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Risk scoping study and compliance assessment for selected permitted activity rules

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June 2011

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Executive Summary

Waikato Regional Council (WRC) has designated many farming activities as ‘permitted’ in its Regional Plan. This approach recognises the desire for land owners to undertake their businesses with the minimum of rules and associated costs. Permitted activities (PA) therefore provide an opportunity for farmers to undertake many of their activities related to water without the need for a consent but they must still comply with the conditions set out under the PA rules.

An inherent difficulty with permitted activity rules is that there is limited ability to address the variability in natural resources and land use activities that occur across a region as large as the Waikato and this can alter the significance of any non-compliance for a receiving environment. The implementation of these PA rules requires both assessing the compliance of current activities including relative risk to a specific site and looking for indicators of risk of future non-compliance.

The purpose of this report is to provide information for two key outcomes:

1. Identification of the relative risk for contaminant loss as a result of non-compliance with the rules within the six selected Permitted Activity (PA) rules from the Waikato Regional Plan. These rules are:
   - Farm dairy effluent (WRP 3.5.5.1 – Farm effluent onto land)
   - Stock in water bodies (WRP 4.3.5.4 – Livestock on beds and banks of rivers and lakes)
   - Culverts (WRP 4.2.9.1 – Catchments <5ha, 4.2.9.2 – Catchments <100ha)
   - Soil disturbance and vegetation clearance of (WRP 5.1.4.11 – Soil disturbance, roading, tracking and vegetation clearance)
   - Dams and Damming water (WRP 3.6.4.4 – Small dams and damming water, 3.6.4.5 – Existing lawfully established damming on perennial water bodies)
   - Dumps and offal holes (WRP 5.2.6.1 - Dumps on production land, 5.2.6.2 – Offal holes)

2. Provision of guideline notes and the identification of important assessment factors to assist the enforcement and field staff in determining if any activities relating to the above PA rules and the associated discharges that represent non-compliance with the rule or pose an unacceptable risk to the environment.

The main sections of the report provides for the six PA areas an overview of contaminant losses, a risk assessment and guidelines for field evaluation.

<u>Contaminant Losses</u>

This report focus is primarily on the potential impact of contaminants (N, P, microbial pathogens, sediment) loss on water quality. Water monitoring at 113 sites in the Waikato Region between 1987 and 2007 has shown that amounts of N, P, *E. coli* have generally increased, with the largest increases occurring in intensively farmed catchments. The contribution of contaminants by the activities managed by these PA rules is reviewed and summary tables of key contaminants and sources for each rule are provided. The following are some key points on contaminant loss from the PA areas.

Dairy farm effluent discharge onto land: In the Waikato 80% of these farms apply this effluent to land under the permitted activity rule. Farm dairy effluent (FDE) only represents about 10% of the total daily effluent load excreted from dairy cows. A review of New Zealand data on land applying FDE showed that between two and 20% of both N and P applied was either lost in run-off or via leaching. Poor management of the farm dairy effluent and non-compliance with permitted activity rule can result in deleterious effects on water quality by high concentrations of contaminants (primarily N, pathogens, and P) from direct discharges to surface water or rapid subsurface drainage of applied effluent. It appears that under most conditions, the highest proportion of N leachate is sourced from cow urine patches rather than from FDE or fertiliser.

Stock in Waterways: There are three key problems with livestock access to riparian areas (comprising the waterway and associated riparian zone): direct deposition of dung and urine into water; surface runoff of dung from the riparian zone and degradation of the stream banks and riparian zone by stock trampling and grazing.

The extent of impact is highly dependent on stock type, stock density, frequency of access to waterway and size and sensitivity of the receiving waterway. The interrelationships between livestock access and adverse effects on water quality, riparian damage and aquatic habitat are complex. These effects can be short or long term and widespread or localised. Excluding stock from riparian areas will reduce stream bank erosion and input of contaminants.

Soil Disturbance and vegetation clearance: Soil disturbance, mass vegetation clearance and slips can induce short-lived but major changes to farm sediment yield. Farming activities with a high risk of sediment export include: creation of races/tracks, construction of culverts, harvesting and preparation of production woodlots, re-contouring, the drain maintenance and scrub clearance. The potential impact of and soil disturbance and vegetation clearance is difficult to quantify. Most soil disturbance and vegetation clearance activities tend to occur when farms are intensifying, such as from sheep and beef to intensive beef or dairy farming.

Dams and Damming: Well-designed dams can potentially improve the quality of stream water quality by accumulating sediment, controlling flood flow and removing N and P. The dam and damming PA rules are only considering small dams on the ephemeral waterways or existing legal dams. The biggest risk of contaminant loss from these dams is likely to be as a result of dam failure caused by overtopping or structural failure.

Culverts: Poorly designed culverts can increase sediment discharges by scouring of the stream bed and bank erosion caused by changes to channel morphology. They can also restrict fish and invertebrate passage. The scouring and bank erosion that can occur downstream of culverts can increase sediment, suspended solids and P loadings to waterways. There is no research to quantify this contribution relative to other on-farm losses. Culverts are however likely to have a net benefit for contaminant loss as they generally replace a stock crossing point and therefore mitigate the losses which can occur through livestock access to streams beds.

Dumps and Offal Holes: Farm dumps and offal holes can act as point source discharges of contaminants. The most significant issue with farm dumps and offal holes are the introduction of hazardous substances or contaminated material such as sewage, agrochemicals, solvents, detergent, or oil (or their empty containers).

Risk assessment of PA areas

In this section environmental risks from non-compliance are identified and prioritised. For each PA rule the consequences for contaminant loss from these risks and the factors that can influence the number and scale of these consequences are outlined in tables.

A risk matrix is a tool that can be used to evaluate the relative risk of environmental harm from a range of activities. The risk matrix combines the relative assessments of consequences and likelihood of actions/events into a matrix. A risk matrix is applied to the six PA rules to evaluate their relative risk. This identifies the activities that can have high consequence and high occurrence. It also provides an indication of potential variability.

This assessment shows that farm dairy effluent possess the highest potential risk followed by stock in water ways and then soils disturbance. Each of these do have high potential variability depending on site specific factors.

