TIME IS OF THE ESSENCE TO A COLIFORM REDUCED PRESENCE

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ABSTRACT

The Patea Wastewater Treatment Plant (WWTP) discharges treated wastewater into the tidal reaches of the river. Before the upgrade in 2008 the WWTP consisted of a single oxidation pond, with a highly variable effluent quality due to short circuiting, particularly for pathogen indicators.

The resource consent for the discharge to the river expired in 2004. As part of the consent renewal process, an issues and options report was prepared, which recommended upgrading the WWTP by adding a mechanical fine screen and subdividing the pond into multiple ponds in series, to reduce short circuiting. This proposal was supported by key stakeholders.

The WWTP upgrade was completed in 2008 and involved installing a fine screen and subdividing the pond into three ponds in series. A significant improvement in effluent quality was achieved, with median faecal coliforms reducing from 32,000 to 78 cfu/100 ml following the upgrade. Monitoring of pathogen indicators in the Patea River upstream and downstream of the discharge by the Taranaki Regional Council since the upgrade has found that there are now no measurable bacteriological impacts on the receiving environment.

KEYWORDS

Waste stabilisation pond, wastewater treatment plant upgrade, pathogens

1 INTRODUCTION

1.1 BACKGROUND

Patea is a small town with a population of 1,143 (2006 census). The population declined significantly after the closure of the meat works in 1982, when the population of the town was around 2000. Historically, raw sewage was reticulated by gravity to a comminutor before being discharged into the Patea River, approximately 1km upstream of the river mouth. The river and river mouth are used by the local community for swimming, fishing and boating. Shellfish gathering and surfing are popular activities at Patea Beach.

In 1973, an oxidation pond was constructed on a terrace 20m above the river, to treat the raw wastewater before discharging into the tidal reach of the river (see Photographs 1 and 2). A pump station near the comminutor was used to lift the wastewater up to the WWTP. The pond had an area of 2.33 ha and a design capacity of 2,900 population equivalents.

The effluent quality was typical of a single oxidation pond and as such was highly variable, particularly for pathogen indicators (faecal coliforms and enterococci), due to short circuiting (see Table 1). Raw wastewater typically has a faecal coliforms concentration of 10^6 to 10^8 cfu/100 ml. A small amount of wastewater travelling directly from the inlet to the outlet, with a shorter than usual retention time, can result in very high effluent concentrations.

Plant performance monitoring is carried out three times per year by the Taranaki Regional Council (TRC), which produces an annual consent compliance monitoring report. Before the WWTP upgrade, a typical summary statement in the monitoring report was, "*Effluent quality was considered typical of a single pond treatment system receiving minimal industrial loadings. The pond typically supports a good algal community, this being reflected in a relatively high average microflora community index pond score. The effect of the oxidation pond's effluent discharge generally has been limited to occasional small rises in bacteria numbers near the right bank of the Patea River site immediately upstream or downstream of the discharge (dependent on tide conditions) with bacterial water quality measured a further 600m downstream usually similar to that measured upstream of the discharge*." (TRC, 2003).

Photograph 1: Oxidation pond before the upgrade, showing inflow welling up in centre of photo

Photograph 2: Patea River, looking upstream from Patea WWTP

The effluent flow was estimated by the TRC when conducting monitoring and varied between 2 and 20 L/s (which equates to between 170 and 1,730 m^3/d). The 10 year ARI 1 day duration low flow in the Patea River is estimated to be 1,900 L/s (TRC, 2004).

Table 1: Effluent Quality Monitoring Data Summary 1987 – 2002

Parameter	Median	90th Percentile
Dissolved oxygen (g/m^3)	8	16
BOD_5 (g/m^3)	28	42
BOD_5 filtered (g/m^3)	5	9
pH	8.8	9.3
Conductivity at 20°C (mS/m)	82	107
Chloride	69	82
Ammonia nitrogen (g/m^3)	3	9
Dissolved reactive phosphorus (g/m^3)	4	6
Suspended solids (g/m^3)	73	101
Turbidity (NTU)	37	82
Faecal coliforms (nos/100 mL)	32,000	144,000
Enterococci (nos/100 mL)	2,400	16,000

1.2 ISSUES AND OPTIONS REPORT

A year before the consent expired in 2004, a report was prepared that identified issues of concern with the WWTP and explored options for upgrading treatment and disposal. These were evaluated based on technical feasibility, predicted or required effluent quality, environmental outcomes, capital and operating costs, and operational and environmental risks. As the trend in declining population could be reversed in the future, a design population of 2,400 was used.

