CLASS A APPROVAL PROCESS FOR THE WODONGA WATER RECYCLING SCHEME

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67th Annual Water Industry Engineers and Operators' Conference
Sports and Leisure Centre - Wodonga
1 and 2 September, 2004

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ABSTRACT

North East Water has undertaken a program to verify the West Wodonga Purification Plant (WWPP) capability to reliably produce Class A recycled water. The WWPP is a Biological Nutrient Removal plant with continuous backwashing sand filters and chlorine contact tanks that have been designed to provide Class A recycled water. This approval process will pave the way for many similar schemes across the state, and change the perception and increase the value of this water as a commodity.

The approval and verification process for the plant involved:

- Consultation with both the EPA and DHS;
- Incorporating principals from the Hazard Analysis Critical Control Point system (HACCP) by adapting the existing ISO9001 Quality Management System at the WWPP and;
- Conducting a plant verification trial.

The verification trial was conducted over an 8-week period to establish the minimum rate of pathogen reduction at critical control points in the treatment process. The results of this trial had demonstrated some linkage of pathogen reduction at critical control points to the surrogate parameters of chlorine and turbidity. Linkages of the surrogates to protozoa reduction were more difficult to establish due to issues with laboratory detection limits. It was found that the ability to monitor these surrogates in real time ensures that if water quality deviates significantly from set points, corrective action can be undertaken immediately, ensuring health targets are met.

KEY WORDS

Recycled Water, Class A, Verification, HACCP, Giardia, Cryptosporidium,

1.0 INTRODUCTION

North East Water provides water and wastewater services to 36 towns, servicing an estimated population of 91,000 people in an area of approximately 20,000 square kilometres in North East Victoria. The West Wodonga Purification Plant (WWPP) treats sewage from and estimated population of 35 thousand and a recent upgrade has more than doubled the capacity of the and substantially improved the quality of the effluent discharge to the Murray River.

The Victorian Environment Protection Authority (EPA) Discharge Licence for the plant requires North East Water to maximise reuse opportunities in the region. The WWPP upgrade was undertaken by PURAC Pty. Ltd. under a Design Build and Operate contract. This upgraded plant has been designed to produce Class A recycled water for beneficial reuse. Class A recycled water is high quality water produced from advanced sewage treatment processes and has been verified to contain extremely low levels of pathogens (Table 1). The reuse opportunities that have been identified include industrial, urban (open public space) and intensive horticulture reuse.

Table 1: ***EPA Guideline Values for Class A Water (EPA 2002)***

Parameter	EPA Guideline Limit
E.coli	10 orgs/100mL
Turbidity	<2NTU (24hour median value)
BOD, SS	10 mg/L, 5 mg/L
pH	6-9
Chlorine	>1 mg/L residual
Helminth	<1 per L
Protozoa	<1 per 50L
Virus	<1 per 50L

Historically the WWPP has supplied approximately 200ML per annum recycled water to an urban reuse scheme that consisted of irrigation at the Wodonga Country Club, Latrobe University (Wodonga Campus), Wodonga TAFE and Victory Primary School. This urban reuse scheme was initially developed in the late 1980's and was granted a licence for operation by the Department of Human Services. In 1996 the regulation of this scheme was transferred to the EPA.

