Combined land and water discharges – the way of the future?

Hamish Lowe[A,D], Jon Roygard[B], Katie Beecroft[C]

[A]Lowe Environmental Impact Ltd., PO Box 4667, Palmerston North
[B]Horizons Regional Council, Private Bag 11025, Palmerston North
[C]CPG NZ Ltd., PO Box 562, Palmerston North
[D]Corresponding author. Email: Hamish.lowe@lei.co.nz

ABSTRACT

Direct discharge to surface water is the most common method of wastewater discharge in NZ. Continued use of direct surface water discharges of municipal wastewater has become unsustainable on a number of fronts, including environmental, social, cultural and in many cases financial. The alternative most frequently identified is land treatment. There are often significant issues with the adoption of land treatment due predominantly to perception of cost (land, infrastructure, compliance) and risk (land ownership, management requirements).

Social and cultural perceptions of direct discharge to surface water are becoming the greatest barrier to continuing this type of discharge. These considerations are difficult to quantify and near impossible to discount, as they are a fundamental of any assessment under Part 2 of the RMA. Further, increasing costs to comply with direct discharge conditions, in particular nitrogen, phosphorus and pathogen reduction technology costs, are making the cost to continue direct discharges more prohibitive. Land treatment is increasingly a feasible alternative to direct discharge.

Despite being an alternative, there remain significant limitations to land treatment, particularly in regard to managing wet weather flows and saturated land conditions. The use of schemes which include the best parts of water discharges and land discharges have the potential to provide cost effective and socially acceptable solutions. Combined land and water discharges (CLAWD) can be designed to enable the use of the wastewater resource (water and nutrient) to assist in growth of a crop (pasture, fodder, trees etc) during low soil moisture conditions (summer, spring, autumn), while allowing discharge to water where land application is unsuitable (high soil moisture, low plant uptake) and impacts on surface water can be demonstrated to be minor (high flows, cooler temperatures, lower recreational use).

INTRODUCTION

Background

The alternative most frequently investigated to surface water discharges is a land based discharge. A review of district council perspectives on land treatment of municipal by CPG (Lowe, 2009) indicated significant issues with the adoption of land treatment due predominantly to perception of cost (land, infrastructure, compliance) and risk (land ownership, management requirements).

Social and cultural perceptions of direct discharge to surface water are rapidly becoming the greatest impediments to continuing this type of discharge. These considerations are difficult to quantify and therefore difficult to address, however they must be considered under Part 2 of the RMA. Further, increasing costs to comply with conditions for direct discharges, in particular nitrogen, phosphorus and pathogen reduction technology costs, are making the cost to continue direct discharges more prohibitive. This is especially so when having to address low flow conditions in waterways. Land application is a feasible alternative to direct discharge.

Land application has been through an evolving process in the Manawatu Wanganui region, with the predominant means of discharging agricultural effluent changing from 439 discharges to water in 1997 to 16 in 2009 (Roygard, 2009). Despite being an alternative, and being adopted within the agricultural industry, there remain significant limitations to land treatment for municipal wastewater. Many of these limitations are in regard to managing wet weather flows and saturated land conditions. In general, when soils are saturated and wet weather flow conditions are present, discharge of treated wastewater to water will not produce any measurable adverse impact on the receiving environment.

The use of schemes which optimise the best parts of water discharges and land discharges have the potential to provide cost effective and socially acceptable solutions. Combined land and water discharges (CLAWD) can be designed to enable the use of the wastewater resource (water and nutrient) to assist in growth of a crop (pasture, fodder, trees etc) during low soil moisture conditions (summer, spring, autumn), while allowing discharge to water where land application is unsuitable (high soil moisture, low plant uptake) and impacts on surface water can be demonstrated to be minor (high flows, cooler temperatures, lower recreational use).

THE WATER DISCHARGE SOLUTION

History

Most New Zealand cities and major towns were established on sites at or near the coast; with the few that were not being invariably located alongside rivers or lakes (Palmerston North, Hamilton, Rotorua, Masterton and Gore, for example). When reticulated sewage systems were first introduced, the priority was to get the discharged wastewater from a property away from the house. The location and environment of where it was discharged was of a lesser concern.

From those early beginnings, public wastewater systems have been upgraded as required to meet actual and perceived needs. High profile discharges, or discharges that have historically generated obvious and significant public health effects, have largely been dealt with. Now, the focus of discharge upgrades is based more-so on improvements to the environment.