Field evaluation of PA rules

In this section guidelines are provided in tables for field evaluation. These follow an assessment framework that considers three aspects of evaluation:

1. Current compliance assessment: This focuses on what are the key compliance criteria to pay attention to when assessing permitted activity rules. The criteria are chosen as they could be strongly indicative of an unacceptable compliance outcome. The criteria are only aiming to identify high and medium priority non-compliance.
2. Evaluation of the risks for future compliance: This step of the field assessment process is about looking into the probability of any risks and identifying ways to minimise their occurrence and possible significance of any impact should they occur
3. Encouraging the adoption of best management practices: It is helpful for monitoring and compliance staff to understand and identify opportunities for practice improvements. This could help to reduce the future risk for contaminant losses, but also assist farmers to improve their systems.

1 Background

1.1 Purpose of Report

The purpose of this report is to provide information for two key outcomes:

1. Identification of the relative risk for contaminant loss as a result of non-compliance with the rules within the six selected Permitted Activity (PA) rules from the Waikato Regional Plan[1]. These rules are:
   - Farm dairy effluent (WRP 3.5.5.1 – Farm effluent onto land)
   - Stock in water bodies (WRP 4.3.5.4 – Livestock on beds and banks of rivers and lakes)
   - Culverts (WRP 4.2.9.1 – Catchments <5ha, 4.2.9.2 – Catchments <100ha)
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2. Provision of guideline notes and the identification of important assessment factors to assist the enforcement and field staff in determining if any activities relating to the above PA rules and the associated discharges that represents non-compliance with the rule or an unacceptable risk to the environment.

To enable these outcomes to be achieved context and framework is also provided on:

- The role of PA's in management of agricultural impacts
- Regional variability relating to PA's
- Assessment and management of risk
- Overview and literature review of information relating to contaminant loss from agricultural land and specific reviews relating to each rule

This report aims to provides background and a structured framework to give council officers information and tools to consistently undertake assessment of these permitted activity.

1.2 Role of Permitted Activities in Management of Agricultural Impacts

It is important to note the basic premises under the RMA that relate to land and water management as these differ. Any activities relating to discharge to water are prohibited unless expressly allowed by a rule in a regional plan. Permitted activities provide an opportunity for farmers to undertake many of their activities related to water without the need for a consent however, they must still comply with the conditions set out within the PA rules. Alternatively discharges from land operate on the opposite premise in that all activities are allowed unless stated otherwise in a plan. Any land issues of concern need to be managed through rules within the regional plan.

Waikato Regional Council (WRC) has designated many farming activities as 'permitted' in its Regional Plan. This approach recognises the desire to land owners to undertake their businesses with the minimum of rules and associated costs. It also recognises that the

[1] See Appendix for details of these PA rules

activity given PA status is seen as only having a minor impact of the general conditions of the rule are met, based on current environmental knowledge at the time.

1.3 Variability in Regional Resources and Activities

An inherent difficulty with permitted activity rules is that there is limited ability to address the variability in natural resources and land use activities that occur across a region as large as the Waikato. The current PA rules tend to be a 'one size fits all' (i.e. maximum loading rate for effluent is 25 mm across the region regardless of soil type).

The Waikato Region has a wide variety of geology and topographic types which can influence the specific suitability and implementation of the permitted activity rules. These differences can vary from elevated, free draining, erodable pumice country with incised streams, to low lying peat and silt soils with high water tables which require extensive artificial drainage.

There are also substantial differences across the pastoral landscape with respect to the intensity of land-use ranging from a high stocking dairy farmers to low producing dry stock hill country. This can mean one activity can have a minimal risk in one area but pose a high risk within areas of intensified land-use.

The Waikato also has areas of high biodiversity significance. Some of these areas can be more susceptible to adverse effects from contamination. Some of this significance is taken into account through rules such as stock exclusion from water bodies, but there are still other areas of aquatic habitat and biodiversity which could be considered when evaluating effects. Giving due consideration of this through a permitted activity rule which has little discretion is difficult.

In summary the assessment of compliance for PA rules is not always straightforward and determining the significance of non-compliance from potential contaminant loss can be dependent on a number of factors which can vary across the region.

1.4 Assessment and Management of Risk - Overview

One of the aims of this report is to provide direction to field staff when implementing PA rules. This implementation requires both assessing the compliance of current activities and looking for indicators of risk of future non-compliance. This report also investigates the potential loss of contaminants from these PA activities and discusses the relative risk of non-compliance on the environment. For context, this section provides an overview of the concepts and principles of risk assessment and management.

Risk assessment and management is a central part of environmental policy development and implementation (Pyle and Gough 1991; EPA 2004; EPA 2007). Although it is overtly being used for managing risk for issues such as public health (ANZECC 2000; MfE 2003), contaminated sites and flood protection, it is also used at the core of developing policy. In policy development and implementation risk assessment and management is used to decide and justify whether an activity is permitted, controlled or discretionary for example in regional planning and in providing guidance on rule implementation and compliance (i.e. determining whether a level of activity is a significant enough risk to justify enforcement).

> The Australia/New Zealand Standard (AS/NZS 2004) defines ‘risk management’ as:
>
> ‘the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, evaluating, treating and monitoring risk’
>
> and ‘risk assessment’ as :
>
> ‘the process used to determine risk management priorities by evaluating and comparing the level of risk against predetermined standards, target risk levels or other criteria.’

For the purposes of this report, the focus will primarily be on risk assessment. Risk assessment is a systematic assessment of the potential adverse effects of contaminants on plants, animals, or ecosystem integrity. Risk assessment lies at the heart of risk management because it assists in providing the information required to respond to a potential risk. Risk assessment essentially asks the question:

‘How likely is it that damage will be or has been done by contaminants?’

1.4.1 The Nature of Risk

While we can assess and estimate risk at a certain point in time we cannot measure it now because of the uncertainty associated with both the probabilities of an occurrence and the potential outcomes. Risk cannot be measured until after events have happened. These uncertainties force the decision maker to deal with many aspects of risk assessment using subjective rather than objective methods (Pyle and Gough 1991).

Risk (encompassing environmental risk) has three basic elements:

- an action which leads to,
- events that have a probability of occurrence,
- these events are associated with outcomes, which are often expressed in terms like 'magnitude', 'consequence', 'severity' or 'significance'.

Risk is about understanding the probability of an outcome and the magnitude of the outcome. Similar outcomes with similar probabilities may have different magnitudes depending on environmental factors. Outcomes cannot be predicted in the face of uncertainty, so value judgements need to be made about outcomes in uncertain situations. When uncertainty is present there can be no 'objectivity' when assessing risk (Pyle and Gough 1991).

