LONG WETLANDS AND PASTURE IRRIGATON AT THE BLENHEIM SEWAGE TREATMENT PLANT

By Humphrey Archer (CH2M Beca Ltd), Graeme Jenner (CH2M Beca Ltd) and Stuart Donaldson (Marlborough District Council)

ABSTRACT

The existing Blenheim Sewage Treatment Plant (BSTP) consists of two separate treatment systems. After inlet fine screening, aerated-assisted facultative and maturation ponds are used to treat domestic flows. Industrial flows are treated using a fine screen, mechanically-aerated ponds, as well as a facultative pond. Treated domestic effluent was continuously discharged to the Opawa River, and separately-treated industrial effluent was discharged to the Wairau Estuary on the ebb tide until early 2014. Marlborough District Council (MDC) has recently upgraded the pond-based system by:

- Combining the domestic and industrial effluent streams in a common maturation pond, followed by polishing treatment in a new 2km long wetland system that conveys treated effluent to close to the Wairau River mouth
- Discharging the combined effluent via a new submerged outfall into the Wairau Estuary mouth on ebb tides which carry the well-diluted effluent into Cloudy Bay
- Irrigating treated effluent onto MDC pasture land surrounding the STP when conditions allow
- Decommissioning the outfall to the Opawa River

The $15m upgrade project was completed in early 2014 and is complying with the consent conditions. This paper will describe the project from the evaluation of options, through to commissioning of the wetlands treatment and irrigation system.

KEYWORDS

Wastewater treatment, waste stabilisation ponds, wetlands, effluent irrigation, Blenheim, Wairau Estuary, ebb tide discharge

INTRODUCTION

The existing Blenheim Sewage Treatment Plant (BSTP) consists of two separate treatment systems. After inlet fine screening, aerated-assisted facultative and maturation ponds, are used to treat domestic flows. Industrial flows are treated using a fine screen, mechanically-aerated ponds, as well as a facultative pond. Treated domestic effluent was continuously discharged to the Opawa River and separately treated industrial effluent was

discharged to the Wairau Estuary on the ebb tide (See Figure 1). Marlborough District Council (MDC) has recently upgraded the pond-based system by:

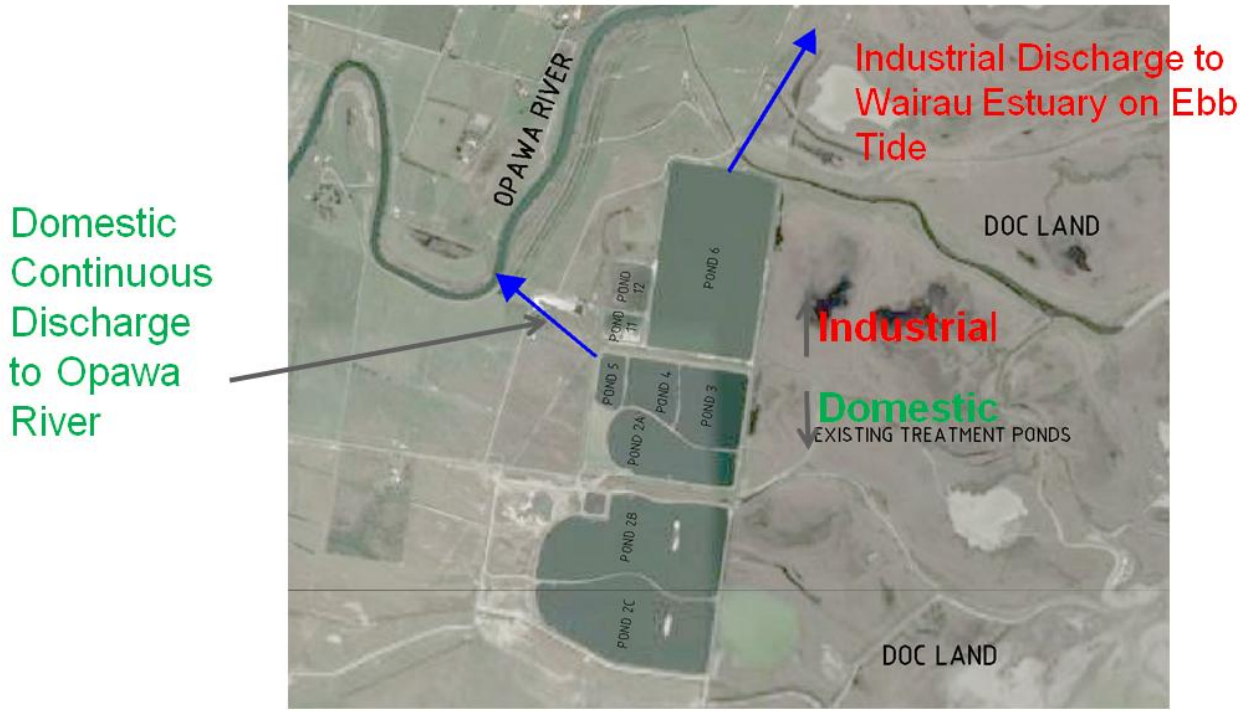
- Combining the domestic and industrial effluent streams in a common maturation pond, followed by polishing treatment in a new 2km long wetland system that conveys treated effluent to close to the Wairau River mouth – Refer to Figure 2 for the treatment schematic.