The main concerns with WWTP discharges are the quality of the water being discharged and, culturally, the impact that it may have on the mauri of the water. The traditional contaminants, being pathogens (some disease producing), organic material and nutrients, have been routinely monitored in wastewater and there is a good scientific and engineering understanding of how to remove these from wastewater.

Treatment technology exists to allow contaminant levels to be reduced to acceptable levels, even to a point which allows their presence in drinking water, albeit minimal to non-existent. The ability to treat water to a high standard is not typically the limitation for treatment plant upgrades to achieve a desired water quality standard; rather the real limitation is the cost to achieve that standard.

Cultural considerations

Maori hold the view that wastewater discharges impact on the state of the water making it waimate (dead water) and it impacts on the water's mauri (life force). The common view is that the mixing of waste and water is abhorrent physically, culturally and spiritually (Awatere, 2003). The means of cleansing water from a Maori perspective requires some form of passage through Papatuanuku (the earth). Observations of wastewater upgrades and consenting processes around the country indicate that the extent of cleansing prescribed is variable, with some iwi accepting of a lesser degree of land passage. In many cases the extent of land passage is a reflection on the compromises iwi make between a 'current bad situation' and a 'situation that can be afforded' by that community. In other words, limited land passage is not ideal, but some land passage is better than no land passage, especially as alternatives may not be affordable to the community. Opportunities for "land passage" include irrigation systems infiltration fields, overland flow systems, rock filters and constructed wetland.

Basic design considerations

From a scientific and engineering perspective, waterway discharges can be technically feasible and operated with no adverse environmental effects. The specific effects are dependent on the contaminant load, with the impact being observed in many ways. Possibly the three main influences are on:

- Direct toxicity effects from BOD, ammonia, suspended solids and pathogen;
- Eutrophication (nutrient enrichment) which in turn impacts on aquatic life; and
- Impact on the viability of water use, as a source for drinking, recreational activities or from which to gather food.

LAND TREATMENT AS A DISCHARGE SOLUTION

What is land treatment?

Land treatment of by-products and waste is the utilisation of the biological, chemical and physical properties of the terrestrial environment (being plant and soil) to further treat and assimilate wastes in a beneficial manner. Land treatment aims to beneficially use the applied 'waste' material for productive use, while using the environment to provide further treatment of the waste material, through nutrient sequestration and removal, evapotranspirative uptake and atmospheric loss, and pathogen reduction.

Basic design considerations for land treatment

An ideal land treatment system would allow for the uniform application of wastewater (and solids) onto the soil surface at such a rate that maximises plant uptake and minimises leaching and contaminant/nutrient build up in the soil. This can be achieved through appropriate

applications system and the establishment of actively growing crops which are removed on a regular basis. It also ideally requires soils that are loamy and well developed that minimise preferential/bypass flow and retain nutrients for subsequent plant use.

In developing a land treatment system, there are a series of basic design parameters which need to be considered. These predominantly relate to the rate at which material is applied to a given area of land. One of these will form the limiting design parameter on which loading rates will be based. The main design parameters are hydraulic, organic, nutrient and pathogen loading.

WASTEWATER TREATMENT IN THE MANAWATU WANGANUI REGION

The region

The Manawatu Wanganui region has a total population of approximately 222,400 people. Its population ranks 6th in size out of the 16 regions in New Zealand with 5.5 % of New Zealand's population (Statistics New Zealand, 2006 Census data). People live in an estimated 85,194 occupied dwellings.

The region covers 10 local authorities, 7 completely within its boundaries. The area covers 22,215 km^2 of land which is 8.1% of New Zealand's land area. Figure 1 shows the extent of the region.

Figure 1: Manawatu-Wanganui Region (showing Territorial Local Authority Boundaries) (Source; www.horizons.govt.nz).

There are approximately 42 council administered community sewers in the region. Nine use land application, albeit high rate with limited treatment, with two using combined land and water discharges, the remaining discharge to water.

THE NEED FOR EVALUATION OF OPTIONS INCLUDING CLAWD

The ability to cease all or part of the point source discharge from any contributor can greatly assist water quality. However, evaluating the potential for each community individually on a case by case basis could be a very costly and time consuming process.

While the need to address water quality is a high priority for the Regional Councils, it does not feature so highly with many TLAs since there is no mandate for TLAs to manage water quality. This creates an opportunity for collaboration between Regional Councils and TLAs to assist with the prioritisation of reducing point source discharges from WWTPs. This can be the development of a methodology for evaluating and potentially implementing either the complete removal or partial removal of waterway discharges.

There is the potential that either direct water discharges or land application could work satisfactorily in many instances. However, there are the combined benefits that a CLAWD system potentially offers.

