A risk management framework for land treatment systems

James Li, Hamish Lowe

Glasson Potts Fowler Limited, PO Box 562, Palmerston North

ABSTRACT

The Hawke's Bay Regional Council (HBRC) is currently reviewing its resource management framework for on-site wastewater systems management. The current rule in the Proposed Regional Resource Management Plan is considered adequate for dealing with individual systems. The HBRC wishes to develop a methodology to assess cumulative effects and potential risk from on-site wastewater treatment and disposal.

Factors affecting on-site system performance and public health risks were reviewed and organised into three matrices. These were applied to thirteen coastal Hawke's Bay communities to test the methodology at a desktop level. Three communities were then included in the field validation stage.

Results from field sampling and community surveys suggested the framework predicted pollution impacts and health risks from the communities systems correctly, so it has the potential to be used as a policy development tool .

Keywords: on-site wastewater treatment and disposal, health risk, resource management framework, field validation, matrix, cumulative effects

INTRODUCTION

Background

Hawke's Bay Regional Council (HBRC) is currently reviewing its resource management framework for on-site wastewater management. The current rule structure in the Proposed Regional Resource Management Plan (PRRMP) is considered adequate for dealing with effects of individual consents. But there are still several difficulties in properly addressing cumulative effects of multiple systems in any given area, especially coastal environments.

HBRC engaged Glasson Potts Fowler Limited (GPF) to develop a consistent basis for further development of its regulatory framework for on-site wastewater systems. It is intended that developed policies and rules should relate to assessment of actual environmental constraints governing the effectiveness of onsite treatment systems, potential public health and environmental risks and potential risk pathways.

Study objectives

The study objectives were:

1. To develop a consistent risk assessment framework/methodology capable of assessing factors influencing the long-term suitability of on-site wastewater treatment systems

across the Hawke's Bay region, and the potential risks to human health and the environment from on-site wastewater treatment and disposal operation;
2. To provide an assessment of risk(s) associated with ongoing operation of on-site wastewater treatment systems at thirteen settlements in the Hawke's Bay region;
3. To confirm, or otherwise, the findings of the risk assessment process through appropriate field surveys; and
4. To ensure that the findings are readily adaptable for the development or amendment of a resource management framework for the discharge of on-site wastewater under the Resource Management Act 1991 (RMA).

This study was undertaken in four stages.

METHODOLOGY

Stage 1 - Risk framework development

The development of the risk assessment framework involved:
- Identification of factors to be included in the assessment and rationale for inclusion;
- Listing of available information source(s) and type of assessment that each will be taken; and
- Assignment of any weightings to be applied and rationale.

Factors influencing the successful operation and management of on-site wastewater systems included:
- Factors affecting on-site wastewater flow and effluent quality;
- Factors affecting on-site disposal system performance;
- Sensitivity of receiving environment and public health risks;
- Management factors; and
- Social and financial factors.

Thirteen factors were selected to be included in the on-site wastewater risk assessment framework. These factors are:
- Landform;
- Soil condition;
- Impermeable bedrock location;
- Groundwater table;
- Sub-soil drainage;
- Stormwater management;
- Housing density/lot size;
- Seasonal occupancy variation;
- On-site wastewater treatment and disposal system design;
- On-site wastewater system management;
- Water supply;
- Receiving water proximity; and
- Receiving water use

A matrix was created where weightings were assigned to various factors to assess the potential impact of the on-site wastewater system on the receiving environment and the receiving environment sensitivity.

Stage 2 - Risk framework testing

The risk assessment framework developed in Stage 1 was tested by applying it to thirteen Hawke's Bay coastal communities in the Central Hawke's Bay, Hastings and Wairoa Districts. The following data was used as input information:

- Topographical data;
- Groundwater bore and consent details;
- Specific site characteristics, like on-site system locations, collected through preliminary site inspections of each community; and
- Community profile information collected through interviews with territorial authority engineers and inspectors.

