A process for identifying land suitable for land based treatment of wastewater on erodible slopes

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ABSTRACT

Traditionally most municipal wastewater discharges in New Zealand have been to water. As coastal and inland water quality is increasingly identified as a management priority by Regional Councils New Zealand wide, there is mounting pressure on communities to find alternative means of effluent treatment and discharge.

Land treatment of wastewater/effluent is a relatively well understood mode of final treatment and discharge. The use of land treatment for communities of varying sizes is often a favoured option due to increasing regulatory pressures and cultural concerns. Traditionally land treatment of wastewater has occurred on flat sites, but many communities only have erodible hill country available for this purpose. Land based wastewater treatment systems have tended to focus on the hydraulic properties of the soil, but in hill country slope, geology and erosion are significant factors to consider. The challenge is to assess the potential risk of erosion on such land under a scenario of land treatment of wastewater, thereby evaluating the inherent suitability of such land for this purpose.

While many hydrological, nutrient and soil-landscape mapping models exist, few enable the assessment of irrigation on sloping land. This paper describes the process CPG recently developed to assess the suitability of an erodible hill country site for use in the land-based application and treatment of municipal wastewater under hardwood plantation forest. A case study is presented which demonstrates how a land treatment system was identified as an option for an inland community with a small permanent population and an aged reticulation system. The town has an existing discharge to a river in a phosphorus sensitive environment.

INTRODUCTION

Land treatment of effluent is a relatively well understood mode of final treatment and discharge. The use of land treatment for communities of varying sizes is an increasingly favoured option. This is primarily because of:

- Regulatory constraints on discharges that cause degradation in water quality;
- Cultural issues surrounding the discharge of treated wastewater to rivers;
- Land treatment is an attractive option because it can be a comparatively low cost alternative that produces a return; and
- Often wastewater treatment plants are located near to the edge of town and rural land.

Traditionally the main constraint for the land treatment of wastewater has been considered to be the hydraulic properties of the soil, with little consideration given to the underlying geology and erosion risk of the site. However many communities have limited suitable land available for land treatment of wastewater. Suitable flat land is often too expensive or not available due to the local topography surrounding the community. Increasingly communities seek to investigate the feasibility of land application onto hill country, where slope, geology and erosion risk are more dominant issues. It is important that the extent of such constraints can be suitably assessed, then an appropriate approach to land treatment can be developed.

This paper describes the process CPG recently developed to assess changes in potential erosion risk when erodible hill country land is used for land-based treatment of wastewater.

METHODS

The process CPG has used to determine the extent of erosion risk of areas within erodible hill country sites involves several iterations (see Figure 1). A Land Resource Inventory (LRI) map was produced from which a Land Use Capability Assessment (LUCA) was undertaken, according to the process prescribed in Lynn et al. (2009). From a standard LUCA, an Enhanced Land Use Capability Assessment (ELUCA) has been derived. This process involves assessing how land curvature and the proposed land use will impact on potential erosion, and therefore how the Land Use Capability class of the various land units would consequently change. The ELUC units were then transformed into irrigation-based Land Management Units (LMU's) by reclassification of ELUC units into units capable of receiving high, moderate, low or no amounts of irrigated wastewater. Land Management Units were then smoothed and compartmentalised into appropriately sized blocks to allow for the practicalities of applying wastewater. The resultant units were called Irrigation Management Units (IMU's) (Figure 1).

