PEAK WET WEATHER FLOW (PWWF) MANAGEMENT AT SINGLETON IDEA SEWER TREATMENT PLANT

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8th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
PCYC in Orange,
1 to 3 April, 2014

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ABSTRACT

During February and March Singleton experienced several major rain events. That led us to look at ways to better manage peak wet weather flows (PWWF). We then went about analysing inflows to the plant at certain times and duration. This was then compared to the rainfall received and at what time by recording it on a two hour basis. By using this data and then analysing what the capabilities of the plant of the plant were we developed control measures which were then incorporated into a new PLC program. This program is flexible enough to handle PWWF of a short duration e.g. thunderstorms, along with a PWWF of longer durations e.g. floods.

The major benefits of this are avoiding a storm cycle where there is no wastewater treatment process and allows treatment to a degree to maintain the decanting of high quality waste water and reduce any environmental incidents and pollution due to storm cycles.

1.0 INTRODUCTION

Singleton is situated on the Hunter River 80km north west of Newcastle. It has a population of approximately 22 000 in the local LGA. The town comprises of five areas being: Town, Darlington, Maison Dieu, Heights, Hunterview and Retreat.

The treatment works consist of two extended aeration tanks of 10 000 EP capacity each, two one day detention catch ponds and a nine day detention pond at average daily water flow (ADWF). Treated effluent from the aeration tank is discharged into the one day detention pond, which then flows to the nine day detention pond and is finally discharged to a water course named Little Doughboy Hollow leading into Whittingham Swamps.

The sewerage network comprises of nine minor pump stations and four major, which feed the plant. The maximum flow capacity to the plant is 440L/S. The plant operates on 60 minute aeration, 60 minute settling and 30 minute decant. The PWWF control was if the level reached 61%. The process would stop and the decants drop and would continue for a 60 minute cycle until a bottom water level (BWL) of 46% was reached.

This led to the decanting of unprocessed waste water, sometimes over a number of cycles, which is not a desirable outcome. Therefore we started to look at ways of overcoming this and improving effluent quality during PWWF in the future.

2.0 DISCUSSION

How can we detect PWWF other than with tank levels?

The answer was to use the flow meter to the tanks which are incorporated into the PLC. After observation it was determined that if the flow rate to each tank exceeded 60L/s for more than 5 minutes we were in a PWWF event. Initially we incorporated this into the sludge pumps, where if the flow rate continues for more than 5 minutes at above 60L/s the sludge pumps would activate and pump to the sludge lagoon until tank levels fell below 52%.

On Sunday night of the 10th February 2013 we had a wet weather flow event with the plant experiencing flows exceeding 370L/s. Both pumps activated 7 minutes after high flows were detected and started pumping to the sludge lagoons. This managed to avoid two storm cycles, but not completely. Then we asked the question; What if we changed the process due to the dilution effect of high inflows?

We then set about analysing decant rates, so as to determine actual decant flows compared to tank levels. That led us to determine that 45 minutes of decanting would reduce tank levels sufficiently to accommodate 90 minutes of high inflow before next decant. The results were as follows: On the weekend of the 1st of March 2013 Singleton experienced a major rain event, which led to general flooding. To manage the PWWF the process cycle was changed to if inflows exceeded 60L/s the new program was activated, this is 45 minutes aeration, 45 minutes settling and 45 minutes decanting. During this period the plant was observed and waste water quality checked and the new PWWF was found to be working satisfactorily and treatment was maintained.

The plant completed treatment of 15.324ML of waste water on Friday 1st March and 14.24ML on Saturday 2nd March. Normal treatment is 4.8ML per day. At the peak of the rainfall inflow was 430L/s, which is only 10L per second below maximum inflow. The new PWWF avoided overflow and process bypass (storm cycle) which would result in untreated out flows. One PWWF cycle operation has been analysed and explained in Figure 1 and Table 1, waste water quality in Table 2 and PWWF inflows in Table 3.