The application of the framework consisted of three steps:

- Step 1 – assessment of risk potential due to on-site wastewater system runoff, ponding and leaching;
- Step 2 – assessment of receiving environment sensitivity; and
- Step 3 – assessment of on-site and off-site public health risks.

The ranking of the indexes allows comparison among various communities so that communities most at risk could be identified.

Stage 3 - Risk framework field validation

Stage 3 was a detailed site investigation to verify the initial assumptions. It included:

- Door-to-door survey and on-site inspections;
- Soil profiling;
- Percolation tests; and
- Receiving surface and groundwater sampling and analyses.

Field investigations

Three communities (Kairakau Beach, Waimarama, and Mahia Beach South) were included in the field investigations. The field investigations involved:

Receiving water sampling

Receiving water sites were sampled over three rounds, before Christmas, after New Year, and following Waitangi weekend (2003/2004).

- Surface water samples were analysed for total nitrogen (TN), total phosphorus (TP), nitrate and nitrite nitrogen (NO_3-N and NO_2-N), and E.*Coli.*
- Groundwater samples were analysed for total nitrogen (TN), total phosphorus (TP), nitrate and nitrite nitrogen (NO_3-N and NO_2-N), and E.*Coli*. Twelve new groundwater monitoring bores were installed and used in addition to existing bores.
- Marine water samples were analysed for Enterococci only.

- Field measurements of temperature, pH, and conductivity were undertaken.
- Selected samples were analysed by ESR for faecal sterols and whitening agents to verify human influence.

Soil profiling and infiltration tests

Soil profiling and infiltration tests were undertaken in all three communities.

Door-to-door survey and on-site inspections

A door-to-door questionnaire and interview coupled with on-site inspection to individual households was used. The survey questionnaire design focused on factors related to individual on-site wastewater systems and the immediate receiving environment. The factors included were closely related to those presented in the risk framework (Stages 1 and 2).

Field investigation findings

Receiving water quality

Although the limited number of sampling rounds did not provide definitive conclusions about contamination trends among various sites and within the season, monitoring data did indicate possible surface water, groundwater, and marine water contamination at several sites. These sites were sites with expected problems.

Soil profiles and infiltration rates

Soils differ among the three settlements and vary significantly even within each settlement.

Waimarama soils are mostly silt loam with a hard pan existing at 400 mm depth at the north. Towards the south, clay content increases below 500 mm. Infiltration tests indicate rapidly drained to imperfectly drained soils.

At Kairakau Beach, soils change from sandy loam in the north to silt loam overlaying clay type material in the south. Infiltration test results indicate poorly drained to imperfectly drained soil.

Soils at Mahia Beach South settlement may be described as grey/brown silt loam overlaying sticky compact heavy clay with a narrow band of grey silt/sand between 280 and 600 mm. Shallow groundwater is close to the surface, being up to 450 mm, even in summer. Soil infiltration tests in Mahia Beach South indicate poorly drained to imperfectly drained soil drainage category.

On-site inspection and door-to-door survey findings

On-site survey and inspection as well as interviews suggested some common trends and differences among all three communities. It also indicated public perception and potential problems in the three communities. These included:

- Some residents have the view that their septic tank systems perform better than the more expensive secondary treatment units, mainly because the new systems *'smell'*.
- Some areas have a high groundwater table (even standing water in sections) and septic tank discharges did not function well.

- There were a number of pipes discharging directly into open drains around the communities. High pathogen levels confirmed direct wastewater discharge.

RESULTS AND DISCUSSION

Weighting factor to be assigned to matrix factors

The risk matrices initially developed assumed all input factors contribute equally to the overall environmental impact and health risk. Upon revision, a weighting factor was applied to some input factors to reflect their significance.

Framework application to community sub-areas

Although the framework is applicable to a whole community, experience suggests it would be beneficial if the framework is applied to each sub-area of the community with apparently different characteristics.

