OPERATION OF CHLORINATION / DECHLORINATION SYSTEM AT SHORTLANDS WWTP

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COMMISSIONING CHLORINATION – DECHLORINATION PLANT FOR SHORTLAND WWTP

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ABSTRACT

The purpose of this paper is to discuss the commissioning of the chlorination and dechlorination systems for the Shortland Wastewater Treatment Plant. It points out the problems as they occurred and the effective action required to remedy the problems. The reason for writing this paper is to pass onto the AWWOA Hunter Water Corporation's experience so to assist other operators in solving similar problems.

The Hunter Water Corporation provides water and sewerage services to approximately 420,000 people in the Newcastle area *(which is 2 hours drive north of Sydney)*. The Corporation operates twenty-one (21) wastewater treatment plants (WWTP's) which treat sewage from residential, commercial and industrial customers. They range in size from small local plants treating sewage from a few hundred households to large automatic plants capable of processing sewage for over 200,00 people.

KEY WORDS

Chlorination, Dechlorination, Wastewater Treatment

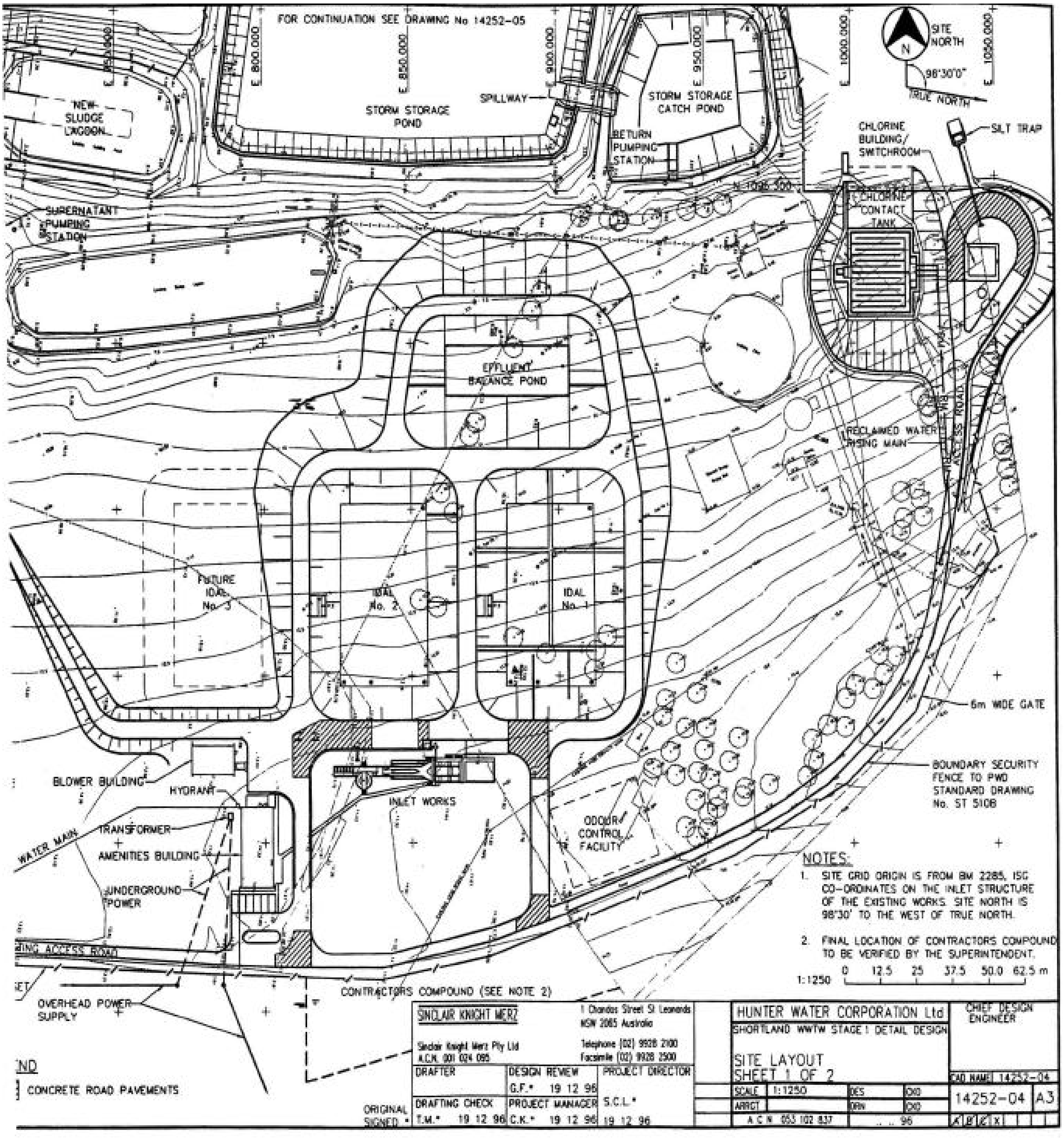
1.0 INTRODUCTION

The Hunter Water Corporation operates twenty-one (21) Wastewater Treatment Plants (WWTP) which treat sewage from residential, commercial and industrial customers. One of the Corporation's works is Shortland WWTP, a new activated sludge plant with a design capacity of 20,000 ep. Effluent from this plant is discharged via an outfall into the Hunter River. To ensure the local fishing industry is protected, the effluent is disinfected with chlorine and dechlorinated with Sulphur Dioxide. This paper describes the problems that have occurred in commissioning the chlorination / dechlorination plant, the effects on the process and action taken to maintain good effluent quality.

The Shortland WWTP is an activated sludge plant (MLE process for nitrogen removal) consisting of an inlet works, Intermittent Decant Aeration Lagoon System (IDAL) with pre-anoxic zone, effluent balance pond, stormwater retention lagoons with pump station for recycling back to the IDAL, chlorination, dechlorination and river outfall *(See Figure 1 - Site Layout).*

The main purpose of the chlorination system, which was started up on the 19 July 1998, is to disinfect the treated effluent from the Activated Sludge Process to reduce the possibility of pathogens infecting oyster leases downstream of the discharge point in the Hunter River. The main purpose of the dechlorination plant is to remove the chlorine residual which could effect the immediate aquatic environment surrounding the discharge point.