- Discharging the combined effluent via a new submerged outfall into the Wairau Estuary mouth on ebb tides which carry the well-diluted effluent into Cloudy Bay

- Irrigating treated effluent onto MDC pasture land surrounding the STP when conditions allow

- Decommissioning the outfall to the Opawa River

Figure 1 – Previous Treatment and Diposal paths at the Blenheim STP.



MDC-owned land around the treatment plant is irrigated with pond effluent on a soil moisture deficit basis when climatic conditions are favourable. Irrigation is by K-line movable sprays and buried driplines, which irrigate a total area of approximately 150ha. Pasture harvesting removes nutrients from the site.

Perimeter areas close to houses and roads, and an existing plantation area, are irrigated by driplines to minimise spray drift effects on neighbours and users of the public walkways. Consent conditions require that spray irrigation ceases if the wind direction could carry spray drift onto neighbouring rural-residential properties, or public access ways. Spray systems are automated and controlled by wind speed and direction monitors.

In an average rainfall year, approximately 40% of the wastewater flow can be irrigated. Effluent that cannot be irrigated, is discharged from the long wetlands into the Wairau Estuary on outgoing tides through a new submarine outfall.

The $15m upgrade project was completed in early 2014 and is complying with the consent conditions. This paper describes the project; from the evaluation of options, through to commissioning of the wetlands treatment and irrigation system.

CONSENT PROCUREMENT

The former outfall from the domestic STP to the Opawa River was decommissioned in early 2014. There were adverse effects on water quality due to inadequate flushing of the small river. Those effects were recognised during an earlier consent procurement process in 1998, which recommended that alternative discharge options and provision of freshwater wetlands be investigated prior to expiry of the consent in 2008. Those investigations culminated in applications for new consents in 2007 which had involved discussions with a Consultative Working Group and iwi -- Rangitane, Ngati Rarua and Ngati Toa. A Cultural Impact Assessment described the cultural and spiritual importance that iwi place on Te Pokohiwa O Kupe (the Boulder Bank) and Te Wahanga a Tangaroa (the Wairau Estuary complex).

After further investigations by the Historic Places Trust and consultation, consents were granted for the upgrading works in Oct 2010 as follow:

Consent U07181 and Key Conditions

- **Discharge Treated Wastewater to Land for a term of 15 years –**
  - Maximum annual nitrogen loading shall not exceed a net loading of 200kg N/ha/year
  - Monthly applications shall not exceed a net loading of 50kg N/ha/year
  - Net loadings shall take into account the N removed in pasture harvested
  - Spray irrigation shall not commence within 150m of adjacent property until buffer planting has grown to 2m
  - Irrigation shall not commence until ground water level is greater than 0.3m below the ground surface
  - Weather stations at two location shall control the adjoining spray lines, and irrigation shall cease within 150m of adjacent property boundaries when wind speed exceeds 15km/hr in the direction of the adjacent properties.

- **Discharge of Treated Wastewater from Wetlands to the Wairau Estuary for a term of 15 years**
  - Discharge volume shall not exceed an average of 28,500 m^3/d nor a maximum of 103,680 m^3/d
  - Discharge shall normally take place over a four-hour period commencing one hour after high tide.
  - During wet weather periods, the discharge period can be extended to continuously if required.

Treated Wastewater Concentration Limits

The only parameters with potential to have an effect on the nearshore coastal waters were:

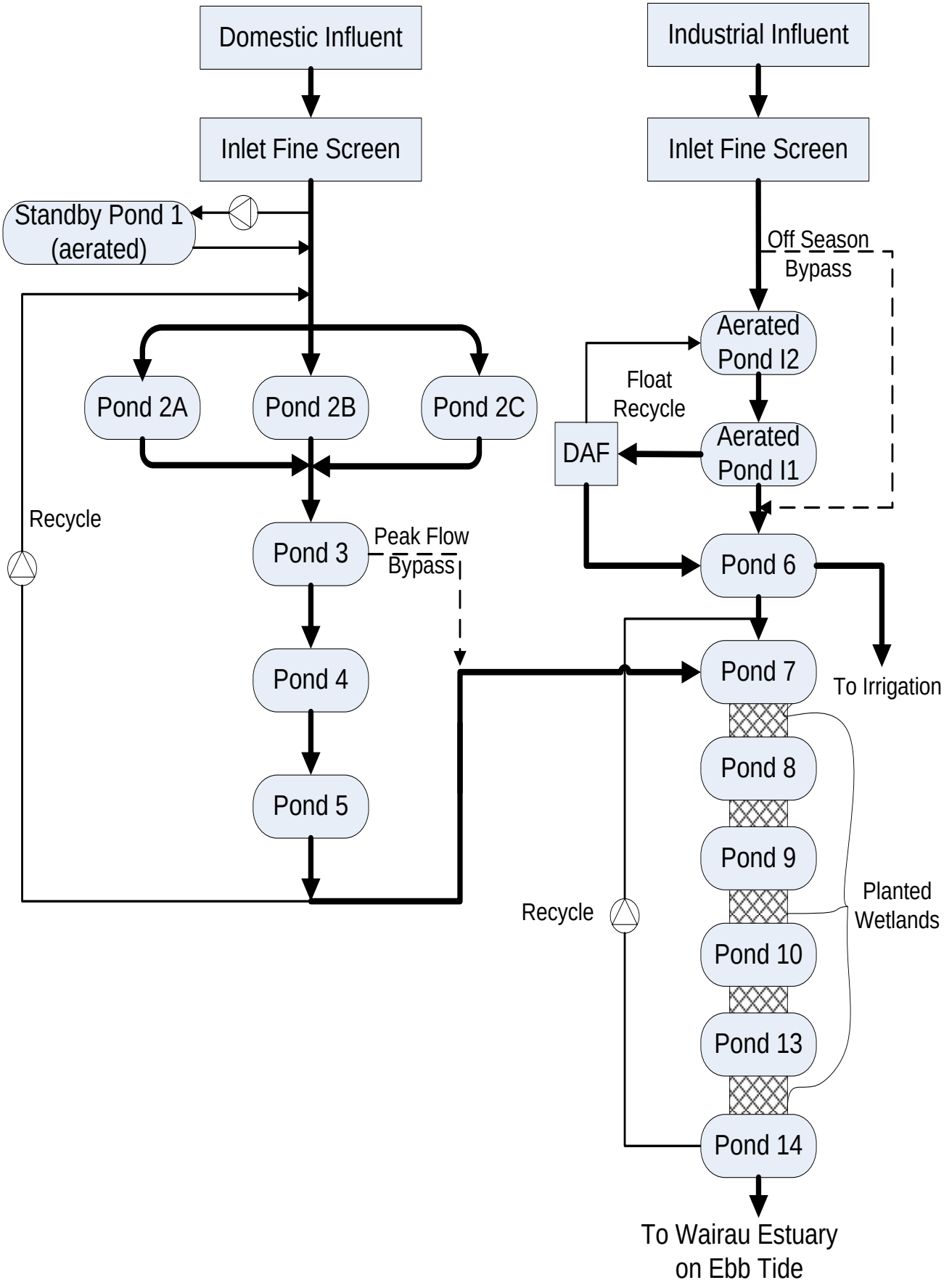
- Ammoniacal Nitrogen (toxicity to fish)
- Faecal coliforms (accumulation in shellfish, and contact recreation)

These parameters have concentration limits in the treated wastewater (after back-calculation from receiving water guideline values using the dilution available) as follows:

Table 1: Discharge Concentration Limits

Statistical Basis	**Ammoniacal Nitrogen g/m^3**	**Faecal Coliforms Cfu/100ml**
Median Existing Flow	30	700
90 Percentile Existing Flow	40	2150
Median Future Design Flow	15	350
90 Percentile Future Design Flow	20	1075