The considered treatment options focused on working within the footprint of the existing pond, to maximise the use of the existing asset and to keep the capital cost at a reasonable level. The recommended treatment option was the inclusion of a fine screen and subdividing the existing pond into three ponds in series, followed by two wetlands in parallel.

The disposal options considered were disposal to land by slow rate irrigation, disposal to land by rapid infiltration and a continued discharge to the river. The recommended disposal option was a continued discharge to the river, but with the outfall pipe replaced with a rock diffuser on the river bank, to reduce the visual effects.

1.3 CONSULTATION AND RESOURCE CONSENT

Consultation with key stakeholders was an important part of the consenting and upgrading process. To provide information to key stakeholders in advance of the consultation meeting, a letter was sent describing the existing resource consents, existing sewerage system, issues with the existing discharge and proposed upgrade work. The consultation meeting involved a site walkover followed by a discussion of any areas of concern. The intention of this initial consultation was to provide adequate information to enable informed consideration of the proposals, and to allow any concerns to be raised early in the process so that they could be addressed in the Assessment of Environmental Effects (AEE) and WWTP upgrade design.

A simple estimate of mixing and dilution characteristics in the Patea River was made based on observations and measurements made during a single injection dye study at low tide (NIWA, 2003). It was observed that much of the discharge leaked through large cracks in the outfall pipe near the bank (see Photograph 3). The dye dispersed downstream in a long narrow plume entrained along the true right bank of the river. Near the outfall, the plume was approximately 5 m wide and broadened to approximately 30 m wide about 300 m downstream of the outfall. The study found a dilution rate of 284 at a distance of about 200 m downstream of the discharge (where downstream water quality is monitored by TRC). While different tide and river flow conditions would result in a different dilution ratio, it was considered that differing conditions would not result in dispersion patterns that were significantly worse for effects on lower Patea River ecological and recreation values.

Photograph 3: WWTP outfall to Patea River at low tide, viewed from upstream (note pink Rhodamine WT dye from mixing and dilution experiment near bank from cracks in outfall pipe)

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South Taranaki District Council (STDC) had previously had a negative experience of wastewater treatment wetlands, with difficulty in establishing wetland plants, so did not wish to have wetlands included in the WWTP upgrade. There were no key stakeholders with strong views that wetlands should be included, so the upgrade design adopted for the AEE was a fine screen and three ponds in series. The predicted effluent quality for the upgraded WWTP in summer is shown in Table 2.

Table 2: Predicted Effluent Quality in Summer After Upgrading (CH2M Beca, 2003)

Parameter	**Median**	**90^{th} Percentile**
BOD_5 (g/m^3)	30	50
Suspended solids (g/m^3)	50	80
Faecal coliforms (nos/100 mL)	2,000	35,000

The draft AEE was circulated to key stakeholders for their comments before finalising and submitting with the resource consent application. Several stakeholders commented that the proposed upgrade would have a positive effect on the environment. As a result of the comprehensive consultation process, only two submissions were received, one in support and one stating that they would be satisfied provided appropriate microbiological monitoring was undertaken. This was resolved with the submitter, so a resource consent hearing was not required.

1.4 DETAILED DESIGN AND CONSTRUCTION

A Huber rotary auger screen was installed upstream of the pump station. A new building was constructed to house the screen, as it was located at the end of a street and accessible to the public (see Photographs 4 and 5). The screen was located near the pump station as the WWTP is approximately 200 m from a power supply. A Parshall flume with a level sensor for flow metering was installed on the gravity line upstream of the screen and emergency overflow point. A flume was chosen over a magnetic flow meter as it was less expensive for pipe size.

Photograph 4: Rotary auger screen (during construction)

Photograph 5: Shed housing the rotary auger screen

The inlet to Pond 1 was relocated to maximise the distance between the inlet and outlet locations. The pond operating level was lowered and the internal dividing bunds were constructed by end-dumping quarried rock to create three ponds in series (see Photographs 6 and 7, and Figure 1).