Figure 1: ***Shortlands WWTP site layout***



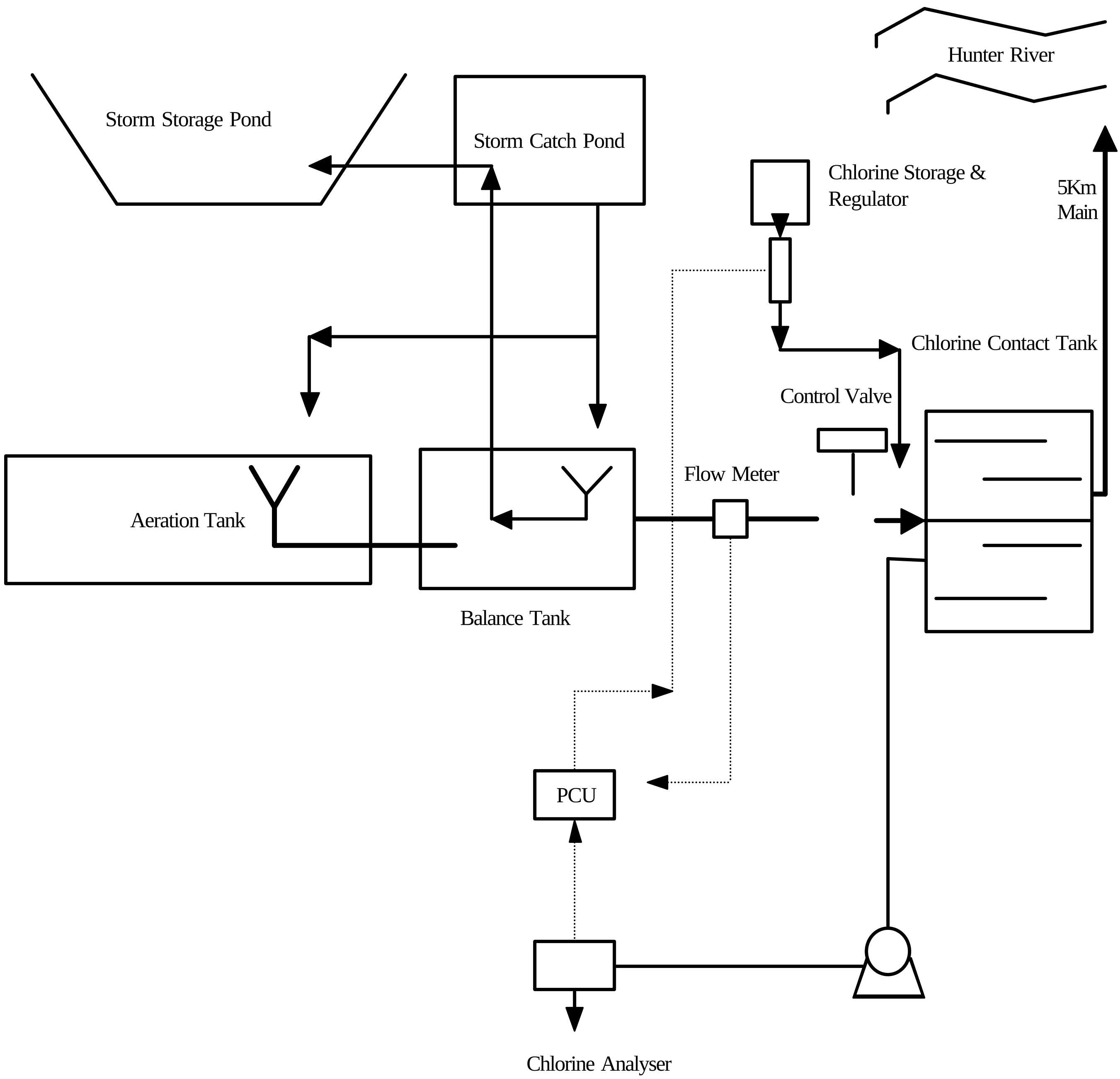
2.0 CHLORINATION / DECHLORINATION SYSTEM

2.1 Chlorination System

Chlorine is dosed into the treated effluent upstream of the chlorine contact tank (CCT). For Stage I the flow rate into the CCT is controlled *(via an actuating valve)* to approximately 60L/s in normal conditions following a decant cycle from the Intermittent Decant Aeration Lagoon *(IDAL)*, and up to 133L/s when in a storm cycle or storm conditions.

There are periods of low flow, eg. At night when the out flow from the balance pond decreases below 60L/s. If the flow drops below the preset minimum, the actuator valve will close, and the chlorine system will shutdown. The signal from the flow meter which regulates the control valve is also used to pace the chlorine dosing system. Residual chlorine measured in the CCT is used as well to trim the dosing rate *(Figure 2 Chlorination Flow Sheet).*

Figure 2: ***Chlorination Flow sheet***



The chlorine system is required to operate over a range of 25L/s to 130L/s. The applied dose of chlorine ranges between 4mg/L and 15mg/L to achieve a residual of 2mg/L of free chlorine after 1.5 hours contact time, or 0.4mg/L *(minimum)* at the effluent reuse draw off point

The chlorine system is designed for compound dosing control with a feed forward on flow and trim residual control for a dosing range of 20:1 overall. Chlorine gas is delivered to the plant in 920kg capacity drums and placed on load cells in Chlorine Storeroom.

Gas is drawn from the drums under pressure via flexible connectors to a manifold and is reduced to vacuum pressure by a vacuum-regulating valve.

There are two (2) chlorinators *(each chlorinator has a single injector)* duty standby. Two (2) dedicated injector high-pressure pumps are provided one duty and one standby. The pressure pumps operate only when there is flow entering the CCT. Two (2) chlorine residual analysers are provided to measure free residual chlorine.

