CONVERSION OF A CONTINUOUS ACTIVATED SLUDGE PLANT TO A DECANT PLANT DURING SECONDARY SEDIMENTATION TANK MAINTENANCE

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ABSTRACT

The Bundaberg City Council East Waste Water Treatment Plant has a procedure in place to convert the activated sludge continuous extended aeration plant into an instantaneous decant extended aeration (IDEA) plant as a contingency to allow the secondary sedimentation tank (SST) to be taken offline.

The paper provides an operations view of how the conversion takes place and the impacts on the combined plant. The programmed decant sequence was developed by Bundaberg City Council operational and trade services staff. The decant sequence along with plant operational results during the conversion explains the plant operations and its performance.

1.0 INTRODUCTION

The City of Bundaberg with a population of 46,540 is approximately 380km north from Brisbane and is located on the Burnett River with the main industries consisting of agriculture, light industrial and tourism.

The East Wastewater Treatment Plant (WWTP) is located off Alexandra St East Bundaberg. Treated effluent from this plant is discharged via gravity to the Burnett River.

The East WWTP consists of three (3) process streams referred to as A, B & C plants. The original trickling filter plant at the East plant is divided into two parallel process trains being the A and B plants. The plant was upgraded in 1983 to included an activated sludge plant with an oxidation ditch and a secondary clarifier. The activated sludge plant is referred to as C plant. The East WWTP overall plant has a design load of 41, 500 equivalent population consisting of;

- A Plant 7,000 persons biological trickling filter plant.
- B Plant 16,000 persons biological trickling filter plant.
- C Plant 18,500 persons activated sludge plant.

The layout of the existing East plant is shown in Figure - 1.0.

