are responsible for coordination of samples and results which are sent away for analysis. Control of data required for reporting and invoicing is also a responsibility of Process Controllers, with appropriate Operator Concern Reports (OCRs) under the company's QA system being issued for processing and action to ensure continuous improvement.

Table 3: ***Operations Organisation***



1.9 Tariffs

Tariffs are paid by SA Water upon commissioning completion of each plant and are in two parts: an availability charge which reflects fixed costs such as debt financing, and a usage charge which reflects operating costs. Water quality, measured from composite samples taken at interface points downstream of the treated water storages, must meet the requirements of the Treated Water Specification and each plant must always be available and capable of meeting the system demand defined by System Operating Rules. Tariff adjustments for failure to meet the System Operating Rules are very severe, while tariff adjustments for failure to meet the Treated Water Specification depend on both the importance of the water quality parameter and the extent of the deviation. Data is entered either from SCADA output fields or manually by Process Controllers into a computerise invoicing system operating on Lotus Notes. The system automatically calculates the monthly invoice for SA Water taking into account any tariff adjustments.

2.0 COMMISSIONING

2.1 Commencement

The Operations Manager was appointed in October 1996, about the time construction commenced. The first Process Controller transferred from Sydney in early 1997 to the Adelaide Head Office to review detailed designs and drawings and procure operating equipment. By July 1997 the number of Process Controllers had increased to 6 in anticipation of commissioning of the first plant at Summit in December 1997. All Process Controllers received training in Water Treatment Plant Operation in Adelaide by the Victorian Water Training Centre and were progressively trained in operation, maintenance and calibration of equipment by suppliers.

As part of plant familiarisation, the Process Controllers conducted a Hazard and Operability (HAZOP) study of Summit plant by systematically reviewing all detailed drawings. This exercise, which realised over 150 concerns (which were passed on to the DD&C contractor), was valuable in providing Process Controllers with a good understanding of plant operation.

2.2 Commissioning

In September 1997, the Process Controllers moved on to the Summit Storage site, allowing a much closer working relationship to develop with the Contractor (BHE). This development was not without difficulty as the Contractor was understandably nervous about having so many North West Water representatives on site. As time went on, however, the sheer commissioning workload meant Process Controllers had to help, and the opportunity to assist in commissioning from an early stage benefited both parties. The cooperative approach which ultimately developed enabled the plant to be commissioned ahead of the anticipated completion date.

Commissioning was carried out in accordance with a 7 stage Commissioning Plan comprising: Precommissioning (dry testing, factory acceptance tests etc), Mechanical A (testing of systems on site), Mechanical B (testing the whole plant under manual control at steady flow), Mechanical C (testing the whole plant under manual control at varying flow), Auto Commissioning (testing of the whole plant under automatic control for 48 hours at greater than 50% flow), Process Verification (operation up to full plant flow to demonstrate compliance with the treated water specification) and a Running in Trial (operation of the plant over a continuous 30 day period with water quality and system operation compliance). The Mechanical A and B stages were carried out at Summit with flow diverted back to the reservoir, allowing the Process Controllers to familiarise themselves with new equipment, assist in commissioning and to identify and have operational faults rectified prior to the start of commercial operation. The first "in spec" water was produced at Summit on 9 December 1997, 14 months after construction commenced.

2.3 Coming On Line

The Running in Trial commenced at Summit on 24 December 1997 and was successfully completed within the 30 day period, marking the completion of commissioning. In the early stages of the trial, the plant was attended 24 hours per day (two 12 hour shifts). At about this time, the group of 6 Process Controllers who worked on commissioning of Summit split, with three remaining and three moving on to the largest plant at Swan Reach (90 ML/d) which was programmed for completion about six weeks behind Summit.

The same commissioning plan was implemented at Swan Reach and will be repeated for the remaining eight plants before the last one at Loxton is commissioned in the latter half of 1999. With the completion of each new plant, one or more Process Controllers remains to attend to plant operations, optimising performance and monitoring the plant throughout the twelve month defects liability period. As the number of plants being commissioned grows and with a finite number of Process Controllers, the need for good planning becomes more critical.

2.4 Plant Operation

The plants are conventional in design, with good mixing of coagulant chemicals, flexibility of dosing and variable flocculation mixing intensity. Distribution of flow through the clarifiers is good with clarified water turbidity generally being less than 10 NTU.

The plants have operated satisfactorily with filtered water turbidity generally being less than 0.2 NTU (specification requires < 0.5 NTU).

At the time of writing, with a raw water turbidity of about 70 NTU, filter run times at Summit were in excess of 60 hours. Although the sludge suckers have been found to work very effectively, there is concern that the sludge lagoons may not be adequately sized to effectively allow drying of sludge.

Overall, the plants commissioned so far have performed reliably with treated water quality consistently meeting the specification.

2.5 Quality Assurance

Construction of the plants proceeded under BHE's QA system which was subject to periodic audit

by Riverland. Although the vast majority of construction was completed satisfactorily, in projects of this scale there are inevitably a large number of problems and defects uncovered during commissioning and subsequent operation which need attention. BHE's QA system was complemented by North West Water's Operating QA system which uses Operator Concern Reports (OCRs) to detail operational and equipment faults. So far some four hundred OCRs have been generated from the four plants commissioned. These OCRs remain current and are tabled regularly with the Contractor until action is taken, with a good record of satisfactory resolution. It has been found that accurate recording and persistent tabling of the list of concerns has been instrumental in getting defects remedied.

2.6 Communication

The round trip to visit all the Riverland treatment plant sites is over 800 km. Each plant, in addition to the SCADA ISDN links, is equipped with phone and fax. Process Controllers have laptop computers, modems with internet and intranet (Lotus Notes) access and mobile phones. Mobile phone coverage in some areas is poor, presenting communication difficulties. A satellite phone is being used by Process Controllers at Swan Reach to overcome these difficulties.

When plants are unattended, plant alarms are communicated via an autodialler to the on call Process Controllers who are able to respond via their remote operator interface laptop computer. The system is flexible in that a number of plants may be accessed by Process Controllers in the event that someone is unable to respond. The communication system also allows the SCADA contractor to access the each plant PLC from the Adelaide office to effect program changes in response to Operator requests or to fault find, eliminating substantial travelling time.

With respect to management, the Riverland Operations organisation has a flat structure which is intended to enable empowered Process Controllers to undertake their duties without excessive bureaucratic encumbrances.

3.0 CONCLUSION

The Riverland Water Treatment Project in South Australia has provided a rare opportunity to experience the rapid consecutive construction and commissioning of a large number of water treatment plants of vastly different capacities spread over a large geographical area.

Commissioning and operating experience to date indicates the plants are robust and well able to meet treated water specifications and system demand requirements. Staffing of plants with skilled and empowered Process Controllers supported by maintenance contractors appears to be a key philosophy in successful plant operation.