In order to prevent fouling / blockages of the analysers, motorised strainers were installed. Water flow is supplied to one analyser from a dedicated sample pump *(one duty, one standby)* in the CCT. The exact location of the draw from the CCT can be selected by manual operation of isolation valves, allowing the residual to be measured and use the feedback control after a delay period of 7.5 to 30 minutes to simulate process lag time. In order to check the exact residual at the outlet of the CCT, a second analyser measures outlet residual whenever the chlorine pressure pumps are operating. When the chlorinator pressure pumps are not operating, solenoid valves energise to allow sample flow from the sample pump, and isolate the connection to the high-pressure supply line. Chlorinated effluent exiting the CCT is pumped to the Hunter River via a 5 Km, 450 mm diameter ductile iron cement lined main.

2.2 Sulphur Dioxide System

Sulphur dioxide is used to dechlorinate water prior to its discharge to the Hunter River. The flow rate from the CCT is approximately 60L/s or 130L/s according to which reclaimed water pump is operating.

Flow measurement in the line discharging to the Hunter River is used as a feed forward control to the sulphur dioxide dosing system.

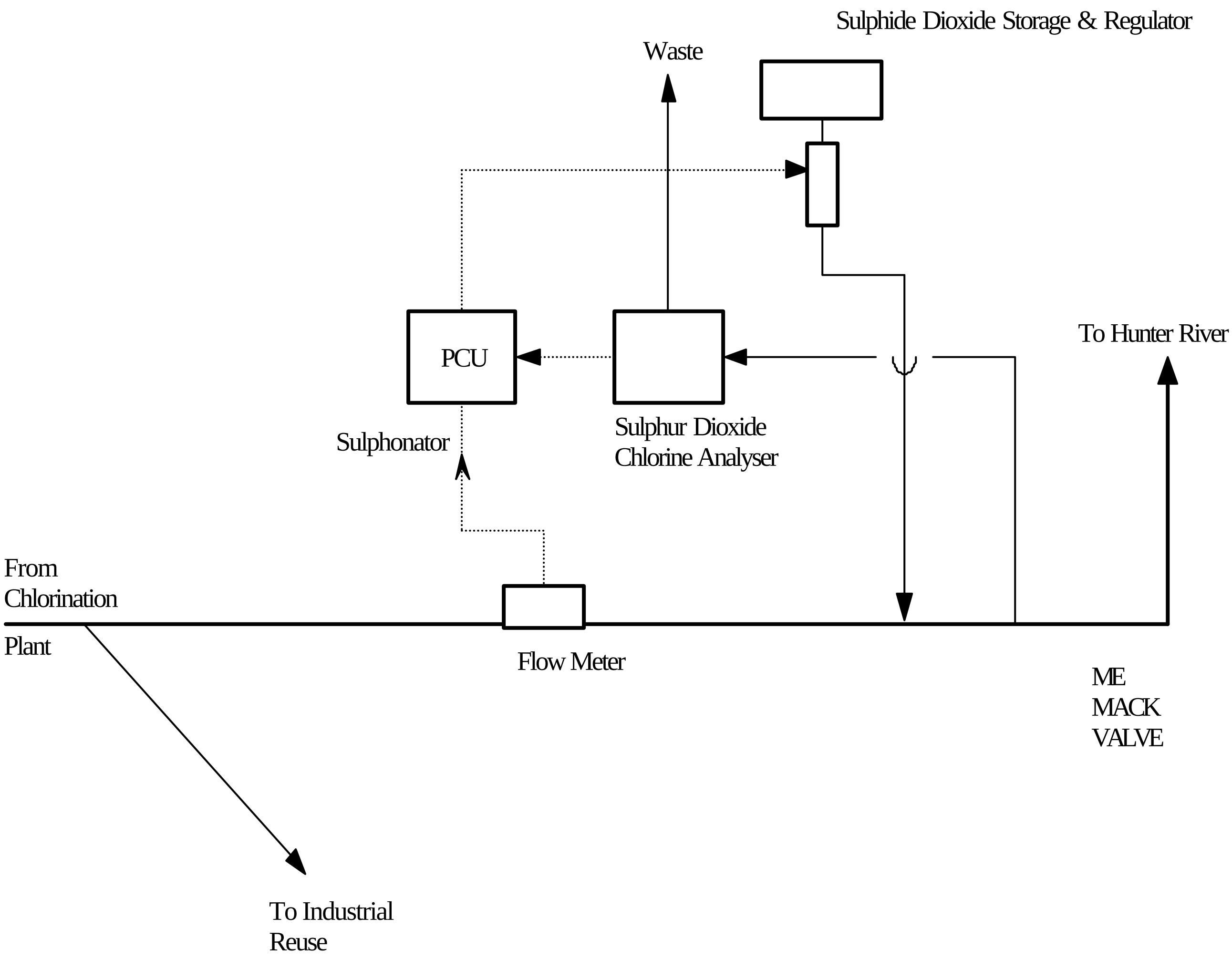
A residual analyser is used to maintain a chlorine or sulphur dioxide residual below 0.1mg/L.
The applied dose of sulphur dioxide ranges from 0.4 to 3mg/L over a flow range between 25L/s and 130L/s in Stage I *(feed range 40:1)*. The sulphur dioxide system is designed to deliver 1.5kg/h

