Combined Land and Water Discharge: Optimising the Environmental Outcome for the Discharge Environment

Katie Beecroft, Hamish Lowe

Lowe Environmental Impact, P O Box 4667, Palmerston North, 4442; Email: katie@lei.co.nz.

ABSTRACT

Combined land and water discharge (CLAWD) schemes are often the most feasible solution for wastewater discharge where ideal land for discharge is not available or where wastewater flows are highest in the winter when discharge to land is not desirable or even possible. There are three main components for managing the discharge of treated wastewater under a CLAWD scheme. They are:

- Discharge to land;
- Discharge to water; and
- Volume of storage available.

Key to the long term success of a scheme is the ability to optimise the three components so that environmental gains in one area do not result environmental compromises in another area. For instance, a reduction in a river discharge outside critical flows which results in damage to soil health by over application of wastewater to wet soils.

It is desirable that storage size is minimised due to the land area requirement and large cost of storage facilities. However reducing the available storage has the potential to result in insufficient water being available when plant growth and soil conditions require it.

In addition to optimising the discharge to the land and water environments, the discharge volume and quality can be changed as part of treatment plant upgrades. Further treatment can increase the volume discharged to the river, increase the irrigation depth and decrease the storage volume. This is often a consideration for industrial wastewaters with high contaminant loading, but management of low strength high volume municipal wastewaters is typically limited by hydraulic loading to land and not nutrient loading meaning that additional treatment can be redundant.

This paper looks at the process of optimising land area, river discharge and storage facilities for a meat works effluent discharge.

Keywords: Wastewater, land discharge, river discharge, combined discharge, water-balance.

INTRODUCTION

AFFCO Manawatu is part way through renewing resource consents for future wastewater discharges from its plant near Fielding. This is requiring current and future treatment and discharge options to be considered. The plant currently operates a two pond system (additional ponds are not currently used) for the bulk of effluent discharged from the plant. This is followed by discharges to both a neighbouring dairy farm and the Oroua River. Whether wastewater is directed to land or water is typically dictated by flows in the Oroua River.

The regional council has indicated that discharges to the Oroua River should be minimised. In order to determine the optimum design for the discharge system the river discharge, land treatment and storage needs to be considered together i.e. the impact of each element on the others must be considered.

The location of the existing processing plant and the land treatment farm are shown in Figure 1 below.

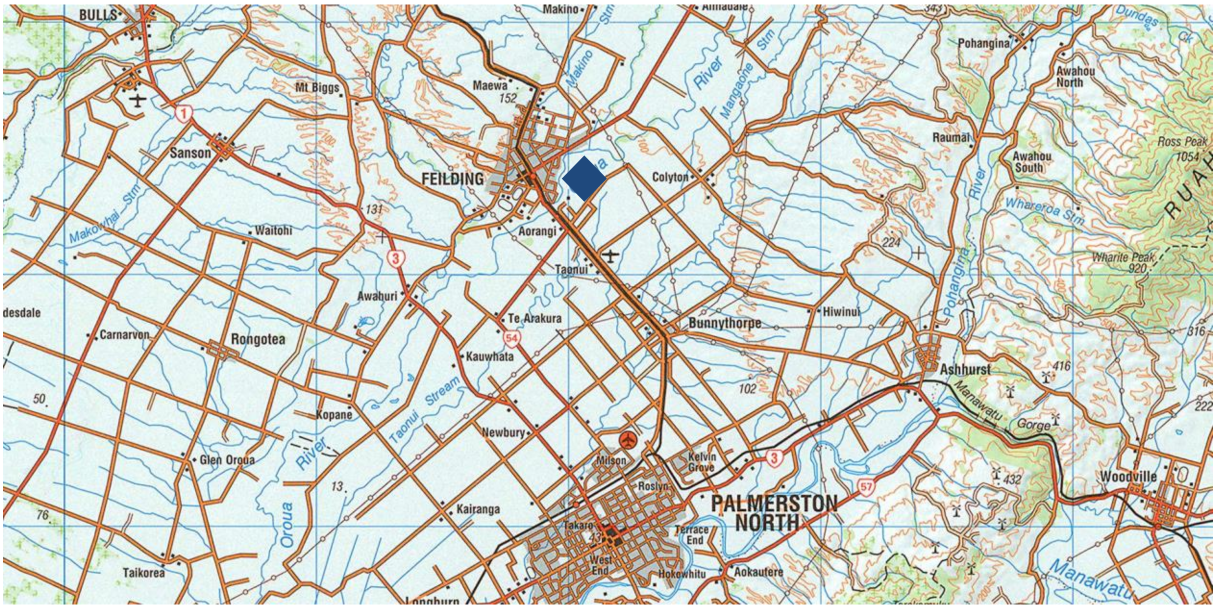

Figure 1: Overview and Location Map

KEY INFORMATION FOR DISCHARGE DESIGN

There are a number of system and receiving environment details that need to be understood to prepare a discharge design suitable for resource consenting and long term operation. Some of these inputs are variable and can be altered to achieve an optimum design/solution. Some inputs are fixed and a discharge design needs work within them. Key input information for a reliable design is as follows:

- Wastewater flows – Varies within and between seasons. Can be altered by operational changes, however it is likely to reflect the stock processing numbers at the time, with greater volumes associated with more stock processed;

- Wastewater quality – Varies as above, however the current pond treatment system provides buffering capacity which evens out variations in wastewater quality. The quality can be altered by plant operational changes (e.g. waste stream diversion) and also the treatment system (e.g. P removal using alum dosing; N removal using a BNR system; and pathogen reduction using UV disinfection);

- River assimilative capacity – Controls and limits how much material can be discharged without causing an unacceptable degradation of river water quality and loss of habitat or amenity value. This is relatively fixed and influenced by factors outside of AFFCO control (e.g. background water quality, other point source discharges, values placed on the water-way by the wider community);

- Land assimilative capacity – Controls how much material can be discharged without reducing the ability of the soil to receive the material i.e. the point at which additional application will cause unacceptable effect off-site. The ability to apply to land can be altered by changes in land area, management changes such as irrigation type and scheduling, and crop selection and management; and

- Storage available – Volume available post-treatment and prior to discharge. This does not include the volume in the treatment system. It allows wastewater to be discharged when either soil conditions or river flows allow. It can be altered by construction of additional storage, however it is has been indicated that this is not being considered for AFFCO Manawatu.

EVALUATION METHODOLOGY

A water balance was prepared using paired daily values for river flow, climatic data and wastewater data. Elements of the water balance such as the land area, river discharge criteria and water use in the plant were varied to determine the sensitivity of the system to changes. This enabled AFFCO to target the areas for changes which could make the most difference to the environmental outcomes of the discharge regime.

RESULTS

A total of 19 scenarios have been evaluated to see what parameters the discharge to land and water from the plant, and required storage volume are sensitive to. Key observations from the evaluation were as follows.

Change Land Area:
Increasing the land area for discharge from 50 ha to 75 ha reduces nutrient loading to land to an acceptable level. Storage volume required is reduced. Discharge to river is not substantially reduced. There is a significant benefit from increasing the land area.

Change Storage volume:
Under current wastewater flow volume conditions storage volume is not limiting to the amount able to be discharged. If wastewater flows increase due to increased production i.e. by 25 % then greater storage is needed if no other changes are made. However, if the rate of pumping to the river increases then no volume increase is needed. Increasing storage volume has a high cost for a marginal benefit.

River discharge criteria:
It is possible under the current wastewater flow conditions to limit discharge to the river to times when the flow in the river is above 80 FP (also known as 20 FEP). If the flow from the plant increases by 25 % then discharge to the river between median flow (MF) and 80 FP is needed. Under all modelled scenarios no discharge occurs from December to March.

Nutrient Loading to Land:
Under most conditions the amount of nitrogen (N) or phosphorus (P) is the parameter that limits discharge to land. By limiting the amount of N and P to levels suitable for discharge to a dairy farm the amount of storage required becomes unfeasible. If a nutrient loading rate

suitable for a cut and carry system is adopted then all other criteria can be met with no increase in storage, even if the flows from the plant increase by 25 %.

Nutrient Concentration Reduction:
The inclusion of N and/or P reduction technologies in the treatment plant (-15 % and -25 % respectively), does not result in a change to the relative or total volumes discharged to land or water, or stored. However the mass loading of nutrients to both the river and the land are reduced. Without other modifications to the discharge system the reduction in the load to land brings the yearly nutrient loading down to a rate which is appropriate for cut and carry, but is not low enough for dairy grazing. Nutrient reduction technologies are likely to have a minor benefit in terms of reduced environmental effects compared to the large cost.

Increase inflows:
All variants of the water-balance were run with flows at 25% more than the current level. At these flows days of discharge to river are higher and days of discharge between MF and 80 FP are about 10 days per year more. In order cope with increased flows the discharge system needs at least 75 ha of land. Discharge will need to occur at flows between MF and 80 FP, as well as above 80 FP. The rate of pumping to the river will need to be increased from the current 2,000 m^3/day maximum, or nutrient reduction is needed.

River Pumping Rate:
The maximum rate of discharge was increased from 2,000 m^3/day to 3,000 m^3/day. Under this condition a higher annual volume was discharged to the river on a lower annual number of days. A lower volume was discharged between MF and 80 FP at the higher pumping rate. This means that the cumulative mass loading the river is higher but the acute effects are likely to be lower.

CONCLUSION

Based on the information obtained from the analysis of scenarios we were able to develop and refine an option for forward planning and consenting purposes, being:

- **Wastewater** flows at 25 % higher with no change to nutrient concentration (no plant nutrient reduction);
- **Land discharge** to 75 ha with cut and carry as land use;
- **Storage volume** as 50,000 m^3;
- **River discharge** at 400 times dilution above median flow (MF) to a maximum daily discharge of 3,000 m^3/day. Effects of this regime are still to be assessed.

Identifying a preferred option enables AFFCO to focus planning and targeting expenditure on the changes to their system which will result in greater environmental improvements. For resource consenting having known parameters enables a detailed assessment of the environmental effect to be undertaken.