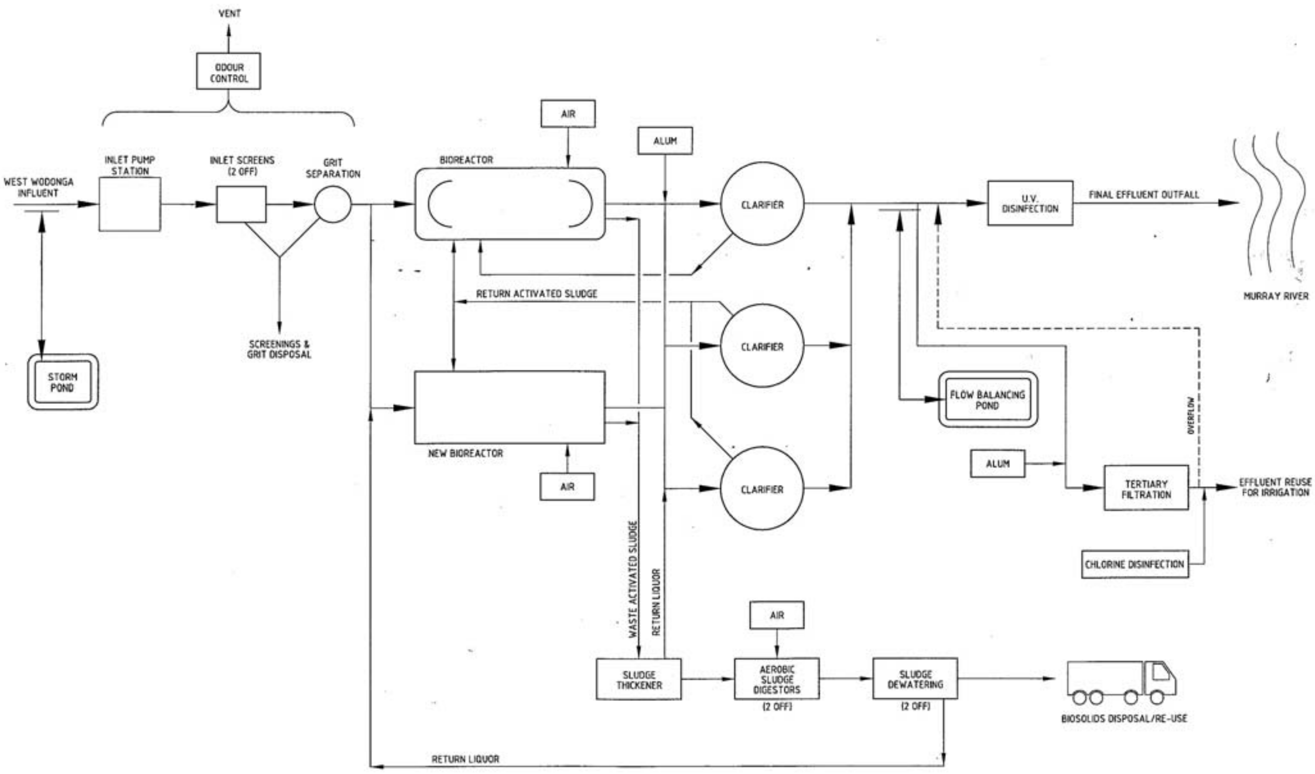
The quality of the recycled water that was supplied to these users conformed to the EPA's Class A as defined by the EPA Publication 464 *Guidelines for Wastewater Reuse*, 1996. In 2002 these guidelines were superseded by the EPA Publication 464.1 *Guidelines for the Use of Reclaimed Water* (EPA 2002). These guidelines outlined that when a plant process or inflow to a plant changes significantly the plant should be re-verified to produce Class A water.

2.0 PLANT DESCRIPTION AND OPERATION

The WWPP currently treats approximately 4000 ML of inflow per annum with the plant throughput expected to increase to 6000 ML annually by 2021. Of this inflow major trade waste customers account for 25-30% of the flows and 50% of the load with the balance being domestic sewage. Under the DBO contract PURAC is responsible for the day to operation and management of this plant.

The design of the WWPP was based on the upgrading of existing facilities and addition of new facilities resulting in a fully integrated plant, providing the latest in Biological Nutrient Removal (BNR) process technology. The plant design includes a high degree of robustness, flexibility and advanced operating features to ensure treatment can be achieved over a wide range of influent conditions. The treatment process consists of duel aerated bioreactors, secondary clarification, ultra violet disinfection and sand filtration (Figure 1).

Figure 1: ***Process Flow Chart for the West Wodonga Purification Plant***



2.1 Reuse System

Effluent from the treatment process is further polished by sand filtration and chlorine disinfection before being supplied to users.

The sand filtration system provides continuous filtration through a deep sand bed that is continuously being circulated and washed (by an air lift pump system). The deep bed sand filtration system is well proven in tertiary treatment applications and has the advantage of high solids removal capabilities. The filter influent is pumped to the filters from the UV channel outlet chamber and dosed with alum to assist coagulation/filtration. A polymer dosing system to assists in particle removal. The filtrate then gravitates to a chlorine contact tank. The dirty water from filter washing flows by gravity back to the biological process.

As the sand filtration system has been designed to be modular, it is relatively simple to install new parallel units to increase re-use treatment capacity in the future.

A 30 min chlorine contact tank is located downstream of the filters and this part of the process provides disinfection of the recycled water. The feed is dosed with sodium hypochlorite to achieve a chlorine residual value as measured by an on-line analyser. Turbidity and chlorine residual analysers continuously measure the treated water quality.

Existing urban users are supplied via pressurised main to onsite buffer storage tanks before irrigation. Individual users in the West Wodonga reuse scheme irrigate according to the individual site management plans as attached to the sale of reclaimed water agreements.