1.4.2 Assessment of Risk

Most situations involving risk require the decision maker to make value judgements about the particular situation. Situations involving risk are often unique in terms of their physical, social and technical factors and there are often site-specific uncertainties. There are some general principles for environmental risk assessment that can be followed.

Environmental risk analysis is often less certain than risk analysis used in some other disciplines. There are a number of reasons for this:

- The complexity of environmental systems means they are often not well understood so the consequences of a pollutant can be difficult to determine.
- Environmental systems are often highly variable. Expert opinion is likely to consist of a range of possible outcomes. Even if measurements of consequence and likelihood are made, the statistical certainty of these will often be low.
- There is often a lack of reliable data about consequences of a pollutant in the environment under consideration. While we can extrapolate from studies of similar systems, no two receiving environments will be the same. This may lead to unexpected outcomes.
- Understanding and managing cumulative effects of particularly diffuse activities is difficult.
- The long time scale that environmental impacts occur over can make prediction of future states very difficult. Some actions may not impact upon the environment until sometime in the future. (EPA 2007)

There are three main parts to the risk assessment process (Figure 1). These interact to some extent and tend to overlap. They are:

1. Risk Identification - identifying actions and outcomes/events,
2. Risk Estimation - estimating probabilities and magnitudes,
3. Risk Evaluation – determining the level of acceptability for risk and making decisions accordingly.

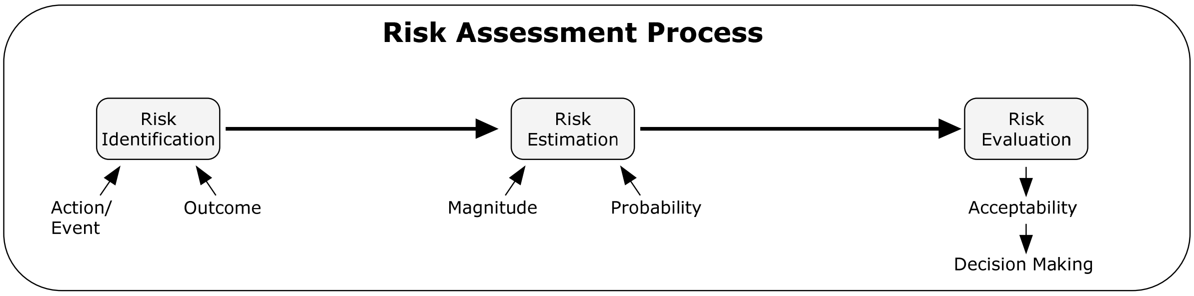


Figure 1: Steps in the risk assessment process

Risk analysis provides a structured and systematic process that makes the best use of available information for making decisions about environmental issues. Determining an acceptable environmental risk is concerned with safety of ecological and social values. Currently, the setting of an acceptable risk is seen as a process that involves members of the community and agencies affected by a decision, both indirectly and directly, such as occur in regional plan development when rules and conditions are defined. Another layer of detail on what is acceptable is defined through development of environmental case law.

1.4.3 Risk Matrix

A risk matrix is a tool that can be used to evaluate the relative risk of environmental harm from a range of activities. The risk matrix combines the relative assessments of consequences and likelihood of actions/events into a matrix. The South Australian EPA (EPA 2007) has used this tool in the assessment and management of risk. This concept of a risk matrix is suitable for use in any situations where WRC wishes to assess the relative levels of risk of environmental harm that could occur from different PA's and thereby identify priority risk areas and the key drivers for this risk.

The New Zealand Fertiliser Code of Practice (Fert-Research 2007) also applies this concept for assessing environmental risk. In this case likelihood and consequences are defined in broad qualitative groupings of low, medium and high (Figure 2). Any environmental risk with a combination of high or medium likelihood and high or medium consequences must be addressed in the Nutrient Management Plan with best management practices chosen to minimise the risk.

		Environmental Consequence *		
		Low	*Medium*	*High*
Likelihood *	*Low*	Low significance	Low significance	Medium significance
	Medium	Low significance	Medium significance	High significance
	High	Medium significance	High significance	High significance

*** Likelihood**

- If there is little chance of the effect happening (i.e. it is possible but not aware of it happening on this property) then the likelihood is **low**.
- If there is some chance of the effect happening (i.e. it has happened in the past, but not often), then the likelihood is **medium**.
- If there is a strong chance that the effect will happen (i.e. it happens regularly), then the likelihood is **high**.

*** Environmental Consequences**

- If the effect is unlikely to cause real environmental damage, has minimal potential to affect other properties and/or would be easy to reverse, then you can call the consequence **low**.
- If the effect has some potential to cause damage or harm, is reversible but could cause adverse effects in the surrounding environment (i.e. could affect neighbouring or downstream properties), then the consequence is **medium**.
- If the effect has the potential to cause significant environmental damage or harm, both in the immediate area and surrounding environment, is difficult to reverse and likely to concern the community, then you must consider the consequence **high.**

Figure 2: Fert Research – Code of Practice risk matrix.

The likely consequence level of an impact may be known from past experience when the event has occurred before, or from similar events. Often it may be necessary to estimate the consequence from knowledge of the system. Research of similar cases may provide useful information.

Likelihood is the chance of a consequence occurring in this case an environmental impact. In the risk matrix likelihood is expressed as the time period an event is predicted to occur in, such as once a month or once a year. Consequence should be estimated first, then likelihood.

2 Contaminant Loss from Productive Land Use - Overview

2.1 Important Water Quality Impacts

For the purpose of this report focus is primarily on the potential impact of contaminants (N, P, microbial pathogens, sediment) loss on water quality. These impacts are seen as significant because they affect both the health of the aquatic ecosystem and uses (productive and recreational) of waterways. Additional comments will also be made about other environment impacts that can result from non-compliance with these permitted activity rules.