Table 1: ***Aeration Tank-1 PWWF cycle observations 02/03/2103***

Mode of Operation	Time of Operation			Tank-1 Level Change			Inflow, L/s		Average Inflow in the PWWF cycle, L/s
	Start	Finish	Duration	Start	Finish	Change	Start	Finish	
Aeration	08:27 am	09:13 am	45 minutes	46.67%	52.52%	5.85%	177.44 L/s	154.52 L/s	145.15 L/s
Settling	09:10 am	09:55 am	45 minutes	52.52 %	58.77%	6.25%	154.52 L/s	134.48 L/s	
Decanting	09:55 am	10:40 am	45 minutes	58.77%	46.82%	- 11.95%	134.48 L/s	115.48 L/s	

Table 2: ***Quality Analysis during the Peak Wet Weather Flow (PWWF)***

Aeration Tank	Date	Ammonium, mg/L	Nitrite, mg/L	Nitrate, mg/L	Total Nitrogen, mg/L	Total phosphorous, mg/L	MLSS, mg/L
Tank-1 Decant Composite	02/03/2013	0.392 mg/L	0.152 mg/L	3.3 mg/L	4.9 mg/L	2.4 mg/L	3570 mg/L, On 03/03/2013
Tank-2 Decant Composite	03/03/2013	0.221 mg/L	0.080 mg/L	3.0 mg/L	4.2 mg/L	2.8 mg/L	3294 mg/L, On 02/03/2013

Table 3: *Peak Wet Weather Flow (PWWF) statistics at Sewer Treatment Plant*

Aeration Tank	Date	Total Flow , KL	Average Flow, L/s	Peak Flow, L/s	Rainfall Amount , mm	Date	Total Flow, KL	Average Flow, L/s	Peak Flow, L/s	Rainfall Amount, mm
Tank-1, 10,000 EP	02/03/13	7,840 KL		177 L/s		01/03/13	8,257 KL		223 L/s	
Tank-2, 10,000 EP	02/03/13	6,580 KL	167 L/s	150 L/s	42.3 mm on 01/03/13	01/03/13	7,067 KL	177 L/s	201 L/s	42.7 mm on 02/03/13
Total, 20,000 EP	02/03/13	14,420 KL		327 L/s		01/03/13	15,324 KL		424 L/s	

2.1 Peak Weather Flow (PWWF) Operation Cycle

Aeration

Aeration time reduced to 45 minutes from normal aeration time of 60 minutes. Decant samples were collected at the time from both tanks 1 and 2, on the 2nd March.3 and 3rd March 2013 and tested for water quality. Tanks 1 and 2 had ammonium concentrations of .392mg/L and .221 respectively and nitrite concentrations of .152mg/L and .080mg/L respectively. It was therefore found that 45 minutes was sufficient to oxidize ammonium and nitrite due to the dilution factor.

Settling

Settling time has been reduced to 45 minutes from a normal 60 minutes. The tanks were closely observed after 45 minutes settling and on checking sludge blanket levels there was 900-1000mm clear water on top of the sludge blanket, which is normal operation with no sludge carry over after this shortened period.

Decanting

Decanting time has been extended from 30 minutes to 45 minutes. This enabled the plant to successfully decant sufficient so as to allow enough capacity to allow 90 minutes of high inflows. Observations concluded that 85% to90% of the tank was disturbed (from inlet to decant end) at the end of 45 minutes decanting with no sludge carry over. The water quality results from both tanks 1 and 2 are as follows: nitrates 2.4 mg/L and 2.8mg/L respectively, total nitrogen 4.9mg/L and 4.2mg/L respectively and total phosphorous was 2.4mg/L and 2.8mg/L respectively. This confirmed that anoxic time (settling and decanting time) is sufficient to reduce nitrate and biological phosphorous removal due to the dilution effect.

2.2 Case of PWWF Cycle-Aeration Tank 1 2nd March 2013

One PWWF cycle of aeration Tank 1 was analysed, refer Figure 1 below. This occurred in the period 8:27am to 10:40am on the 2nd March which was identified as the period of maximum rainfall which resulted in the highest inflows. These were 177.4L/s at the peak down to 115.148 L/s with an average 145.15L/s over the period. During the 45 minute aeration cycle tank levels raised from 46.67% to 52.52%. During the 45 minute settling time tank levels rose from 52.52% to 58.77%. During decant tank level dropped from 58.77% to 46.82% whilst still accepting high inflows.