At present there is limited experience in the design and management of CLAWD systems in New Zealand. Evaluating their operational costs and management requirements can be challenging, making it difficult to accurately evaluate the costs and benefits. The development and implementation of an assessment strategy and process has the potential to provide a consistent method for evaluating the costs, benefits and effects of CLAWD systems.

Benefits for such a strategy or consistent approach to evaluate reductions in the impact from waterway discharges include:

- Many issues are in common between different systems on the same river system. A combined assessment, or identification of issues in common, within a catchment or TLA area will save repetition on investigations;
- Where investigations are needed, they can be shared within a catchment and between individual discharges;
- There will be considerable savings on costs when compared to individual investigations when reviews are approached collectively;
- A review strategy and process will allow a consistent evaluation method to be used, which will assist in prioritising the discharges in need of more urgent attention;
- A strategy and process provides interested parties (e.g. iwi, environmental groups and others) an opportunity to buy into a single and agreed process. This reduces the need for their detailed engagement on each individual evaluation; and
- It can provide an agreed and balanced approach to a prioritised and on-going work programme between the Regional Council and TLAs or industry.

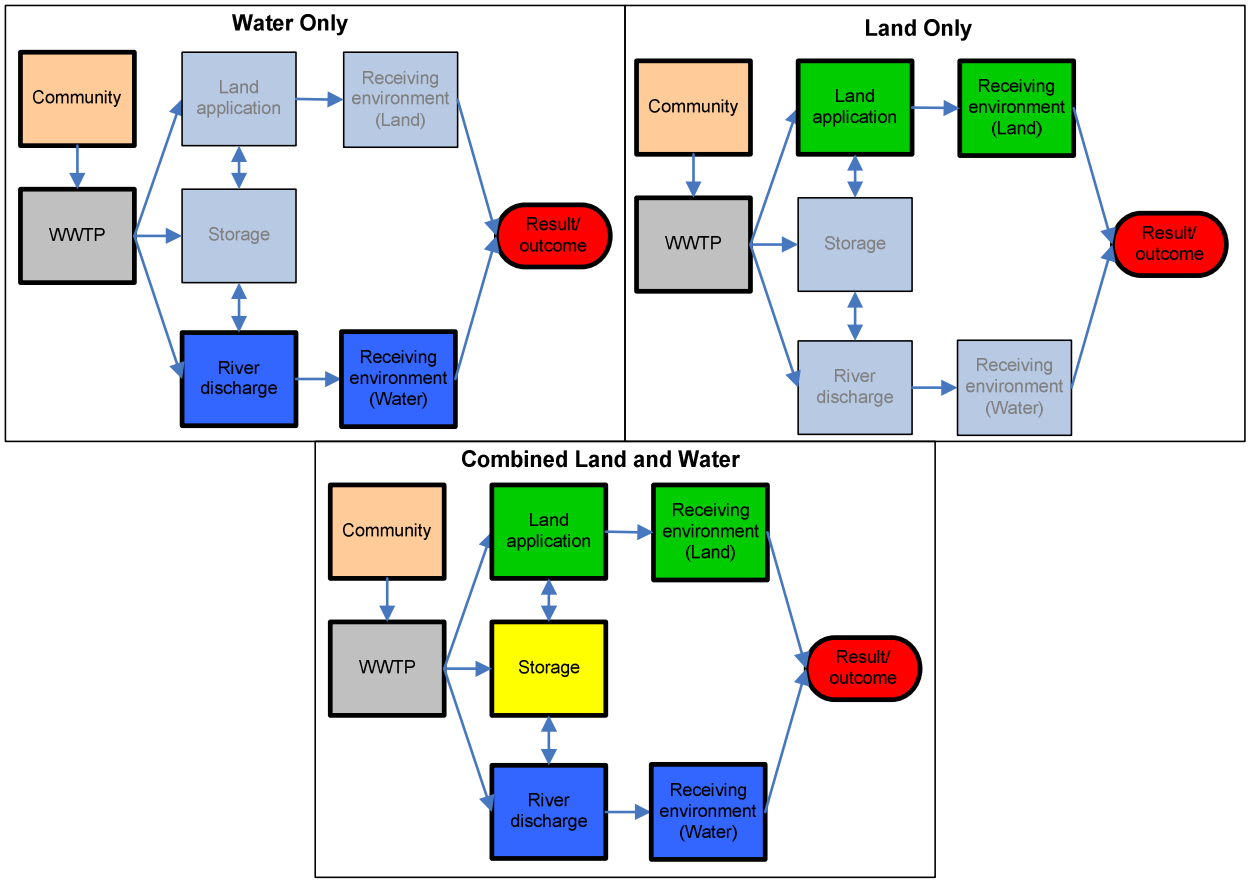
WHAT IS CLAWD?