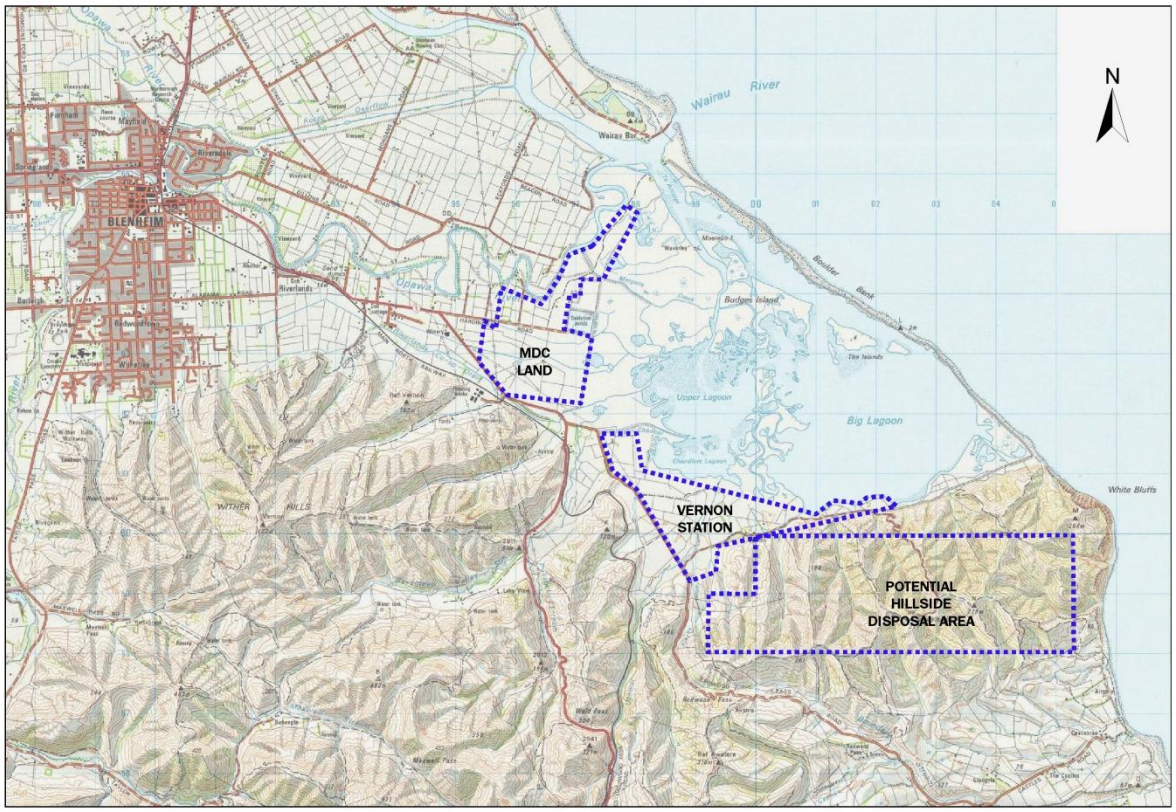
Figure 2: Upgraded Plant Schematic from early 2014



DISPOSAL AND RE-USE OPTIONS INVESTIGATIONS

When PPCS Ltd (now Silver Ferns Farms Ltd) closed its Marlborough meat processing plant, MDC purchased the water and wastewater assets in 2001. These included the wastewater treatment ponds, discharge outfall to the Wairau Estuary and approximately 190 hectares of farm land surrounding the treatment ponds. Conveniently, MDC's own STP was located adjacent to the PPCS ponds. MDC combined its WWTP with the PPCS treatment ponds to create a single facility to treat all domestic and industrial wastewater from Blenheim including the rapidly increasing wastewater from wineries in the Riverlands area - refer to Archer and Donaldson (2012).

Figure 3: Location of Land Investigated for Irrigation of Effluent.



MDC commissioned an investigation of the feasibility of irrigating the farmland surrounding the WWTP with treated effluent. The farm manager of the nearby Vernon Station expressed interest in obtaining wastewater to supplement other sources of irrigation water for that property. The land areas investigated and their location relative to Blenheim are shown in Figure 3.

The investigation indicated that all areas could potentially be irrigated, however the Vernon Station site was not favoured due to the additional pumping costs (infrastructure and ongoing costs), along with the risks of managing the discharge of effluent on a privately-owned property.

Hill areas on Vernon Station and further to the south, were also investigated using non-deficit irrigation of trees, on a year-round basis. It was estimated that net areas of about 1,120 and 1,680 ha respectively, would be required to irrigate all of the existing and redirected future flows from the BSTP. As irrigation would be restricted to land with less than a 35-degree slope, the gross land areas required would have been greater.

Year-round application to land is not favoured, because of the very high capital and operating costs of the option. The capital costs of conveyance pipework and pumps, as well as on site irrigation infrastructure, for a year-round hill country land disposal scheme was estimated at greater than $46 million. Other costs, such as land purchase/leasing and consenting , would be additional. Annual operating costs such as pumping effluent to this area and cutting and removal of trees would be very high.

Consideration would also need to be given to the potential market limitations for the wood from the trees irrigated with effluent.

An alternative to year-round irrigation would be to store the effluent during the winter months. This would necessitate the construction of a pond holding up to 2.5 million m^3 of treated effluent, based on predicted future effluent flow rates, plus rainwater. A net area of at least 1,060 ha would have been required to apply all effluent to land during the 9-month period from September to May.