Water quality problems can occur when soluble N and P occur in concentrations that promote plant and periphyton growth rather than limit it (EW 2008). The relative impact of N or P will depend on whether the waterway is P limiting (generally the case) or N limiting (as is the case in the Taupo and upper Waikato river catchments), size of the water body and whether it is macrophte or periphyton dominated (McDowell, Larned et al. 2008). Excess growth of macrophytes and algae choke waterways, altering flow regimes and reducing water clarity (EW 2008). Some lakes and rivers are prone to large blooms of toxic algae which prevents them from being used recreationally and for stock drinking water during warmer months (EW 2008; BOPDHB 2009). Algal blooms have been known to kill stock, dogs and fish (EW 2008; McDowell, Larned et al. 2008; BOPDHB 2009). The flow of nutrient enriched waters into the sea is also a problem as similar issues with plant and algal growth are also experienced in estuaries receiving high inputs from streams (EW 2008).

The cumulative effect of non-point source discharges of contaminants is a particular challenge to land management. The site or farm specific contaminant losses can on their own be a minor effect but when these are accumulated across a catchment they can result in significant impacts on water quality and ecosystem health. Also the passage of N losses in groundwater can create significant lags between outputs from land use activities and seeing the impact on surface water bodies, particularly lakes.

Excess aquatic plant growth can be detrimental to water quality when the vegetation dies as it is broken down by bacteria which consume and deplete oxygen in the water (EW 2008). Prolonged periods of low dissolved oxygen (DO) can result in a reduction of aquatic biodiversity as tolerances of some fish such as smelt and trout to low DO are minimal (NIWA 2011; Dean and Richardson 1999). Tolerances of aquatic invertebrates to low dissolved oxygen are not well known (Howard-Williams 1991).

Water borne pathogens which can be lost from agricultural activities can have the potential to affect large numbers of people thereby pose health and economic risk. New Zealand has a very high rate of gut infections caused by cryptosporidium and giardia with the rate of cryptosporidium infection in rural areas being 3 times higher than in urban areas (UOW 2009). The Ministry of Health and Ministry for the Environment have developed standards for recreational and drinking water (MFE 2003). Drinking water is required to be *E. coli* free (Donnison, Ross et al. 2004) and waterbodies must be closed to the public when the level of *E. coli* in any one sample reaches 550 cfu/100 mL (MFE 2003).

The management and safe disposal of hazardous chemicals is a specific concern for farm dumps and offal holes as inappropriate use of these areas can have the potential for significant water pollution from leaching and runoff from these areas to surface and groundwater.

2.2 Contaminant Loss from Agricultural Land Use – Overview

This section provides a general overview of contaminant losses from different agricultural systems. This provides the context for Section 3 which looks at contaminant losses as they relate to specific activities under PA rules.

Water monitoring at 113 sites in the Waikato Region between 1987 and 2007 has shown that amounts of N, P, *E. coli* have generally increased, with the largest increases occurring in intensively farmed catchments which are dominated by dairy farming (Vant 2008).

Contaminant loss from forested areas is generally less than from pasture areas (McDowell and Wilcock 2008) while contaminant loss from production forest is higher than losses from native forest (Quinn and Stroud 2002). A comparison of sheep and beef grazing, native forest and young pine forest found that export of suspended solids, N and P from a pasture stream was much higher than from than a stream draining native forest (Quinn and Stroud 2002). Relative losses can be very variable depending on farming and forestry practices, rainfall patterns, soil hydrology and topography. Water quality results from 14 predominantly dairy catchments illustrate the extent that contaminant loss can vary for the same land use at different sites (Table 1.) (MFE 2009).

Table 1: Range of median concentration of selected contaminants from 14 monitored dairy catchments around New Zealand (MFE 2009).

Contaminant	Range
Total nitrogen (N)	0.71-9.6 mg/l
Total phosphorus (P)	0.019-0.281 mg/l
Suspended solids (SS)	1.5-20.5 mg/l
E. coli	7-1,250 cfu/100 ml

Table 2 shows water monitoring results for five ‘Tier 1’ dairy farm catchments. These catchments are part of the ‘Best Practice Dairy Catchments Project’ in which a number of dairying catchments were chosen for long-term monitoring (MFE 2009). Tier 1 catchments were chosen as being generally representative of pertinent water-quality management issues in each Region (MFE 2009). In all cases median values for N and P exceeded recommended levels. This is particularly concerning given that the maximum recorded values were well in excess of median values. In all cases *E. coli* concentrations exceeded the ‘Alert’ guideline level (increase from monthly to daily sampling) and in the Toenepi catchment the maximum recorded level exceeded the ‘Action’ guideline level (stop recreational activity) by 8263% (although it should be noted that E. coli is naturally present in waterways with varying levels of 'background' contamination) (MFE 2003; Donnison, Ross et al. 2004).

Table 2: Median values for nutrients and E. coli in streams and rivers of five 'Tier 1' dairy catchments 2001-2006 (adapted from MFE 2009).

	Toenepi Waikato	**Waiokura Taranaki**	**Waikakahi Canterbury**	**Bog Burn Southland**	**Inchbonnie West Coast**	**Guidelines/Reference Values**
Total N (mg/L)	1.76	3.29	2.30	1.10	0.71	0.614 mg/L[a]
Nitrate (mg/L)	1.19	2.82	1.76	0.755	0.284	0.444 mg/L[a] 0.081 mg/L[b]
Soluble N (mg/L)	2.212	2.846	1.782	0.775	0.388	< 0.295 mg/L[c]
Total P (mg/L)	0.174	0.111	0.120	0.05	0.102	0.033 mg/L[a]
Dissolved P (mg/L)	0.089	0.032	0.075	0.023	0.059	0.01 mg/L[a] < 0.026 mg/L[c] 0.008 mg/L[b]
E. Coli (per 100ml)	367	1,250	290	530	640	260 E. coli per 100 mL (Alert) 550 E. coli per 100 mL (Action)[d] 50-200 E. Coli per 100 mL[b]
Dissolved Oxygen (% saturation)	80.7	96.5	87.4	92.5	90.6	> 80% or >6mg L^{-1} (NIWA 2011)

[a] *ANZECC trigger value for ecosystem protection in lowland rivers*
[b] *Reference value based on median for predominantly natural catchment sites across New Zealand; 1996–2002*
[c] *NZ Periphyton Guideline (Biggs, 2000)*
[d] *Microbiological Guidelines for Recreational Water Quality (MFE & MOH, 2003)*

The presence of nitrates in groundwater is becoming a problem in dairy catchments as high nitrate levels in drinking water poses a risk to human health, particularly to babies and young children (Houlbrooke, Horne et al. 2004). Water quality monitoring in the Waikato found that yields of N from large catchments correlates strongly (r=0.83) with average stocking rate of dairy cows in the catchment (Vant 1999). The highest proportion of total N contamination occurs through subsurface drainage whereas P contamination occurs primarily via surface runoff of sediment and P fertiliser (indirect pathways) or direct deposition of dung in waterways (direct pathway) (Houlbrooke, Horne et al. 2004; Monaghan 2008).