Sulphur dioxide is delivered to the site in 500kg drums and placed on load cells in the sulphur dioxide storeroom. Gas is drawn from the drums under pressure, via flexible pigtail connectors to a manifold and vacuum pressure regulating valves. Gas under vacuum flows through the sulphonators, and is regulated according to the effluent flow rate measured downstream at the discharge flowmeter chamber.

There are three (3) sulphonators *(two duty, one standby)* with a single injector for each sulphonator. There are two (2) pairs of sample pumps, one extracting water upstream of the sulphur injecting point, and the other downstream. The upstream sample pumps supply sample water to a free chlorine residual analyser. The downstream sample pumps supply sample water to the chlorine / sulphur dioxide analyser, and provides feedback control to ensure effective dechlorination. In order to prevent fouling / blockages motorised strainers were provided on sample lines.

To maintain a constant 22 meter head pressure in the pipe line a pressure sustaining valve is installed, this allows positive pressure in the main at all times for effluent reuse during periods of non pumping to the river, and also ensuring that there is sufficient pressure and water available to feed sample water to the analysers *(See Figure 3 Dechlorination Flow Sheet).*

Figure 3: ***Dechlorination Flow sheet***



3.0 COMMISSIONING

In July 1998 the chlorination system commissioning commenced, and immediately it became apparent that the commissioning of this system was not going to be an easy one.

Due to the nature of the system with a process control unit (PCU) with fuzzy logic, flow rates, loop times and analysers, meant that everything to run efficiently and effectively for this system to operate as designed.

As the commissioning of the two (2) systems progressed a number of deficiencies in design and equipment as well as unforseen natural and process problems, created a difficult and sometimes frustrating project for all concerned.

Long and tedious hours were spent on the commissioning by the Operators, Technical Staff, Principal Contractors and the Designers to achieve an acceptable chlorination and dechlorination system.

Table 1 below lists the main problems encountered and the remedies applied to alleviate those problems.