MDC and the Working Group decided that discharge of all effluent to land was not affordable and the investigations then focussed on the strategy of:

- Irrigation of treated effluent on MDC-owned land when soil conditions were suitable, and
- Discharge of wetlands-treated effluent to the mouth of the Wairau Estuary on ebb tides.

Iwi expressed a preference for discharge to Cloudy Bay via and ocean outfall. Further studies of dispersion from an ocean outfall showed that a portion of the plume would enter the Wairau Estuary on incoming tides. With that knowledge, iwi agreed that the ebb-tide discharge to near the mouth of the Wairau Estuary would be a practicable option. Other factors influencing the decision making were –

- An ocean outfall would have cost about $20 million to construct
- The route for the outfall would have crossed the Boulder Bank which is valued for cultural and archaeological reasons being the site of early occupation by Maori arriving from Polynesia

The 15-year consent term reflects the iwi preference for discharge to land or to Cloudy Bay.

The MDC land is not without its limitations, as the land is low lying with surface ponding and high groundwater levels common over winter, which means that irrigation would be normally restricted to the summer and autumn periods. In addition, the soils are saline due to historical inundation during high tides – now protected by tide gates.

Separately to the land application investigations, MDC investigated improvement to the treatment and discharge of effluent to surface water, as it was clear that land irrigation could not handle all the effluent throughout the year.

EFFLUENT IRRIGATION OPTIONS CONSIDERED

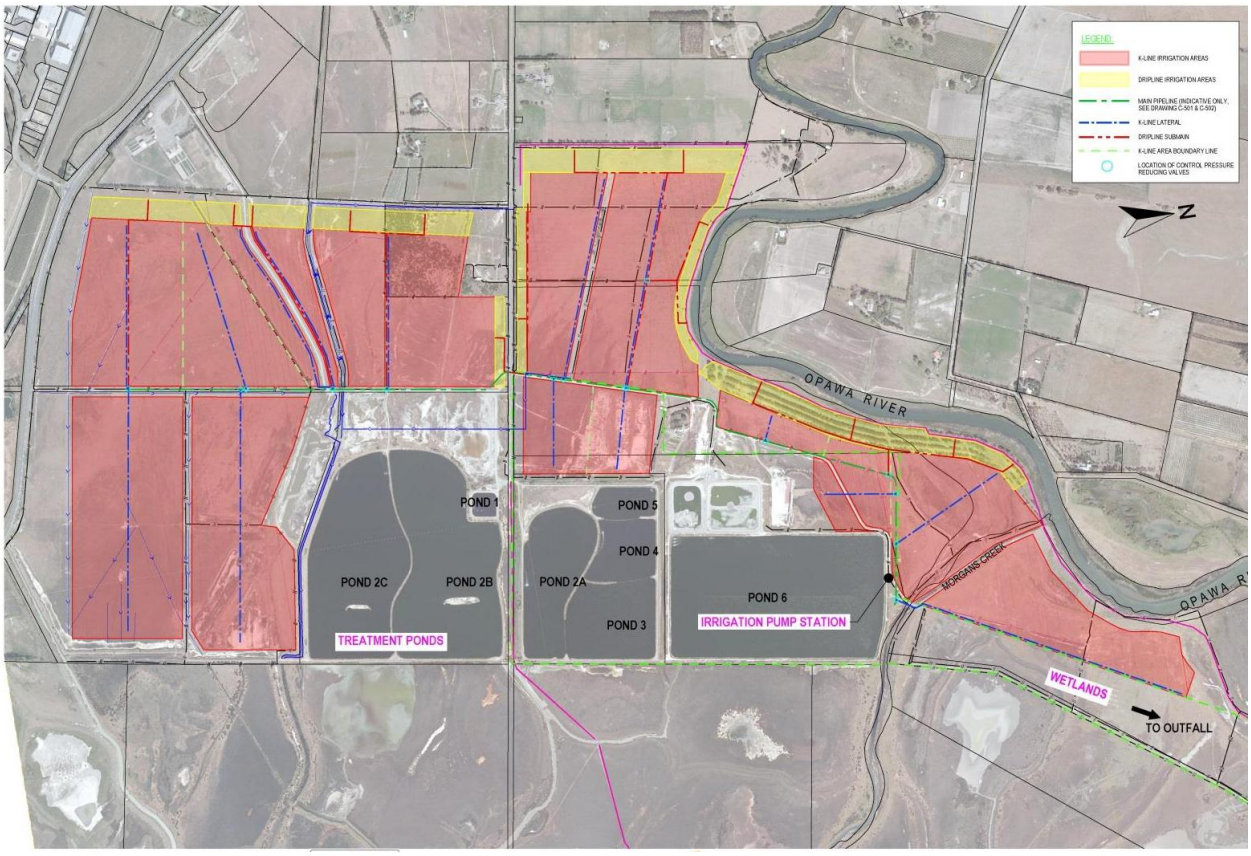
During the initial investigations, a range of irrigation methods were considered: Border Dyke, Centre Pivot/ Linear Spray, Fixed Sprinklers, K-line Spray and Dripline Irrigation. Border Dyke irrigation was eliminated primarily due to technical reasons as the land is too flat to form adequately graded borders without significant earthworks.