Estimated 'average' losses from Waikato dairy farms are three times higher for N and 40% higher for P than those estimated for sheep and beef farms (Table 3). It also appears possible that both dairying and sheep and beef could significantly reduce their contaminant losses through different practices.

Table 3: Estimated 'average losses from Waikato farms (Ledgard and Power 2006)

	Dairy		Sheep and Beef	
	N (kg/ha/yr)	P (kg/ha/yr)	N (kg/ha/yr)	P (kg/ha/yr)
Average	36	0.5	13	0.3
Best practices	33	0.3	12	0.3
Potential practices	20	0.2	8	0.3

Laneways and tracks can be a significant source of contaminants. A study looking at dissolved reactive phosphorus (DRP) found that laneway concentrations in winter samples averaged 420mg DRP/m^2 compared with 0.4 mg DRP/m^2 from pastoral run-off (Lucci, McDowell et al. 2010). Also in laneways DRP concentrations in run-off were strongly correlated with run-off volumes meaning that more run-off would carry greater concentrations of DRP.

E. coli loadings to water will depend greatly on whether stock have access to riparian areas and whether they are likely to access the waterway itself. Sheep generally avoid water, deer only utilise streams for wallowing for a short period every year, and cattle are attracted to water (Bagshaw 2002; Wilcock 2006; Collins, Mcleod et al. 2007). When wallows are in use, E. coli loading to water can be as high as 100,000 cfu/100 ml (McDowell 2007). Dairy cows are more likely to defecate when crossing a stream and walking on a lane (Davies-Colley, Nagels et al. 2004). When cattle have free access to streams a small percentage of faecal matter, typically 1 to 2%, is deposited directly into water (Bagshaw 2002; Wilcock 2006). In an unfenced paddock annual *E. coli* loading to water is likely to be greatest for dairy, followed by mixed, deer and lastly sheep. Stream E.coli concentrations were halved following the installation of bridges crossing of dairy herds across the Sherry River near Motueka (Young, Davies-Colley et al. 2008). Overseas studies have shown stock exclusion at a catchment scale can reduce microbial concentrations in streams by one- to two-thirds (Meals 2001; Line 2003)

These different stock effects should be considered when assessing the relative risk of contaminant sources in catchments of mixed stock types as an accurate risk assessment will result in targeted and effective mitigation measures (Wilcock 2006; McDowell and Wilcock 2008). For example, if a stream in a catchment with deer and sheep present is choked with algae and limited by inputs of P, mitigation could focus on deer rather than sheep (McDowell and Wilcock 2008).

Other areas where faeces can build up, such as laneways and stand-off areas contribute contamination when run-off and subsurface drainage carries microbes to waterways (Ritchie and Donnison 2010).

Sediment losses from land are influenced by both natural processes and land use effects. Geology, rainfall and topography are the main controls on sediment export in New Zealand (Quinn and Stroud 2002). Storm-induced slips and stream bank erosion are the main source of sediment export in hill country with natural stream bank erosion also being a significant contributor in lowland areas (Williamson, Smith et al. 1992; Quinn and Stroud 2002; McKergow, Pritchard et al. 2010). Research at Whatawhata Research Centre (sheep and beef) found that a major slip at the study site contributed the equivalent of 42 times the sediment export of pasture and 129 times that of native forest (Quinn and Stroud 2002). Sediment export from pasture was 3 times greater than that from native forest at Whatawhata with a similar study in Hawkes Bay finding that pasture exported 2.4 times more sediment than production forest (Quinn and Stroud 2002). Slip material from pine forest and pasture were found to make up a large proportion of soil export to the Wharekawa Estuary, with erosion from logging operations also a problem during storm events (Gibbs and Bremner 2008).

Topography and stock type are very influential in determining the relative impact of different farming practices. Sediment export from hill country pasture is significantly higher than export from lowland pasture with a higher stocking rate (Quinn and Stroud 2002) and deer farms export more sediment than dairy farms due to higher rates of paddock wear and wallows located in or near streams (McDowell 2007; McDowell 2009). It is not known exactly how much sediment export occurs as a result of livestock damage to stream banks but studies have shown that waterways where stock are excluded have lower rates of suspended solids than those with stock access (Quinn, Williamson et al. 1992; Line, Harman et al. 2000; Davies-Colley and Parkyn 2004; Parkyn 2004; McDowell 2007; Monaghan 2008; Wilcock, Betteridge et al. 2009; Storey 2010).

Research has found that wet or poorly drained areas of catchments can yield most of the run-off in small-medium events (McColl, McQueen et al. 1985; Smith 1987). It was found that half the catchment generated 95% of the run-off. These are critical source areas generate high levels of sediment and other contaminants, and should be the focus the management. McDowell and Wilcock (2008) analysed catchment contaminant loads from 38 studies (1975-2007) to determine if there were differences in loads between land under a range of pastoral uses and non-agricultural use. Their results on N, P and sediment and results from Wilcock (2006) are summarised in Table 4.

Table 4: Relative losses of contaminant from different land use.

Contaminant	**Relative Land Use Losses**
Median loads of nitrogen	Dairy > deer = mixed (sheep & beef) > sheep > non-agricultural
Median loads of phosphorus	Deer = mixed > dairy > sheep > non-agricultural
Median loads of sediment	Deer > sheep > mixed > dairy > non-agricultural
Annual loadings to land of *E. coli*	Sheep > Dairy > deer > beef cattle

3 Contaminant Loss From Permitted Activity Areas

3.1 Dairy Effluent Discharge onto Land

Overview of contaminant losses

The Waikato region has 4110 Dairy farms with an average herd size of 340(DairyNZ 2010). All of these farms are required to catch and treat their farm dairy effluent (FDE). Currently in the Waikato 80% of these farms apply this effluent to land under the permitted activity rule.