Photograph 6: End-dumping rock to create internal bunds

Photograph 7:   Completed internal dividing bunds

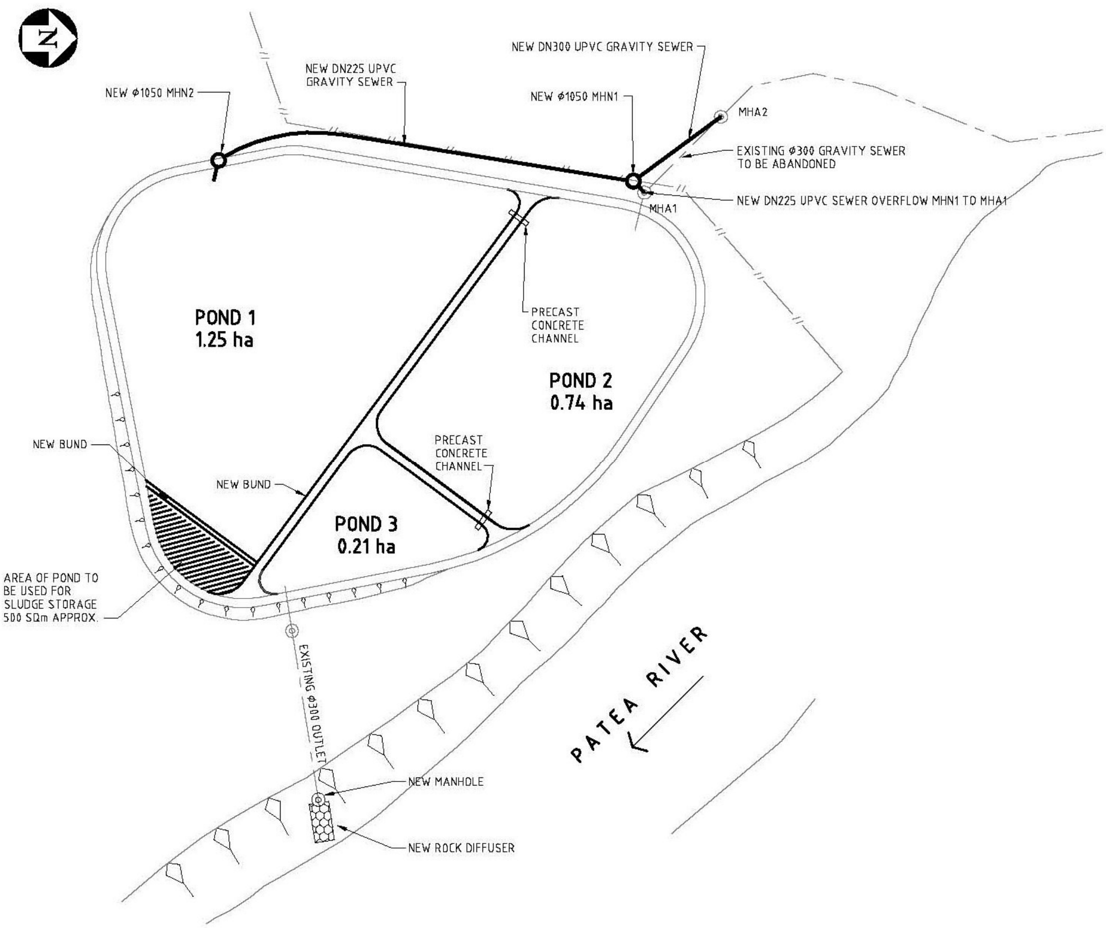

Figure 1: Upgraded WWTP layout

The upgrade was also an opportunity to desludge the pond. A sludge survey showed that sludge occupied 31% of the total pond volume, with an average depth of 0.32 m, compared with an average pond depth of 1.03 m. Clear water depths of less than 0.75 m were recorded in the middle of the pond (MWH, 2004). It was proposed to drain Pond 1 and leave the sludge to solar/air dry.

At its nearest point, the edge of the river terrace is 6 m from the edge of the pond, which was identified as a risk to the WWTP if the bank failed. A geotechnical assessment of the bank stability was undertaken, which recommended that the two ponds closest to the river bank (Ponds 2 and 3) should not be desludged, as there was a risk that the increased seepage from the base of the pond could destabilise the river bank and create a slip. It was also recommended that some sludge should be left in Pond 1 to reduce seepage, and that Pond 1 should be lined.

A v-notch weir and level sensor to monitor effluent flow were installed in the outlet chamber. The in-bank rock diffuser was constructed by surrounding the end of the outlet pipe with large rock above the low water spring tide level (see Photograph 8).

The upgrade was completed in June 2008 and the total capital cost for the upgrade was $630,000.

Photograph 8: In-bank rock diffuser

1.5 ISSUES ENCOUNTERED DURING CONSTRUCTION

1.5.1 ARCHAEOLOGICAL SITE

As part of draining Pond 1 for the upgrade, the contractor dug trenches in the nearby sand dunes and drained the pond to these. The sand dunes turned out to be an archaeological site of high national significance, as it had been an Imperial Army camp in 1865 and may also have been occupied by Maori and the Armed Constabulary at various times. Archaeologists were called in to assess the area. No human remains were found and the area was reinstated.