It was assumed that neighbours would be sensitive to the risk of spray drift and buffer zones to the neighbouring land were proposed for the spray irrigation options. Consultation meetings were held to discuss the irrigation options. These highlighted the concerns that neighbours had about spray drift and changes were made to the application. These included:-

1. Increased buffer distances from spray irrigation to the site boundaries when wind was blowing towards residential properties,
2. Removal of irrigation options that sprayed effluent into the air at height (such as Briggs Rotorainers and big guns on the end of centre pivots)
3. Use of drip irrigation on the land that would not be spray-irrigated.

The original scope of drip irrigation was to use surface-laid irrigation. However, after considering concerns from neighbours regarding the ponding of effluent and the management of drip irrigation on grassed areas, it was decided to bury the drip line in areas other than some tree plantings that existed on the site. The irrigation zones are shown in Figure 4.

Figure 4: Irrigation Zones



Because of limited soil permeability in places and high groundwater level, it was proposed that irrigation would be managed using deficit irrigation, i.e. treated effluent is applied to the land only to meet the evapotranspiration losses.

The selection of appropriate irrigation methods needs to consider many factors. For clean water irrigation, centre pivots have proven to be more cost-effective than other means of irrigation. Benefits of using centre pivots include minimising labour inputs, particularly in busy farming operations. However, in this situation the constraints associated with needing to move access roads and surface water channels, meant that the selection of centre pivots was more expensive than fitting K-line irrigation into the existing site constraints. In addition, a farm manager had to be employed and that resource can be used to move K-lines.

Distinctive features of the irrigation system are: the site's physical constraints, the large scale use of K-line sprays, harvesting of pasture (cut and carry) to remove and the flexibility of also being able to discharge to surface water when soil conditions are not suitable.

The area has saline soils and salt tolerant plants. Part of the area was irrigated with meat works effluent in the 1990's and grass growth was good. It is expected that application of mixed domestic, meat processing and winery effluent (well treated), will promote good grass growth after a period of soil development.

EBB TIDE DISCHARGE AND LONG WETLANDS

Pond-treated industrial flows had been discharged through a 375mm diameter pipe to the Wairau Estuary over 4 hours on the ebb tide since 1982.

Cawthron Institute assessed the environmental effect of the former industrial pond discharge to the Wairau Estuary and predicted the potential impacts of future STP options (Cawthron, 2007). The former estuarine outfall had no more than a localised downstream effect on water quality and benthic ecology. The well-flushed nature of the area of the outfall mitigated any significant adverse effects.

Drogue and dye studies carried out by Cawthron showed that the flow direction in the Estuary changes about two hours into the tide, but almost immediately on the ebb tide, yielding about eight hours of ebb and four hours of

flood during each cycle. The effluent forms a very narrow plume (30 – 40 m wide). See Figure 5. During the normal discharge period, the plume is always detected at least 1 metre below the surface, trapped under the freshwater layer.

It was concluded that a minimum dilution of 50:1 was achieved at a distance of just over 300 m from the outfall, while the average dilution at 300m was approximately 100:1.

Figure 6 shows a series of aerial photographs taken during the dye test and demonstrated that the plume is split into two streams after crossing the bar, one travelling northwest along the coast and a second, that disperses off shore and to the south. The north-westerly stream was the largest and tended to stay closer to shore for approximately 500 m. The southern plume moved offshore and to the south and did not appear to make bank contact.

A computer model (USEPA CORMIX-GI) was used to predict the mixing processes under current and predicted future flows. Results of the predicted dilutions at distances from the outfall, are shown in Figure 7. A dilution of 50:1 is considered a reasonable "worst case" value, at the end of a 300 m mixing zone, under existing STP flows. The results of modeling indicate that a dilution of 25:1 would be a reasonable "worst case" under future discharge flows. It would be feasible to discharge up to 900 L/s on the ebb tide without the effluent plume rising to the surface.