FDE has received a lot of attention across the country with respect to non-compliance to regional rules. FDE only represents about 10% of the total daily effluent load excreted from dairy cows (Cameron and Trenouth 1999). A review of New Zealand data on land applying FDE showed that between two and 20% of both N and P applied was either lost in run-off or via leaching (Houlbrooke, Horne et al. 2004). However, poor management of the farm dairy effluent and non-compliance with permitted activity rule can result in deleterious effects on water quality of high concentrations of contaminants from direct discharges to surface water or rapid subsurface drainage of applied effluent (Houlbrooke, Monaghan et al. 2010). The primary contaminant of concern is microbial as they can impact quickly on water quality. Following this the discharge of high loads of nutrients to water bodies is of concern.

It appears that under most conditions, the highest proportion of N leachate is sourced from cow urine patches rather than from FDE or fertiliser (Di and Cameron 2007; Monaghan 2008). However, the relative contribution of different sources is highly dependent on farming practices, soil type, artificial drainage and water loading (Monaghan, Hedley et al. 2007). P sources are subject to more spatial variation than N and are more heavily influenced by farm management practices (McDowell 2008). Studies have shown that P mobilised from dung is an order of magnitude greater than P mobilised from soil but that this differs once dung has dried (McDowell, Nash et al. 2009). Direct deposition and drainage of raw FDE are therefore potentially large sources of P, with studies showing that dung is the source of 20-30% of farm P loss (McDowell 2008; McDowell, Larned et al. 2008; McDowell, Nash et al. 2009). The contribution of overland flow sources has been difficult to ascertain due to the difficulty of accurately sampling flow under field conditions (McDowell 2008).

Microbial contamination occurs via direct deposition of microbes to water from stock in water and also indirectly via subsurface leaching of FDE and surface runoff of grazing effluent (Collins, Mcleod et al. 2007). While FDE does not constitute a large proportion of the microbial loading to land compared with activities such as wintering pads and normal stock grazing (Wilcock 2006), it is difficult to estimate it's relative importance in water contamination because of differences in rates of die-off and filtering by surface and subsurface components for each source (Wilcock 2006; Collins, Mcleod et al. 2007). Documented contamination of waterways has occurred due to rapid drainage of FDE via surface run-off ($3x10^4$ cfu/100ml), mole-pipe drainage ($4x10^3$ cfu/100ml), boarder dyke wash ($4x10^4$ cfu/100ml) and direct deposition to waterways (10^{10} cfu/per day for a 175 cow herd) (Collins, Mcleod et al. 2007; Monaghan, de Klein et al. 2008). In the Bog Burn catchment, Southland, direct drainage of irrigated FDE through mole-pipe drainage is estimated to provide approximately 78% of the annual *E. coli* load from soil to water (Monaghan, de Klein et al. 2008).

On-land treatment of FDE is preferred by Regional Councils because soil filtration is considered to be more effective than traditional two-pond treatment systems (Houlbrooke, Horne et al. 2004). This is certainly true under ideal conditions, with up to 98% of nutrients being retained by the soil (Ritchie 2007). When soil conditions and irrigation practices are poor, surface and subsurface drainage of N, P and microbes into waterways typically occurs (Monaghan and Smith 2004). It is estimated that between 2-20% of nutrients are transported to waterways when drainage occurs (Houlbrooke, Horne et al. 2004). The volume of surface runoff and leachate depends on a combination of: subsurface drainage characteristics, soil moisture deficit, application loading and depth and irrigation method (Monaghan and Smith 2004; Collins, Mcleod et al. 2007; Monaghan, Hedley et al. 2007).

Good soil for FDE application contains micro-pores that allow nutrients and microbes to come into contact with soil particles, but not so free draining that moisture is not held (DairyNZ 2007). The depth of the loam layer is important as this is where filtration occurs. The influence of soil type can be illustrated by comparing the results of an N leaching trial on pumice tephra at Reporoa between 1998 and 2002 and a 1997 trial on Horotiu silt loam at Ruakura (Burgess 2003; Houlbrooke, Horne et al. 2004). The minimum N loss from FDE treated areas on pumice soil was 75 kg ha^{-1} (loam layer of 15cm and FDE N loading of between 269 and 506 kg ha^{-1}) whereas only 2.1 kg ha^{-1} of N was lost from silt loam soil (FDE N loading of 375 kg ha^{-1}). The Reporoa loss was well above, and the Ruakura loss well below, the average dairy farm N loss of 30 to 45 kg ha^{-1} (Burgess 2003). Applying excess FDE to heavy soil will result in surface runoff or preferential flow through large pores, cracks and wormholes (Houlbrooke, Horne et al. 2004; Collins, Mcleod et al. 2007). Application of excessive amounts of FDE to very light soils will result in rapid drainage from the active root zone where the greatest opportunity exists for adsorption by soil and plants (Houlbrooke, Horne et al. 2004). Collins (2007) states that around 50% of North Island soils have high potential for bypass flow with large areas of the Waikato falling into this category.

Soil moisture condition prior to FDE application is also a very important factor in determining whether preferential and surface flow will occur as soils with low capacity (<50%) to hold water or very dry cracked soil will encourage bypass flow (Collins, Mcleod et al. 2007; DairyNZ 2007).

Many Waikato dairy farms will have an increased risk in the form of artificial mole and tile drains. Mole drains are subsurface fissures and pipes which facilitate the drainage of water from paddocks to a main tile drain which typically discharges into canals or streams (Monaghan and Smith 2004). Once FDE reaches mole fissures (c. 45mm in depth) it quickly moves into collection channels with no opportunity for adsorption or uptake (Monaghan and Smith 2004). Furthermore, large macro-pores are often created above the mole-pipe fissures to facilitate water bypass thereby exacerbating the problem (Houlbrooke, Horne et al. 2004). Monaghan and Smith (2004) found that the risk of direct drainage through a mole-pipe system is greatest when FDE application depth exceeds the soil deficit depth. They also found that the twin-gun travelling irrigators used in their study applied FDE at double the average application depth close to the edge of the irrigator run. Although drainage volumes were relatively small (between 1.4 and 17.2% of FDE applied) the concentration of N, P and

E. coli in the drainage water approached that of the applied FDE (Monaghan and Smith 2004).

Reducing the contaminant losses from FDE application requires that practices ensure that effluent is only applied to well-drained soils and applications are scheduled to avoid saturated or near saturated conditions (Houlbrooke, Monaghan et al. 2010). As typically FDE only represents about 10% of the daily nutrient output in dairy cattle excreta, effective mitigation techniques for N loss on these well drained soils should target the cumulative effects of urine patches deposited during animal grazing.