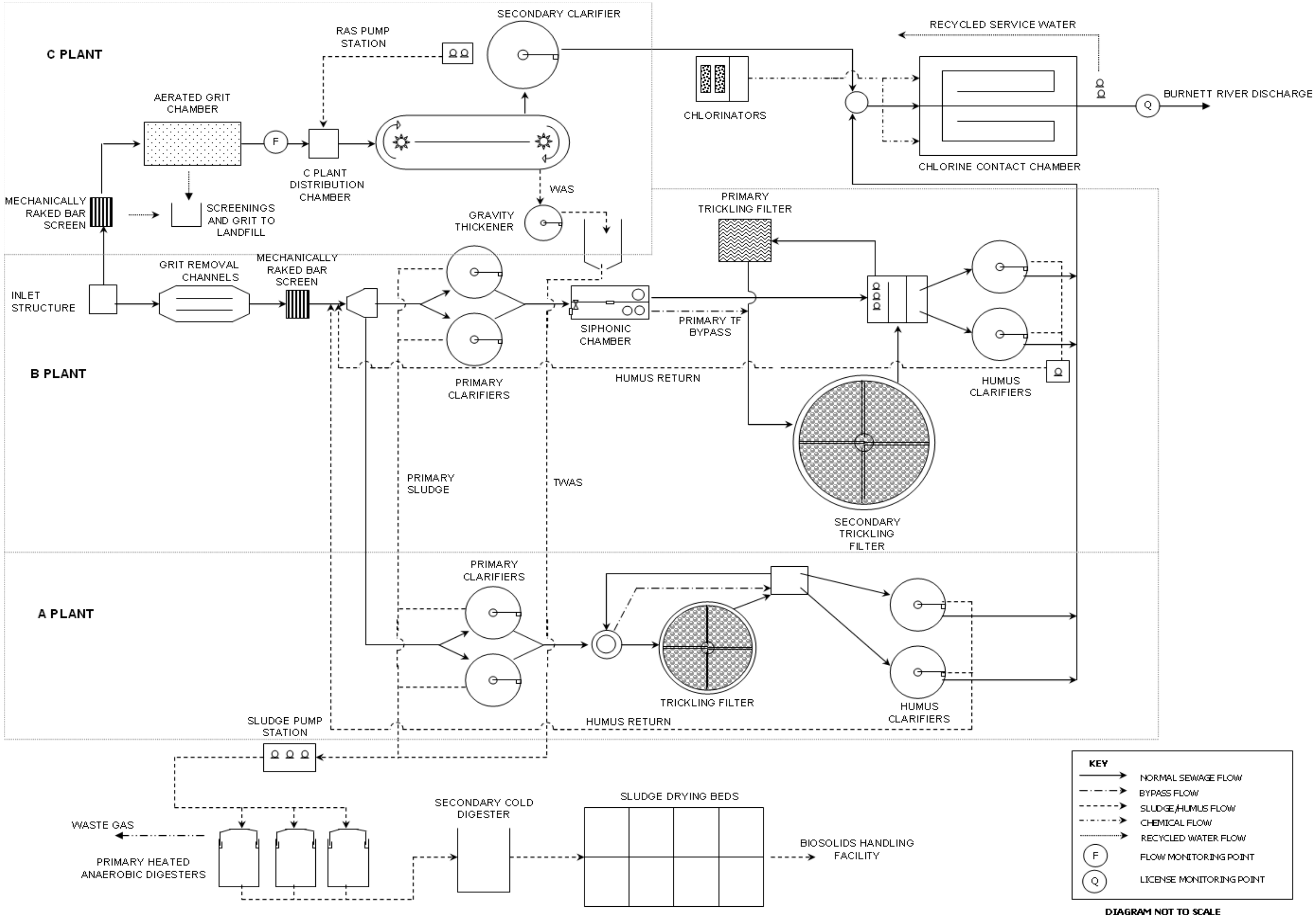

Figure 1.0 – *East WWTP Schematic*

2.0 BACKGROUND

The activated sludge C plant SST required planned maintenance consisting of repairs to steelwork, replacement of pivot bearing along with the overhaul of drive gearboxes. The works plan was to conduct the maintenance in May 2006 when there is low probability of wet weather flows to reduce the impact on the final effluent quality.

The activated sludge plant had to be converted some weeks prior to the planned maintenance to an IDEA plant to enable the tank to be taken off line.

The work was scheduled to take up to 5 weeks to complete. The whole project from converting the plant to a decant plant and the SST maintenance was carried out by the council workforce.

3.0 CONVERSION PREPARATION

The preparation to convert to a decant process occurred while the SST was online so as to contain any carryover solids during trialing until the decant processes was proven to be reliable with acceptable quality effluent.

The conversion preparation was made-up of five (5) main steps consisting of;

- Initial manual simulated trial to develop a control sequence.
- Program PLC with the initial simulated control sequence.
- Fine tune the control sequence to improve operations.
- Set-up waste activated sludge line direct from the aeration basin.
- Decanted final effluent diverted to isolate the SST for maintenance.

3.1 Manual Simulation

The initial manual decant sequence involved an amount of trial and error. It was evident that the inflow to C plant had to be reduced to approximately 50% to allow enough volume in the aeration basin. The aeration basin's decant sequence volume from the available 300mm travel of the motorised adjustable weir equated to 390 m^3 with the decant step cycle occurring over a 2 hour period.

The plant flow was reduced by 50% from 3.0 to 1.5 MLD and the aeration was stopped. Settling characteristics in the aeration basin were recorded for 60 minutes with sludge blanket depth measurements made every 5 minutes. It was observed that the blanket settled to a depth of 1 metre after the 60 minutes. This gave confidence to proceed to the next decant stage.

The next phase was to determine the rate at which the weir could be lowered over the 300mm. The plan was to find the maximum lowering rate that would provide for reliable effluent quality. It was discovered that the best results were obtained by having a step lowering sequence after the initial settling period of 1 hour.

The fill/aeration sequence step was trailed by a level electrode situated in the aeration basin where the aeration cut-off point was 100mm below the top travel level of the weir. The fill/aeration duration varied due to inflow activating the cut-off level resulting in aeration times ranging from 1.5 to 3.0 hours with the whole cycle ranging from 3.5 to 4.5 hours.

The aeration cycle time variance was overcome by adjustable aerator duty selections. Duty selections involved running either combination of the two (2) available aerators on low or high speed or in parallel to obtain acceptable operating parameters.

3.2 Program PLC and Fine Tune Control Sequence

The manual simulation revealed settings for the initial decant sequence. The initial settings were fine tuned and programmed into the PLC. The final decant sequence steps as programmed into the PLC are listed in Table 1.0 – Decant Sequence Steps.

Table 1.0 – *Decant Sequence Steps*

<table>
<tr><th>Decant Sequence Step</th><th>Time (mins)</th><th colspan="2">Sequence Details</th></tr>
<tr><td>Settle</td><td>60</td><td colspan="2">After 60 minutes all movement in the basin stops and the sludge blanket settles out to approximately 1000mm.</td></tr>
<tr><td>Decant</td><td>60</td><td colspan="2">The weir will commence to ramp down in 5-10mm increments until it has traveled the full 300mm distance.</td></tr>
<tr><td rowspan="4">Aeration

(Aeration variance due to diurnal flow).</td><td rowspan="4">90 - 180</td><td colspan="2">The cut-off electrode stops the aerators when the liquid level is 100mm below the fully raised weir. Approximate aeration configuration was;</td></tr>
<tr><td>6:00am to 12:00pm</td><td>Two aerators in parallel on high speed.</td></tr>
<tr><td>12:00pm to 6:00pm</td><td>Nº 1 aerator - high speed and Nº 2 aerator - low speed</td></tr>
<tr><td>6:00pm to 6:00am</td><td>Nº 1 aerator on low speed</td></tr>
</table>

3.3 Redirect Waste Activated Sludge

The normal mode of wastage is as MLSS via the SST inlet distribution chamber. As the SST was to be isolated a temporary wastage line was fitted from the aeration basin scour line to the sludge thickener inlet line so wastage could still occur.