Cumulative/add-on effects of settlements

The application of the framework confirms greater risks with increased community size and density. It is possible that as the community expands, the receiving environment sensitivity may be higher (due to closer proximity to receiving water, and receiving water use), thus demanding a better on-site system to achieve similar on-site risk rating.

Importance of receiving environment sensitivity

When assessing health risk posed by any on-site wastewater treatment and disposal activities, or formulating policies regarding on-site wastewater systems, it would be appropriate to work backwards, i.e., from the receiving environment back to the treatment system requirement.

If no water is going to be used (for domestic, production and recreational purpose) from the receiving environment, and/or the receiving environment has a low ecological value or high assimilative capacity, it may be disputable whether a higher treatment quality is necessary for the on-site wastewater system.

But if water is going to be used extensively from the receiving environment, a better treatment and disposal technology may be specified for on-site wastewater systems.

Vetoing factors

Soil condition and groundwater information may be used as vetoing factors, i.e., where these factors are confirmed unfavourable, on-site wastewater disposal should be avoided. This could be used to assist in prioritising ‘worst case’ communities.

Data source and verification

When applying the risk framework, the data source should be checked and the data validated with field investigations. This is especially important for soil related factors, such as drainage categories and/or soil texture. Care is needed to ensure the information used is sufficiently

representative to reflect the community as a whole, and not just known problem areas within the community.

Reliability of on-site technology vs risks

While the traditional septic tank and disposal field relies on natural forces (gravity flow, gravity separation, and soil process) for the treatment and disposal/purification of wastewater, modern secondary treatment/disposal systems rely on mechanical means to facilitate wastewater treatment (e.g. aeration) and purification (e.g. pressure dosing and distribution).

The risk increases with some of the modern treatment and disposal system as they rely on the need for adequate design and maintenance to be effective. To achieve the designed system performance, management and maintenance programmes must be followed by the system owner (or their agents).

Application of the framework as a decision making tool

Public health risks in relation to on-site wastewater treatment and disposal systems are complex. To enable a sound assessment, reliable and accurate data is required to provide a quantitative interpretation of individual community needs. It is recommended that the application of the current risk assessment framework should be limited to assess the relative impact potential and health risk among communities or areas of communities.

The matrix could be used to provide a series of 'bands', each with specific on-site requirements, which in turn could be used to provide regulatory direction. For example, a revised Regional Plan might identify communities (or areas) as fitting into one of four groups for on-site wastewater. These groups may include:

Group A - minimal and low-tech treatment systems are suitable – no resource consents required (permitted activity).

Group B - some degree of advance treatment design and maintenance is required (permitted) – otherwise installations need to meet controlled activity status.

Group C - advance treatment design and maintenance is required for on-site sewage systems (controlled) – otherwise any installations would be discretionary activities.

Group D - on-site treatment systems are not suitable in these areas – on-site sewage disposal is a prohibited activity.

It is possible that a matrix output range could be identified for each band and any new system must be evaluated in relation to these ranges. Alternatively, regional maps could be prepared which highlight areas that comply with the various bands, however, when using this approach it may be difficult to take into account housing density and community layout.

CONCLUSIONS AND RECOMMENDATIONS

- The risk framework, as developed, shows potential to be used as a tool for policy development addressing on-site wastewater treatment and disposal issues.
- There is a large variation in soil properties within and between communities. Undertaking a more extensive investigation of soil conditions at the various communities could

produce a hazard map that identifies limitations to drainage, or excessive drainage, in various areas. This could highlight 'risk' areas and allow the avoidance of these areas, or the need for specific design requirements within designated areas.

- There are several ways the risk assessment framework could be incorporated into regional policy. One option is to create bands of preferred practice, of which there may be different consent processing requirements for systems in each band.
- If bands were to be used, then consideration would need to be given to what is an acceptable range and more accurately defining the input variables. It is possible that regional maps could also be produced which indicate band areas and various requirements for the operation of systems within those areas.

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