Extended decanting achieved the desired result while reduced aeration and settling time increased the number of process cycles and kept the tank levels below overflow level.

Due to the dry conditions we did not experience until November 29th where we received 43mm of rain in a short period. Over 85 minutes inflow was 1.928ML with an average of 378L/s. Maximum inflows were 431L/s which were 70L/s over March levels. The process was maintained over the period with no overflow, however it was observed that medium water level should be dropped from 52% to 48% so as to prevent premature exit from the cycle. Decant and effluent catch pond samples were collected and analysed and are as follows:
Tank 1-Ammonium.111, Nitrite .140, Nitrate.9, Nitrogen 2.4 and Phosphorous 3.4.

Tank 2-Ammonium .048, Nitrite .047, Nitrate .4, Nitrogen 2.1 and Phosphorous 3.8. Effluent Catch Pond-Ammonium .496, Nitrite .097, Nitrate .8, Nitrogen 3.4 and Phosphorous 4.1.

This confirmed that our previous results from March and the new PLC program was functioning and achieving the desired outcome.

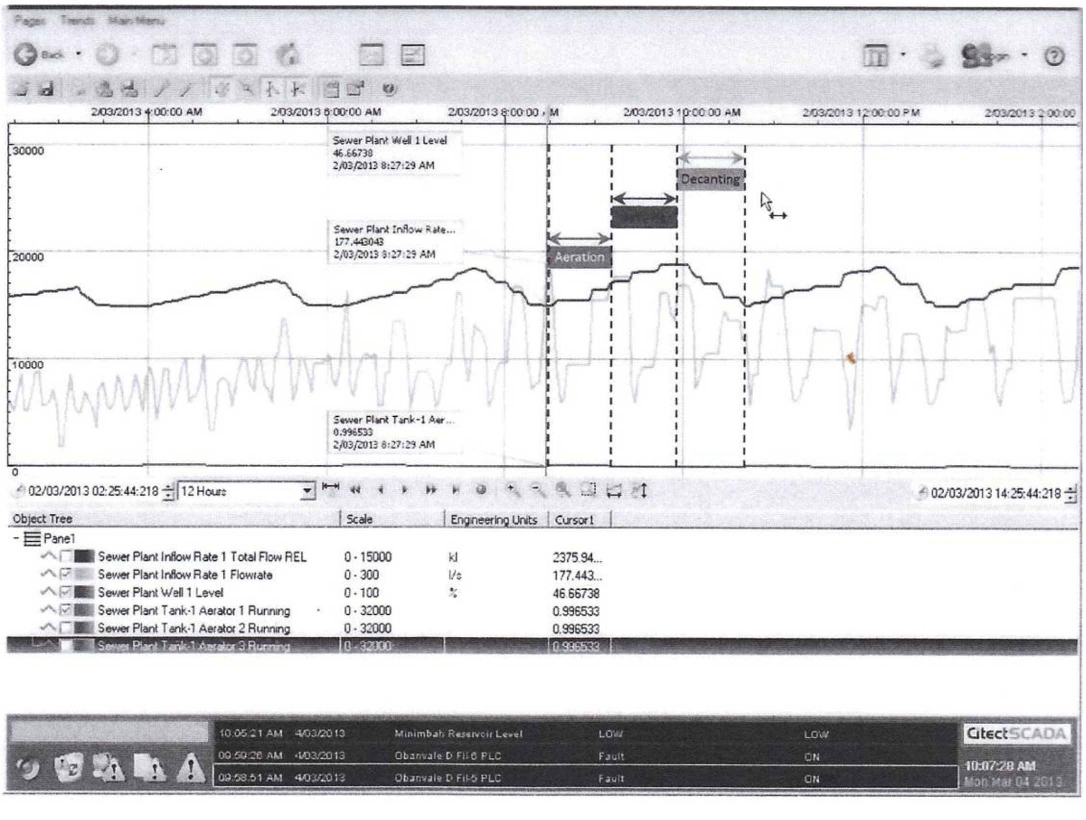
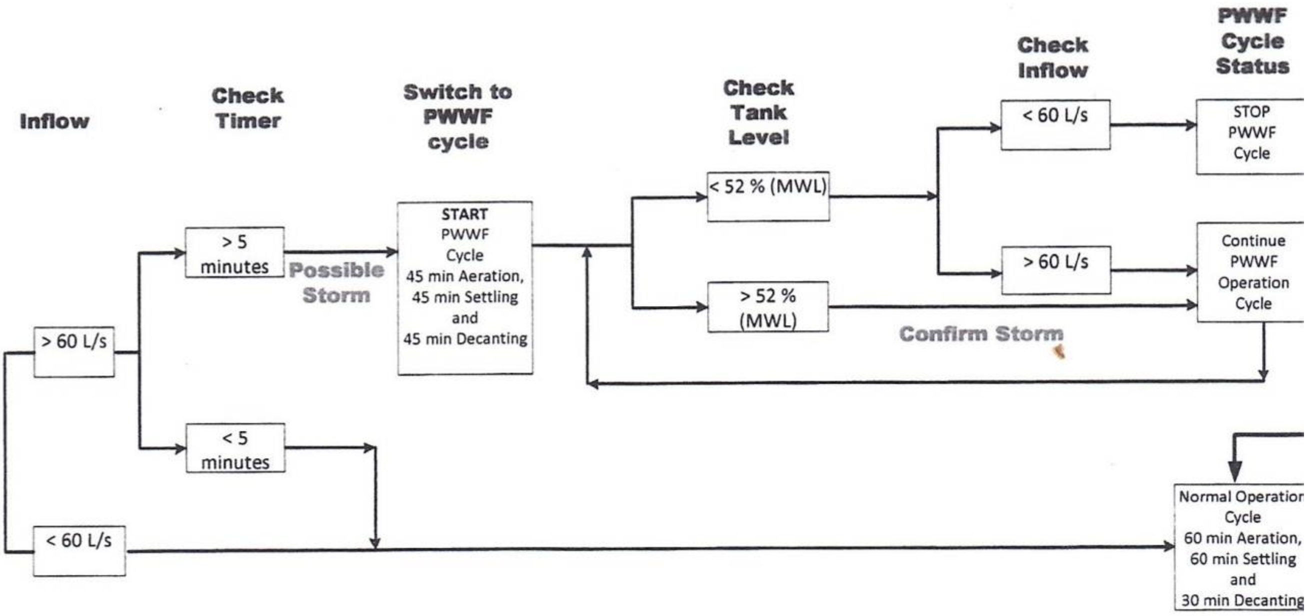