3.4 Divert and Isolate Secondary Sedimentation Tank (SST)

A 300mm AC diversion pipe was fitted to the SST inlet distribution chamber to allow the decanted effluent to flow directly to the chlorination chamber allowing the SST to be isolated. All SST associated equipment such as the RAS and tank gearbox drives were locked out and isolated.

4.0 OVERVIEW OF SCHEDULED MAINTENANCE

The scheduled maintenance of the SST started in May 06 and was completed in June 06. The maintenance went well with the replacement of the centre bearing giving the trades some resistance with the removal of the old bearing. A scope of maintenance works is listed;

- Empty and clean down tank and machinery.
- Inspect and remove machinery for overhaul and painting.
- Repair concrete work.
- Water blast, sand blast concrete work and steel work.
- Paint all concrete and steelwork as required.
- Replace steelwork as required.
- Overhaul gearboxes, scrapers.
- Test run, refill tank and place back into operation.

5.0 Operational Procedures in Decant Mode

In the initial decant trial the settleability was found to be acceptable when the MLSS was between 1800 – 2200 mg/L with a 30 minute settleability test of 300 mL/L. Certainly the lower the settled volume the better. The decant sequence was not introduced until the MLSS of 1800 mg/L was achieved. Initially there were many operational checks to ensure all parameters and sequences were working to ensure there was no carry over of floc.

The wastage rate from the aeration basin to the sludge thickener was adjusted to maintain the desired MLSS. Aeration rates were adjusted through duty selections based upon the operational test results.

6.0 Operational Test Results

Operational tests were conducted on samples collected at the end of the aeration and decant cycles. Results of these tests allowed for the fine tuning of the aeration and wastage rates. Results from the operational tests along with a comparison of the plant in continuous mode is summarised in Table 2.0 – Aeration Basin Test Results and Table 3.0 – Final Effluent Test Results.

Table 2.0 - *Operation Test Results*

Mode of Operation	Inflow (KL)	pH	MLSS (mg/L)	Stirred Settled Sludge Volume (mL/L)	SSVI
Normal - Continuous	2817	6.99	2480	307	127
Decant Operation	1514	7.09	1920	235	125

Table 3.0 – *Final Effluent Test Results*

Mode of Operation	Suspended Solids (mg/L)	Ammonia - N (mg/L)	Nitrite – N (mg/L)	Nitrate – N (mg/L)	Total Alkalinity - $CaCO_3$ (mg/L)
Normal - Continuous	4	0.6	0.03	2.0	108
Decant Operation	8	5.0	0.05	2.5	136

7.0 Biological Trickling A & B Filter Plants

The conversion of C plant to a decant mode caused an extra 1.5 MLD to be directed to the A & B biological trickling filter plants. The plant settings and operational checks had to be increased to allow for the increased loadings such as monitoring manual bar screens on a more regular basis through to adjustments of sludge draw off times. The recirculation rate of the humus pumps was increased to keep sludge blankets to a minimum due to the increased hydraulic load.

8.0 Chlorination Chamber

The chlorination chamber consists of a tank containing two mixing chambers and two contact chambers. The contact chambers are operated on a duty/standby arrangement. The chambers were alternated every week during the decant mode to allow for the removal of accumulated solids to minimise carryover.

9.0 Conclusion

The conversion was developed due to necessity to do plant maintenance and as they say in the classics “necessity” is the mother of invention.

The conversion was intended for planned maintenance but can also be implemented as a contingency measure in the case of a major SST failure, such as vandalism or tank bearing collapse.

The hydraulic loading created on A & B plants if C plant was completely offline would have had a greater impact on the final combined effluent quality.

The decant conversion is not intended to be the preferred long term contingency plan as any future plant upgrades could include a second SST to address the need for process redundancy.

The conversion has also given operations staff a better understanding of the different operational aspects of the East WWTP processes leading to improved performance now the plant has returned to normal operations.

10.0 Acknowledgements

The author would like to acknowledge the support and efforts of Bundaberg City Council Process Operations and Trade Services staff.