Background

In reality there are only two receiving environments in which to discharge wastewater; being water and land. While land application could replace waterway discharges it should be noted

that land application is not the ultimate answer for all discharges; and in some cases waterway discharges may be more appropriate. Figure 2 provides a schematic summary of discharges to the two receiving environments, being land and water. CLAWD systems are effectively a hybrid of the two established methods of wastewater discharge. They are not new and have been used successfully in New Zealand (albeit on a limited basis) and around the world.

Figure 2: Schematic of Discharge Options



Principles of a CLAWD System

The principle of a CLAWD system is that wastewater is discharged into a river or stream at times of higher flow, and is applied to land at times when either the stream flow is low, or when the land has ability to receive it.

An essential component of a CLAWD system is the need to balance the flow of water to the varying receiving environments. In most environments this requires the use of storage. Storage allows the wastewater treatment requirements to be moderated, allowing for less intensive treatment to meet low flow dilution requirements as no discharge is needed. Similarly, if the soils are wet and river flows do not have sufficient flow, storage can be used.

Developing and managing a balance between land and water discharges requires a water balance approach to be used. This needs to consider soil moisture conditions, river flows and the storage available.

It should be noted that while the assessment methodology may be similar between sites, there will be the need to assess individual communities and their discharges on a standalone basis. This is because no two discharges will be the same. This also applies to the receiving environments which will charge from location to location.

What a CLAWD System can offer

A CLAWD system can offer the following:

	Positive	**Negative**
Environmental	Avoids water discharge during sensitive rive periods Avoids irrigation when soil conditions are not ideal. Can avoid WWTP upgrades.	
Economic	Reduces storage requirements. Irrigation benefits. Fertiliser benefits.	Two sets of infrastructure required. Need for treatment to meet industry standards.
Social	Enhances water recreational values. Irrigation and river discharge complementary.	Perception issues due to continued use of a water discharge environment.
Operational		Two systems to manage and monitor.
Cultural	Partially addresses cultural objectives.	Does not fully meet cultural objectives.

Steps included in a evaluating a CLAWD System

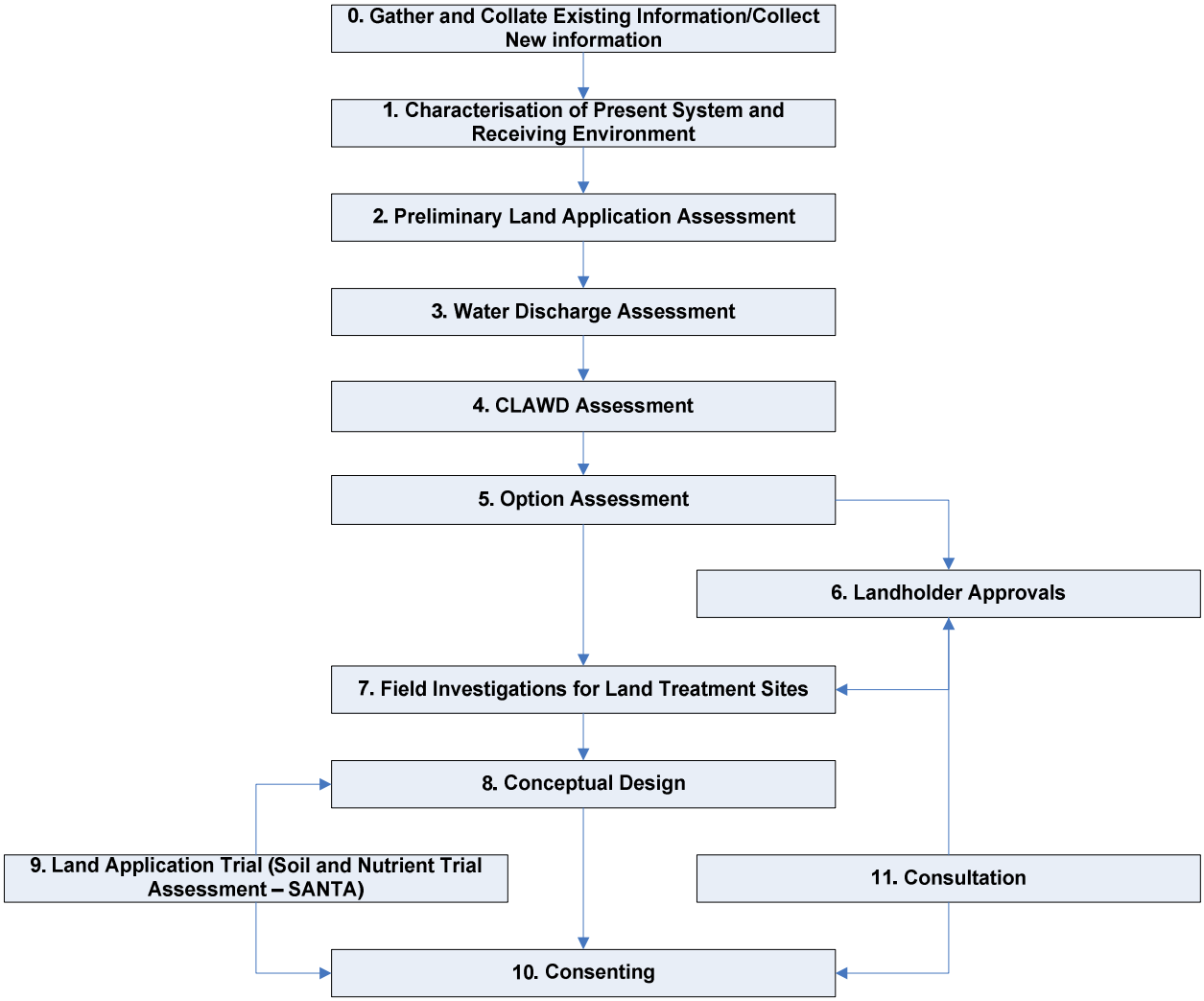
In order to fix a problem, it has to be defined. Consideration and adoption of a CLAWD system must be based on sound science and engineering, as well as observing economic, social and cultural factors.