Figure 1: ***Peak Wet Weather Flow (PWWF) Cycle of Tank-1***

2.3 How the Peak Wet Weather Flow Cycle Operated

Normal inflow into each tank will not exceed 60L/s for any period longer than 2 to3 minutes. Using telemetry and observation it was apparent that if the inflow to any tank exceed 60L/s for more than 5 minutes, then that inflow originates from storm flow. Therefore a PLC program was installed so that if the inflow to any tank is above 60L/s for more than 5 minutes the PWWF cycle begins. PWWF operations cycle will stop operating when the inflow goes below 60L/s and tank level reaches MWL of 48%.

The process logic control (PLC) diagrams to activate and deactivate the PWWF cycle is represented below.



<u>Figure 2:</u> ***PLC logic diagram to activate and deactivate PWWF cycle***

3.0 CONCLUSION

With the use of inflow rates we can now determine PWWF at the time they first occur, this means the cycle changes earlier and avoids storm cycle. Avoiding the storm cycle maintains the complete process; aeration, settling and decant, so as to continue to produce high quality waste water and prevent untreated waste water being disposed to the tertiary pond and finally to the environment.

4.0 ACKNOWLEDGEMENTS

A. S. M. Mohiuddin for all his work on this project and the production of the tables.

K. Roach for his assistance.

A.Hesse.

Water and waste team.