The management of odour and aerosols from land application of FDE is a really the only other environmental impact associated with this permitted activity.

Summary Table – Contaminant losses from Farm Dairy Effluent:

Contaminant	Main Sources
N, P, Microbial	- Direct runoff of stored and irrigated effluent to surface water - Leaching from surface ponding of irrigated effluent and overflow from storage - Preferential flow through large pores and cracks from overloaded or saturated soil to subsurface drainage or groundwater
N	- Overloading soils with nitrogen – in excess of 150kg/ha/yr

3.2 Livestock in Waterways

Overview of contaminant losses

Livestock use of riparian areas and overland flow of eroded soil are the two key agricultural transport mechanisms of sediment to waterways (Monaghan 2008). Table 5 provides a summary of water quality impacts that result from stock damage to riparian areas and sedimentation of waterways.

Table 5: Effects on water quality as a result of livestock access to riparian areas (Ryan 1991; Quinn, Williamson et al. 1992; Williamson, Smith et al. 1992; Boubée, Dean et al. 1997; Rowe and Dean 1998; Broekhuizen, S. et al. 2001; Richardson, Rowe et al. 2001; Davies-Colley and Parkyn 2004; McKergow and Hudson 2007; McDowell, Larned et al. 2008).

Result	Mechanisms	Impacts
Increased bacterial and nutrient loading	Direct defecation into water or riparian area	Decrease in water quality and habitat health
Increased sediment loading and suspended solids	Stock trampling and grazing of stream banks	Sedimentation downstream causes changes to channel morphology and habitat quality Increased turbidity and reduced water clarity Lower feeding rates or death for filter feeding animals

		Reduced feeding rates of native fish Barrier to migration for native fish species which actively avoid turbidity or are slowed by it e.g. banded kokopu Decreased diversity of fish and invertebrates Possible decrease in photosynthesis and production by macrophytes Increased rate of P release into water column
Degradation of bank soil condition	Increase in bare ground due to vegetation removal Compaction and reduced infiltration	Greater soil erosion, more surface runoff and consequent nutrient and microbe contamination
Reduced channel stability	Erosion and slumping of stream banks particularly in moist areas and for streams <2m wide	Streambed siltation, local channel widening Reduced instream habitat for aquatic species e.g. bank undercuts and vegetation cover
Reduced channel width	Growth of grasses which trap sediment Accumulation of sediment causes narrowing and bed thickening	Reduced benthic habitat and reduced quality of benthic habitat Reduction in invertebrate diversity and density Change in channel morphology influences flow
Degradation of bed sediment texture	Siltation of the streambed by fine particles	Reduced benthic habitat and de-oxygenation of the interstitial layer Reduction in riffle habitat for fish e.g. torrentfish, blue-gilled bully and koaro Reduction of fish spawning habitat Less food available for fish, invertebrates which prey on benthic organisms and algal grazers Increased invertebrate drift or death and consequent reduction in invertebrate diversity and density Reduced exchange of oxygen and elements between bed and surface water
Reduction of riparian vegetation	Grazing of riparian vegetation reduces stream shading	Increase in water temperature, greater variation of diurnal temperature, reduction of wood and overhang for instream habitat, increased algal growth Decreased habitat for invertebrates, reduction of invertebrate diversity
Overall degradation of waterway	Combination of the above	Habitat becomes less suitable for native species and trout but more suitable for pest fish species Aesthetics become poor and waterway less suitable for recreational activity

There are three key problems with livestock access to riparian areas (comprising the waterway and associated riparian zone): direct deposition of dung and urine into water;

surface runoff of dung from the riparian zone and degradation of the stream banks and riparian zone by stock trampling and grazing (Davies-Colley and Parkyn 2004; Monaghan and Smith 2004; Collins, Mcleod et al. 2007). Cattle are particularly damaging to stream banks because of their large hoofs and heavy weight (Davies-Colley and Parkyn 2004). Cattle are particularly attracted to riparian zones because these areas provide water, and sometimes shade, for drinking and cooling (Bagshaw 2002; Davies-Colley and Parkyn 2004). Studies have shown that cattle have a strong tendency to linger in water and will fight to gain access to water at preferred access points (Bagshaw 2002; Davies-Colley, Nagels et al. 2004).

A behavioural study of beef cattle in New Zealand found that individuals spent an average of 4% of a 12 hour day in the riparian zone (defined as the stream plus 2m of bank either side) (Bagshaw 2002). The same study determined that half of faeces excreted in the riparian zone was deposited in the water and half on the stream bank where there is high potential for surface runoff (Bagshaw 2002; Collins, Mcleod et al. 2007). Collins (2007) estimates that around 10^{10} *E. coli* are deposited directly to water by a 175 head herd per day.

A study of the water quality effects of dairy herd crossings of the Sherry River, Motueka, found that the total N yield from a return crossing of 246 cows was 1448 gm (Davies-Colley, Nagels et al. 2004). Ford crossings caused temporary spikes of *E.coli* that were 100x greater than the background level of *E.coli* contamination (Davies-Colley, Nagels et al. 2004). Crossings also resulted in large spikes of suspended sediment. These results indicate that regular herd crossings have a significant impact on water quality, particularly for farms milking twice a day. The authors distinguished three main sources of contamination: 1) direct voiding of dung and urine into the water, 2) wash-off from the hooves and lower legs and 3) bacteria released from the sediment via disturbance (Davies-Colley, Nagels et al. 2004). Sediment disturbance by stock and farm vehicles also has implications for the release of bio-available P from suspended solids (McDowell, Larned et al. 2008). No quantitative research investigating direct deposition of urine to streams appears to have been carried out, but a study of urine activity patterns in the paddock has revealed that urine patches are non-random with higher deposition occurring in areas where stock congregate (Draganova, Betteridge et al. 2010). This has implications for riparian areas; particularly in summer when stock spend more time in the riparian zone.