A process to evaluate individual communities needs to consider a range of factors, including the limitations of the current system, limitations of the current waterway environment, limitations of available land and likely climatic constraints. These require individual assessments, which when combined can form the basis of mapping out a community specific plan.

Prior to evaluating a CLAWD system it is essential that consideration is given to all existing data, including compliance and State of the Environment monitoring. Wastewater characterisation is also very critical, especially the establishment of discharge flow characteristics. This should include rates and composition, and ideally it would provide consideration of stormwater and ingress implications, as well as future system improvements and on-going development. Should there be a deficiency of information, collection should start as soon as possible, so that any CLAWD system is based on observed facts and data, as opposed to estimated projections.

The process of considering the use of a CLAWD system should effectively be a series of steps that can be used sequentially to determine the viability and operational functioning of a CLAWD system, if it is seen as being appropriate.

The steps in a draft process include the following components:



CONCLUSIONS

Wastewater from treatment plants can be discharged to two environments; being into water or onto land. The majority of municipal treatment plants around the country, with the Manawatu Wanganui Region being no exception, discharge into water.

Improvements to wastewater treatment plants to create more acceptable wastewater quality prior to surface water discharge are possible. Discharges to water require the contaminant loading to be able to be assimilated within the river system. During higher waterway flows this is more feasible than during low flows.

Discharge to land is also possible in many cases to completely cease surface water discharges. Land application requires suitable land to be identified, with one of the major limitations in the Manawatu Wanganui region being wet soils during winter.

The combination of the two limitations of water and land discharges provide an opportunity to use the best of both, enabling discharge to be applied to land during low flow conditions and discharge to water during periods of high soil moisture.

There is an opportunity for Councils to develop a strategy and process for evaluating the suitability of current wastewater discharges, and ways that alternative discharges could work, including the use of combined land and water discharges. This approach would be assisted, locally and regionally, with a standardised method to enable communities within the same geographical area or river catchment to share information needed for such an assessment. Such a consistent approach would also enable a method for prioritisation at a Territorial Local Authority level, or a regional level, to advance and justify upgrades of the treatment plants having the greatest impact on water quality.

REFERENCES

Awatere, S (2003): Tangata Whenua Perspectives. New Zealand Land Treatment Collective, Technical Review No 24.

Lowe (2009): Recent History and Rationale for Wastewater Treatment Plant Upgrades. Prepared for Horizons Regional Council.

New Zealand Land Treatment Collective, (2000): Guidelines for utilisation of sewage effluent on land, Rotorua.

Roygard (2009). Roygard 2009 Section 42A report prepared for the One Plan Hearings on behalf of Horizons Regional Council.

Statistics New Zealand, (2006): Census data from: http://www.stats.govt.nz/Census/2006CensusHomePage