1.5.2 SLUDGE DISPOSAL

Just prior to the desludging at the Patea WWTP, STDC was also desludging the oxidation pond at Manaia. The sludge from Manaia was been transported to the Patea Landfill, which was consented to receive wastewater sludge. The local Maori community protested vociferously at the use of the landfill for sludge disposal, which also made the national news. It was resolved that the sludge would be dewatered and stored in a lined and covered corner of the pond, until a district-wide sludge disposal site was found and consented.

1.5.3 SLUDGE REMOVAL

Unfortunately, poor weather over the summer when solar/air drying of the sludge was attempted meant that the sludge did not dry well enough to allow the liner installation. The sludge was instead removed by dredge and dewatered using a centrifuge. 263 tonnes (1315 m^3) of sludge were removed from Pond 1.

1.5.4 POND LINER

It was proposed to line the pond with a 1.5 mm thick HDPE membrane liner. However, the sludge did not dry sufficiently to allow the liner to be welded. The liner was too large to be welded and pulled in segments into place over the sludge. A geotextile liner was therefore used. This quickly sealed with sludge, as evidenced by the liner ballooning to the surface in places, buoyed by biogas produced from the anaerobic digestion of the remaining sludge (see Photograph 9). The ballooning was dealt with by slitting with a knife and sinking with sand bags. Cutting slits in the fabric did not destroy the integrity of the liner because the fabric was laid with overlapping strips (not sealed) and was intended to provide "reinforcement" to the sludge layer in the event of a preferential seepage route developing through the sand base.

Photograph 9: Pond liner ballooning to surface, buoyed by biogas

1.5.5 BANK SLIP

The river bank adjacent to the pond slipped after heavy rain. Brush willow were planted to stabilise the soil, which has been successful so far.

2 RESULTS

In addition to the routine consent compliance monitoring undertaken by TRC, STDC has undertaken monthly monitoring of key parameters since the upgrade, to assess the effectiveness of the upgrade in improving effluent quality. A summary of results is shown in Table 3. It can be seen that there has been a large improvement in faecal coliforms and some improvement in suspended solids concentrations. BOD concentrations have remained the same. The pH is unusually high for a conventional pond system (pH 7.5 to 8.5 being typical). The high pH is likely due to a healthy algal population, which consumes alkalinity during the daytime.

The improvement in faecal coliforms concentrations in the effluent can be attributed to the reduction in short circuiting, through subdividing the pond and creating a serpentine flow path. The high pH could also be contributing to die off of pathogen indicators (Davies-Colley, 2005).

Ammonia and total nitrogen concentrations are also low. Since the upgrade, ammonia has been measured on five occasions and ranged between 0.025 and 8.5 g/m³. It could be that the high pH is driving the ammonia equilibrium towards ammonia gas, which is being lost to the atmosphere by volatilisation. Total nitrogen has been measured on three occasions and ranged between 8.5 and 14 g/m³, which is low for a pond system.

Table 3: Effluent Quality Monitoring Data Since Upgrade (March 2009 – June 2010)

Parameter	**Median**	**90th Percentile**
BOD_5 (g/m³)	26	53
pH	9.0	10.0
Suspended solids (g/m³)	43	77
Faecal coliforms (nos/100 mL)	78	472

The most recent consent compliance monitoring report from TRC stated, "*There were no measurable impacts of discharges from the upgraded oxidation ponds' system recorded during the two monitoring surveys of bacterial numbers in the Patea River*." (TRC, 2010).

3 CONCLUSIONS

Several key lessons were learned on this project that are applicable to other projects.

The first lesson is that comprehensive consultation with key stakeholders early in the project makes for a much smoother consenting process. It was identified early on that the continued discharge to the river had the potential to be contentious, given that the river is used extensively by the local community for recreation. The stakeholders appreciated being involved early in the project, at a time when they could influence the outcomes.

The second lesson is that even if an activity is permitted by a consent, if it is proposed to do something which is not normally done, it is worth advising the local community in advance of undertaking the activity.

The third lesson is that all sludge should be removed from the base of a pond before placing a liner, even if the liner is supposed to be permeable. The sludge will continue to anaerobically digest and buoy the liner to the surface.

The final lesson is that significant improvements in effluent quality (particularly pathogen indicators) can be achieved with a lightly loaded oxidation pond at reasonable cost, by subdividing the pond into multiple ponds in series.

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