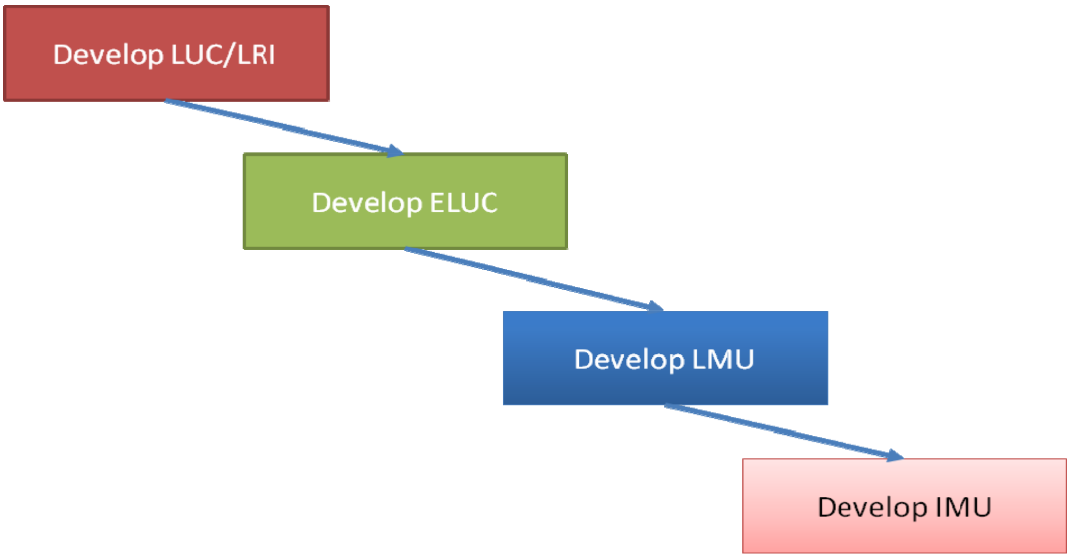

Figure 1. The development of irrigation management zones.

CASE STUDY: PERMANENT TOWN OF 1,900 PEOPLE

A potential land treatment site was identified and composed of rolling to steep land predominantly underlain by argillite rock, in an area subject to tectonic faulting and folding (Kingma 1962, Kingma 1967). On such country and under the proposed land use there is potential for slight to severe surface erosion (sheet and wind), slight to very severe mass movement erosion (soil slip) and slight to severe fluvial erosion (rill, gully and tunnel gully).

Overall this particular site occurs within a broader context of extremely slump prone muddy shales associated with sulphur layers, so it is the best available option. It is important that the erosion risk is adequately taken into account in the design of the land treatment system.

By using the process above, it was possible to establish that even with all the constraints of the site with regards to erosion risk, there is still a significant amount of land available that is suitable for the intended land use, being irrigation of a plantation forest.

Table 1 below shows the areas of LMU's and IMU's that resulted from this process.

Table 1. Study site land management unit summary.

Land Management Unit	Enhanced Land Use Capability Classes	Area of Land Management Units (ha)	Area of Irrigation Management Units (ha)
High input Slight erosion potential	3e (planar). 3e (divergent). 3e (convergent). 4e (planar). 4e (divergent). 4e (convergent).	15.67	10.50
Moderate input Moderate erosion potential	5e (planar). 5e (divergent). 5e (convergent). 6e9 (divergent). 6e13 (divergent).	24.56	25.00
Low input Severe erosion potential	6e13 (convergent). 7e (planar). 7e (convergent). 7e4 (divergent).	18.01	25.00
No input Waterway	5w.	16.76	14.00
No input Very severe erosion potential	8e (planar). 8e (convergent).		
Total		75.00	74.50

The process adequately identified the presence and extent of erosion issues on the site and enabled further work to establish appropriate hydraulic loadings for each IMU. This part of the process is discussed by Beecroft et al. (2010).

CONCLUSIONS

This report has outlined the process CPG has used to determine the extent of erosion risk of areas within an erodible hill country sites for the purpose of land treatment of wastewater. This involves an assessment based on the long-standing Soil Conservation techniques of LRI mapping, and LUCA. From a standard LUCA, an ELUCA has been derived, with enhanced focus on the suitability of the mostly sloping soils of the site to receive irrigation. From this in turn, irrigation based LMU's have been identified and mapped, grouping areas of land with the same assessed responses to irrigation. IMU's have then been derived from the LMU's by reclassifying the units as capable of receiving high, moderate, low or no amounts of irrigated wastewater. IMU's have also been smoothed and compartmentalised into appropriately sized blocks.

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