3.0 APPROVAL PROCESS

The EPA *Guidelines for Reclaimed Water Use* outlined that not only should Class A schemes conform to set limits but also have in place a risk management and assurance program to demonstrate that the treatment process can reliably produce Class A recycled water. These new guidelines also outlined that any verification program for Class A must have the endorsement of the Victorian Department of Human Services (DHS) before submission to the EPA for sign off.

3.1 EPA and DHS Consultation

As the WWPP plant was one of the first of this type plants in Victoria designed to produce Class A water there was no tried and tested approval and verification process developed. To develop and gain approval for a suitable approval process for the plant several meetings were conducted with the EPA and DHS. This period of consultation was important to gain an understanding of the requirements that would be required to gain endorsement of this particular treatment process to reliably produce Class A water.

As a result of this consultation an appropriate approval process was recommended by the DHS. This process comprised of weekly sampling over a two month period of both influent and product water for the following parameters:

- *E. coli* (also sampled Post BNR and Post Clarifier)
- Adenoviruses
- Cryptosporidium
- Helminth parasites
- Turbidity
- Suspended solids
- BOD
- pH
- Chlorine residual (in product water only)

During this period of consultation it was stressed that an appropriate quality assurance program be established that should link continually monitored operational parameters (pH, turbidity and chlorine residual) with the plant efficiency.

3.2 WWPP Quality Assurance Program

It well recognised that preventative risk management provides the best practice for a quality assurance system (Cunliffe and Stevens, 2003). The HACCP risk management system has been very successful in both food and water industry in providing safe produce and water. It is recognised that this system is appropriate for ensuring consistent quality of Class A water produced at a treatment plant.

The structure of HACCP systems basically incorporates seven principals:

1. Identification of significant hazards;
2. Assessment of the Critical Control Points;
3. Establishment of performance limits to manage risks at Critical Control Points;
4. A system of monitoring to ensure that control measures are effective;
5. Have in-place corrective action procedures;
6. Have in place a formal system of organising records and procedures;
7. Be able to verify that the system is working.

The WWPP has an externally audited quality assurance program that has been certified under the ISO 9001 Quality Assurance System. This QA System structure is consistent with the principals of HACCP and has specifically set limits and follow up actions on the reuse system consistent with EPA guideline requirements.

Table 2: ***WWPP Reuse Critical Control Points and Reporting Limits***

Critical Control Point	Critical Control Limit	Excursion / Reporting Limits	Actions
Tertiary Filter Turbidity, trend over 24 hours	Over 2 NTU	<1 NTU 1 to 1.5 NTU 1.5 to 2 NTU Over 2 NTU	OK Check tertiary Alum dose Check tertiary Alum dose and tertiary filter operation Stop off site reuse, check tertiary filter operation, Notify EPA
Turbidity single event		Over 5 NTU	Stop off site reuse, check tertiary filter operation, Notify EPA
Re use pH Trend over 24 hours	Should be in range 6 to 8	Out side range	Stop reuse and investigate Notify EPA
Disinfection Chlorine residual trend over 24 hours	Over 1 mg/L (preferably between 1.2 and 2 mg/L)	Below 1mg/L	Stop off site reuse, Between 1 and 1.2 mg/L increase chlorine dose Notify EPA
E. coli	40 orgs/100mL	>40 orgs/100mL	Stop off site reuse, notify EPA undertake investigation
Treatment	<10 mg/L BOD <5 mg/L SS	>10 mg/L BOD and >5mg/L SS median over 12 months	Report

A HACCP based approach is important as it is well recognised in the water industry that management based on compliance testing alone is not an effective way of managing risk. As for drinking water the analysis of recycled water takes time and the exceedance of guideline values is generally only detected after water has been supplied to the customer (Cunliffe and Stevens 2002).

To overcome this problem critical control points and limits have been developed based on the plant design and EPA guidelines. The two critical stages in the process for pathogen removal have been identified to be the filtration stage (protozoan and helminth removal) and the chlorination or disinfection stage (virus and bacteria removal). At these stages performance parameters are monitored continually in real time to ensure that the treatment process is operating within set conditions.

4.0 PLANT VERIFICATION TRIAL

4.1 Sampling and Assessment Program

The verification trial was conducted at the WWPP with sampling commencing on Wednesday the 21st January 2004 for an 8-week period with the final samples being collected on the 10th March 2004. It was important that the trial was timed to ensure that the results would reflect a typical irrigation season. All samples were collected in accordance with EPA guideline and analyses at NATA accredited laboratories.