Table 1: ***Problems Encountered with Chlorination System and Suggested Remedies***

PROBLEM	REASON	REMEDY
Blocking of analyser sample lines, unable to maintain constant loop times	Due too inadequate filter selection internals corroded and blocked up analysers	Replaced existing metal strainers with PVC flushing 'Y' strainers.
Corrosion in Chlorine analysers	Chlorine Gas corroded internal steel screws and fittings for analyser	Replaced with stainless steel screws and fittings.
Analysers unable to read accurately (unreliable)	Possible changes in effluent quality, sample line blockages, etc.	Trialing different types of free chlorine analysers. Early indication show they are all similar and not reliable.
High and Low Chlorine Residual	Inaccurate loop times, false analyser readings	Operate Cl_2 system on flow pace only
Inability for the Sulphur Dioxide System to react to sharp changes in Chlorine residual	Caused by the quick seesaw effect of changing chlorine levels in the Cl_2 system.	Operating Cl_2 system on flow pace only. This gave more consistent results.
Varying sample pressure to the analysers	Analysers sharing sample pumps causing loss of flow to analyser.	Dedicated sample pumps and analyser
High Dosing Cl_2 pressure. Damaging pipe PVC work	PVC pipe work unable to cope with 1350kpa. No reason given by contractor for selecting such a high pressure	Reduced pressure by installing a pressure reducing valve. Current pressure now 600kpa.
Choking dosing pumps	Pumps choking on small material such as plastic, fat, cotton bud sticks and feathers	Encased pumps in a fine screen, installed energy dissipater baffles and screening baskets at effluent pump station.
Minor Cl_2 Gas Leaks	Pigtails leaked at connection points	Replaced fibre washers with lead washers.
Leaking PVC Valves in the Cl_2 System	Seals and 'O' Rings perished due to Cl_2	Replaced seals and 'O' rings with chlorine compatible material.
SO2 injectors allowing dosing water to enter gas lines	Seals and 'O' Rings perished and distorted by SO2	Gas lines dried out, seals and 'O' rings replaced with compatible material.
Blue-green algae affecting Cl_2 demand and process in IDAL	Blooms in the storm storage lagoon in the summer	No remedy at this point *(possibly a gravel filter in future)*.
Tortoises and eels choking pumps etc.	Travelling from the local wetlands to storm storage pond	Installed screens to prevent them from entering the PS.
Dechlorination SO2 / Cl_2 analysers running out of sample water during periods of no flow	The pressure sustaining valve would fail to close from time to time, draining the pipe line, resulting in loss of sample water	Regular cleaning of the filter for the pressure sustaining valve regulator.

4.0 CURRENT STATUS

At this particular stage the chlorination and dechlorination systems are working as well as can be expected, with excellent final effluent results. The free chlorine residual is equal to 2mg/L after two (2) hours detention *(for dry weather flows)* with low faecal coliform counts of less than 200 per 100mls.

The chlorination system is operating automatically by flow without quality trim due to the fact that Hunter Water is unable to find a free chlorine analyser that is able to perform accurately and reliably.

The dechlorination system is operating as designed, but still encounter problems with shortages of sample water from time to time due to the pressure-sustaining valve failing.

Further trialing of different types of free chlorine analysers will continue as well as the trialing of a redox probe and controller to allow the quality trim to function for the chlorine system as planned. The designer is also investigating options that are available for replacing the pressure-sustaining valve on the effluent rising main to the Hunter River.

5.0 CONCLUSIONS

As Water Authorities continue to encourage effluent reuse, the more stringent the quality levels for disinfection are becoming. As demonstrated at Shortland WWTW's requirement by the EPA for disinfection was chlorination and dechlorination in order to protect the downstream Oyster Industry.

Thus when Authorities are requested to install processes that are new to an organisation some of the following points would be worth considering to prevent a repeat of the problems experienced at the Shortland WWTP.

- Visit similar plants and speak to operators and engineers about their process, reliability of equipment and operator input.
- Make a list of designers and equipment suppliers / installers who have successfully completed a similar project.
- Ensure that suitable time is allowed in the planning stages to discuss the system philosophy and how it should operate.
- Have regular meetings with designer during the design stage to ensure the operational concept is on track and is practical.
- Have an operator working closely with installation contractor so he becomes familiar with equipment and can test its reliability at an early stage of the contract as well as have on the job training.
- Make sure that if equipment supplied is critical to the overall process that a standby unit is incorporated rather than having to wait for months for overseas parts.
- Do not accept the equipment in the system until it has completed a 7 day reliability period without a major malfunction.