Figure 5: Dye Dilution Study Results for the former Outfall Discharge of 115/s

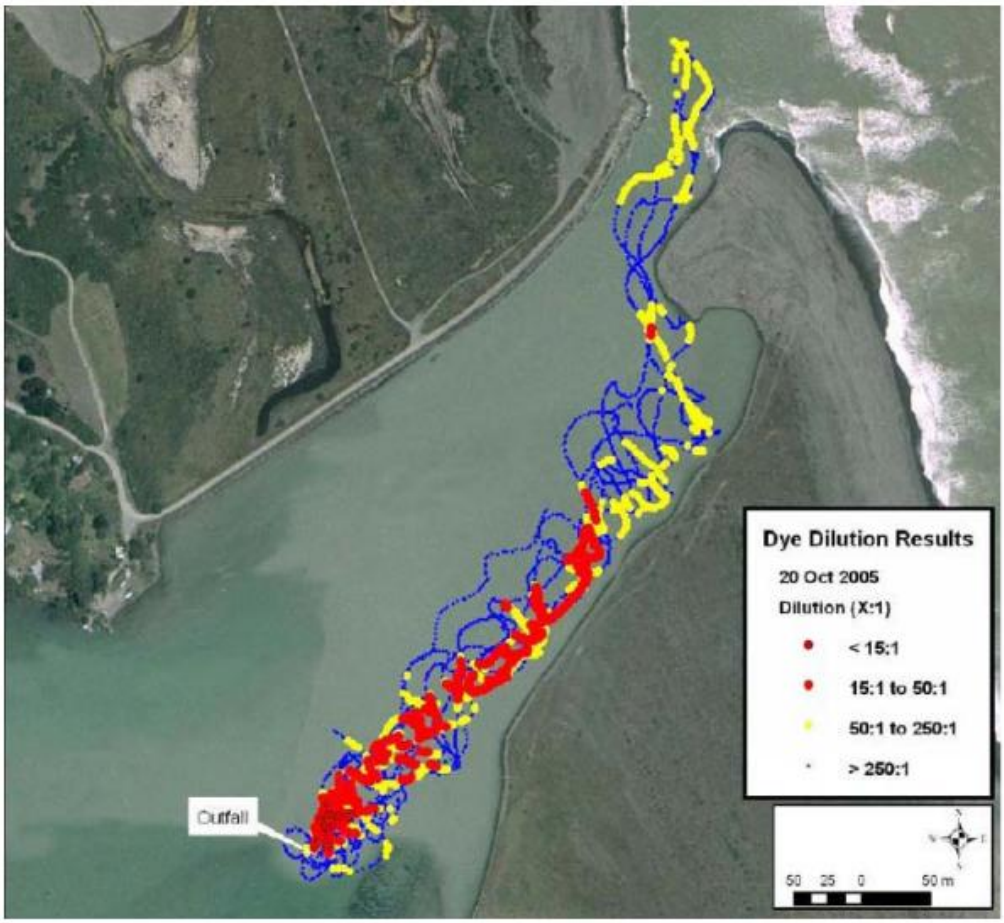


Figure 6: Results of Coastal Dye Studies

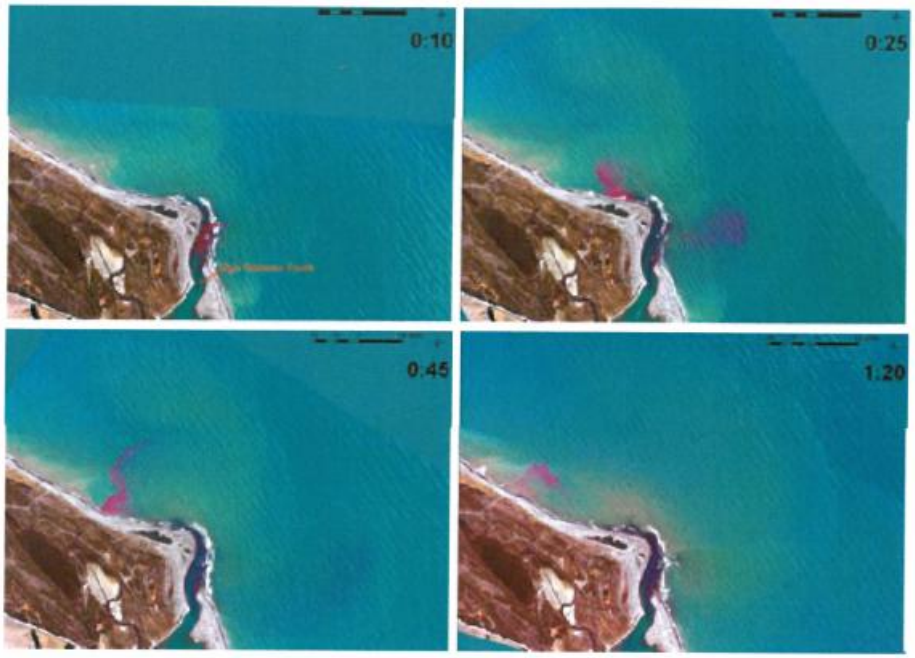
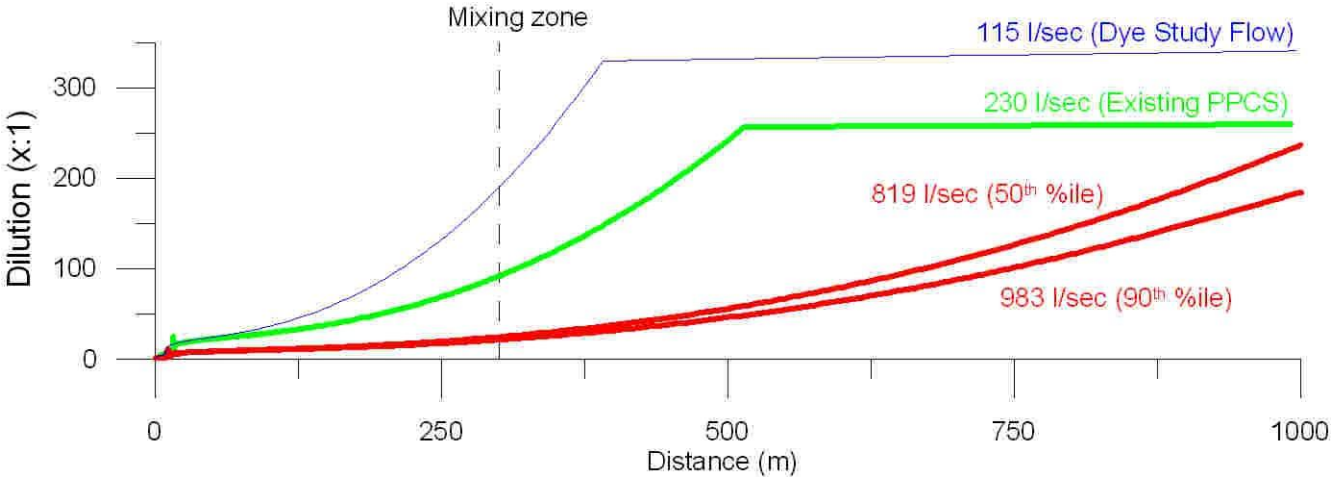


Figure 7: Predicted Dilutions at Distance from Outfall for Existing and Future STP Flows



The options for conveying the existing and future flows to the Estuary were assessed and it was found that a large diameter pipe (needed for ebb tide discharges), would have a similar cost to conveyance wetlands.

Previous consultation by MDC had indicated that wetlands were favoured for polishing treatment and habitat creation reasons. The wetlands act as holding ponds for ebb tide discharge through a short discharge pipeline (about 400m) with a new outfall pump and diffuser outfall. Provision was made to discharge continuously from the wetland when storage capacity is exceeded under prolonged wet weather events. River flows are expected to be high during such events thus providing additional dilution and flushing. The overall layout of the site and vicinity is shown in Figures 8 and 9.

Figure 8: View looking south with construction underway of the long wetlands with Opawa River in foreground and Wairau Lagoons upper left and the STP ponds upper right.

CONCLUSIONS

MDC carried out investigations into the application of treated effluent from the Blenheim STP onto land, either for the total flow or a portion of the flow. This work facilitated discussions with iwi and other stakeholders, regarding the affordability of the options.

It was agreed with all parties that application to MDC-owned land surrounding the STP was feasible but that year-round discharge of all effluent to land was unlikely to be sustainable or affordable. Parallel investigations had shown that discharge of wetlands-treated effluent to the Wairau Estuary on the ebb tide, would have negligible effects in the receiving waters.

The long wetlands which convey pond effluent from the Blenheim STP, also provide further polishing treatment, habitat enhancement and storage to allow discharge on the ebb tide. The construction of the wetlands and irrigation system was overseen by local iwi and provided additional useful information on the cultural and archaeological values of the area.

The upgrading of the STP has provided MDC and the community with a win-win situation. Land application is maximised during the summer months. Pasture growth is being enhanced by the irrigation of pond effluent and nutrients are being removed by the 'cut and carry' harvesting of pasture. During the wetter periods, when land discharge is not sustainable, well-treated effluent is discharged to the Wairau Estuary, where it quickly reaches the open waters of Cloudy Bay. There are no longer any discharges to the poorly flushed reaches of the Opawa River.

Figure 9 – Plan of Overall Site (Note North is to the Right)