In addition to the parameters recommended by the EPA and DHS the information in Table 3 was also collected.

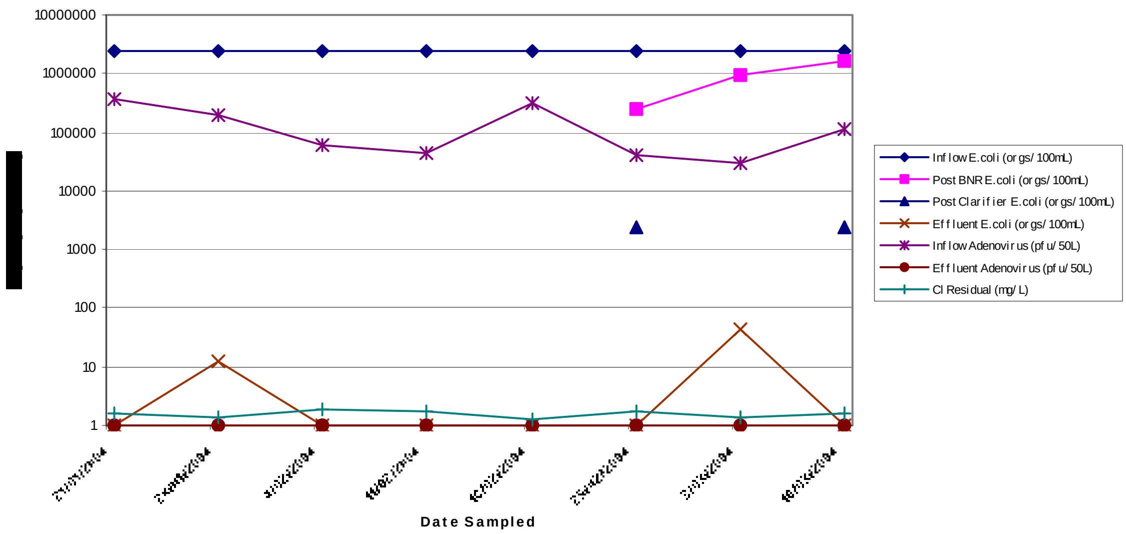
Table 3: ***Plant Information Collected***

Sewage	Effluent	Recycled Water
Plant trend data of inflow to the plant; COD; Suspended Solids; Phosphorus; and Ammonia	Plant trend data for effluent discharge; Phosphorus; Ammonia; Nitrogen; BOD; and Suspended Solids	Plant trend data for reuse supply for pH, turbidity and chlorine residual Operational issues affecting the quality of the reclaimed water, including flow and daily volume;

4.2 Results of Verification Trial

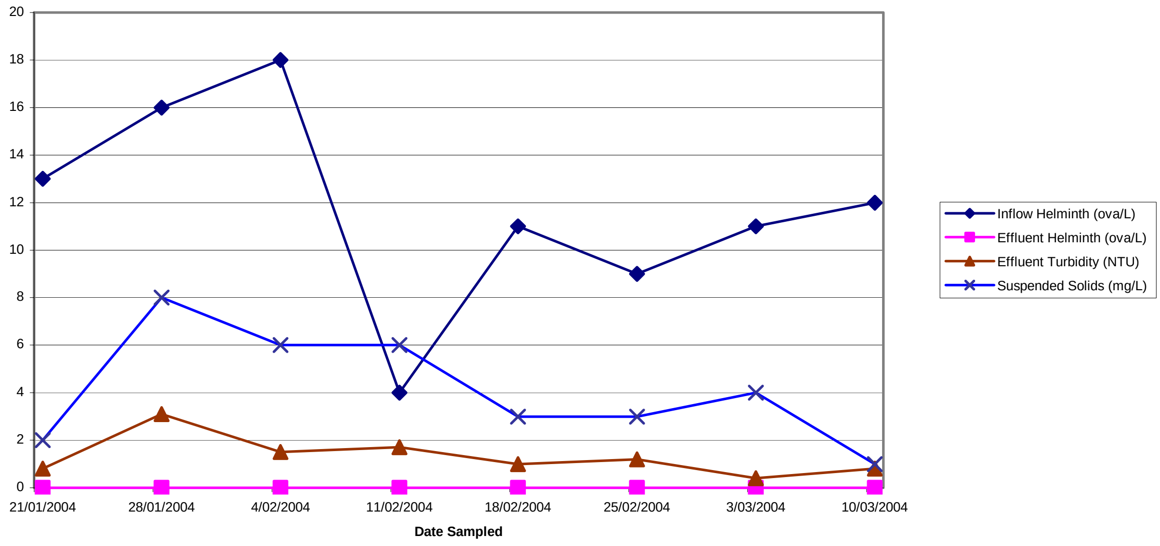
At the conclusion of the trial, results were collated and graphed to help make a comparison with recorded chlorine residual, suspended solids and turbidity information. No Adenoviruses were detected in the recycled water but E.coli was detected on two occasions. Free actual chlorine residual for the trial was maintained between 1.3 mg/L and 1.9mg/L throughout the trial.

Figure 2: ***Inflow and Effluent E.coli and Adenovirus Compared to Actual Chlorine Residual***



The inflow helminth varied between 4 ova/L to 18 ova/L and no helminth ova were detected in the recycled water. Turbidity was below the 5 NTU EPA guideline limit for all individual samples. During the trial the 24-hour mean turbidity remained below 2 NTU.

Figure 3: ***Total Helminth, Suspended Solids and Turbidity***



Both total Giardia *spp.* and Cryptosporidium *spp.* were analysed, with all samples (influent and recycled water) returning results below the detection limits of the laboratory.

5.0 VERIFICATION TRIAL ISSUES AND DILEMMAS

An issue that became apparent from the outset of this Class A verification process was that there were no other examples of the process for this type of treatment plant in Victoria. As a result extensive consultation with both the EPA and DHS was needed to develop an appropriate verification process but even with this consultation it was still unclear that a conclusive result for the trial could be obtained. The difficulty was in designing a verification trial was that to measure the plants reliability to remove pathogens there must be a measurable inflow of the pathogens into the plant and the difference in the outflow will give the plants pathogen reduction capacity.

For this trial Adenovirus was studied as they are indicative of virus and widespread in nature (present in birds, mammals and man). Given this there is a high probability that they would be present in significant numbers in the inflow and provide a useful indicator of viral pathogens for this trial.

The results (Figure 2) demonstrate that there is at least a 6 log removal of e.coli and a 4 to 5 log removal of Adenovirus through the treatment process. All the results obtained for inflow (raw sewage) E.coli were above the detection limit of the laboratory. The expected raw sewage E.coli concentration is in the order 7E+6 orgs per 100mL (Ashbolt and Fane 2000) which compares favourably the laboratory limit of 2.4E+6 orgs per 100mL.

The chlorine residual at the plant is monitored and controlled automatically. Due to a delay between monitoring and chorine dosing a residual of 1.2 mg/L is maintained to ensure adequate disinfection. From Figure 2 it is demonstrated that this critical control limit for chlorine was monitored and there was no identified Adenovirus in the recycled water.

In a tertiary BNR treatment process with filtration it is expected that the majority of Helminth ova, Giardia cysts and Cryptosporidium oocysts are removed in the filtration stage. In line with this, the main critical control point for these parameters is the deep bed sand filters. The EPA guidelines (2002) indicates that a turbidity of 2 NTU (mean over 24 hours) as a guide will provide adequate removal of suspended solids including protozoan and helminth. This trial demonstrated that this critical control limit on turbidity has been successful in ensuring the removal of all Helminth ova (Figure 3) but the results obtained for both Giardia and Cryptosporidium were inconclusive with all results below the detection limit of the Laboratory.

As mentioned previously to conduct the verification trial there needs to be a measured input of pathogens to the plant. Even though the filters may be efficient at removing both Giardia and Cryptosporidium this cannot be demonstrated. The Giardia and Cryptosporidium Laboratory detection limit for all but one set of result were more than that of the EPA Class A water limits. Due to the process involved in the laboratory analysis of Giardia and Cryptosporidium it could be generalised that the detection limit is a function of how "dirty" the water is i.e. the cleaner the water the better the detection limit. As a result it is difficult to verify these filters for compliance to the EPA guidelines using this trial method.

6.0 CONCLUSION

An approval process was developed to gain endorsement from the DHS and EPA for the for the WWPP production of Class A Water. The process involved consultation with both departments, the adaptation of the plants existing ISO9001 quality assurance system to include HACCP principals, and the development and conduction of a plant verification trial.

The results of the verification trial indicated that the critical control limits set for both turbidity and chlorine residual provide sufficient control for managing pathogen risks. The protozoan result from the trial was inconclusive due to the trial design and further investigations will be required to verify this part of the process.

7.0 ACKNOWLEDGEMENTS

I would like to thank the operators at the West Wodonga Purification Plant, Mr Peter Tolsher and Mr Charlie Suggate for their valuable assistance in the trial.

8.0 REFERENCES

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