Stock damage to stream banks is often more noticeable for small stable streams compared with large meandering streams which are prone to natural erosion processes (Williamson, Smith et al. 1992). In the Waikato Region, total stream bank erosion and pugging erosion is most abundant where cattle have access to riparian margins (Storey 2010). Grazing removes stabilising vegetation making banks more prone to erosion and slumping and prevents vegetative shading of streams (Quinn, Williamson et al. 1992; Williamson, Smith et al. 1992). Streams that are fenced on a single bank appear not to be better protected than those with no fencing as cattle cross the stream to get at vegetation on the fenced bank (Williamson, Smith et al. 1992; Storey 2010). Storey (2010) found no significant difference in the amount of stream bank erosion for dairy vs drystock farms in the Waikato. Mobilisation of riparian soils and bank slumping promotes silt transport to streams, increasing ‘siltation’ of the stream bed and loading of suspended solids (Davies-Colley and Parkyn 2004).

Excluding stock from riparian areas will reduce stream bank erosion and input of contaminants. Grass filter strips (3-10m wide) have shown to successfully remove 61-99% of nitrate, 54-73% of P, 64-87% of faecal bacteria and 70 to 87% of sediment from surface and sub-surface flow (Fajardo, Bauder et al. 2001; Parkyn 2004).

Research under taken for Environment Canterbury has indicated a threshold for stocking rate above which the effects are seen to be adverse and unacceptable. This research has proposed a two-step policy on livestock exclusion. Above 8 stock units (SU)/ha livestock access would be a prohibited activity. Below 4 SU/ha livestock access would be a permitted activity. At intermediate stocking densities (4-8 SU/ha), livestock access would be a discretionary activity, with land owners required to demonstrate to the satisfaction of Environment Canterbury that their operation would not impair water quality, degrade habitat or cause physical damage (McKergow and Hudson 2007).

The interrelationships between livestock access and adverse effects on water quality, riparian damage and aquatic habitat are complex. These effects can be short or long term and widespread or localised. In catchments with higher stocking densities and unimpeded access to waterways the cumulative effects of stock impacts can cause an adverse decline in water quality. This damage can be both immediate and longer-term as future events, unrelated to the previous incursion of livestock (e.g., storm events, additional livestock incursions), will remobilise deposits of bacteria, particulate material and nutrients. The impacts from livestock access also increase the potential for future damage as a consequence of the physical damage to riparian vegetation, stream banks and the streambed, creating the potential for compounding impairment of water quality. The contaminants introduced through livestock access may be transported from reaches of low susceptibility to reaches that are very sensitive to degradation, such as lakes sensitive to eutrophication, fresh and coastal waters used for contact recreation, and shellfish harvesting or aquaculture (McKergow and Hudson 2007).

Livestock having access to waterways can also cause a number of other environmental effects. The lack of tall riparian vegetation as a result of stock access can result in reduced shading on small streams resulting in elevated water temperatures. This lack of riparian vegetation can also reduce the in-stream habitat value (i.e. cover, leaf litter).

<u>Summary Table – Contaminant Losses for Livestock in Waterways:</u>

Contaminant	**Main Sources**
N, P, Microbial	- Direct defecation into water - Run-off from riparian area - Re-suspension from bed disturbance
P, Sediment	- Bank trampling and erosion - Riparian area disturbance (vegetation loss/pugging) - Trampling of the stream bed

3.3 Soil Disturbance and Vegetation Clearance

Overview of contaminant losses

Earthworks, mass vegetation clearance and slips can induce short-lived but major changes to farm sediment yield (MFE 2001; Quinn and Stroud 2002; Gibbs 2006; EW 2009). Farming activities with a high risk of sediment export include: creation of races/tracks, construction of culverts, harvesting and preparation of production woodlots, re-contouring, the drain maintenance and scrub clearance (MFE 2001; EW 2003; DEC 2006; Gibbs 2006; Gibbs and Bremner 2008; EW 2009). The risk posed by each activity is dependent on the proximity to a waterway, scale of the activity, the extent that slope stability is reduced, geology, topography and the amount of rainfall. One large slip can transfer more sediment to a waterway than all other farming activities combined over several years (MFE 2001; Quinn and Stroud 2002; Gibbs 2006). Similarly mass movements in pasture catchments can dominate the long-term sediment export from small catchments. (Quinn and Stroud 2002).

Plants play two important roles in maintaining soil stability: 1) hydrological stabilisation such as interception of rain drops by foliage and removal of excess water via the root system and 2) mechanical stabilisation by roots which reinforce the soil (Phillips, Ekanayake et al. 2000). A combination of deep rooted and shallow rooted plants is important for maintaining soil stability and preventing surface erosion (McDowell and Wilcock 2007). Deep rooted plants are anchored into firm strata thereby creating a buttress for up-slope soil; shallow rooted plants increase the strength and cohesion of top soils (Wilmshurst 1997; Phillips, Ekanayake et al. 2000). The risks association with vegetation clearance is highest in hilly topography and lowest in flat lowland areas; but the removal of vegetation cover on any stream bank will greatly increase the risk of localised sediment export particularly where banks are steep (Williamson, Smith et al. 1992; Quinn and Stroud 2002; McDowell and Wilcock 2007).

Transport of soil into waterways causes siltation of the stream bed, stream channel narrowing, increased suspended solid loading and is a major source of P contamination (McDowell and Wilcock 2007). Phosphorus levels are particularly high in top soil and stream bank sediments (McDowell and Wilcock 2007). Subsequent water quality issues from sediment are the same as for livestock access to streams (Section 3.2).

The potential impact of and soil disturbance and vegetation clearance is difficult to quantify. The potential exists from some operations to have large sediment inputs into waterways. The management of these activities involve risk management in that with areas of soil disturbance there is a period of time when adverse effects could occur under circumstances such as intense rainfall. This risk is mitigated primarily by the use of best management practices.

Most soil disturbance and vegetation clearance activities tend to occur when farms are intensifying, such as from sheep and beef to intensive beef or dairy farming. Management of these permitted activities can therefore be focused on farms or areas where this change is occurring.

Summary Table – Contaminant losses for Soil Disturbance and Vegetation Clearance:

Contaminant	Main Sources
Sediment, P	- Overland flow and erosion of exposed soil and subsoil - Mass movement of sediment from destabilised slopes and spoil piles
Microbial, N, P	- Increased surface runoff is earthworks leads to more tracks near waterways

3.4 Dams and Damming

Overview of contaminant losses

Well-designed dams can potentially improve the quality of stream water quality by accumulating sediment, controlling flood flow and removing N and P (NIWA 2010). However, in general dams are characterised by degraded water quality and can also potentially prevent fish passage (Maxted, McCready et al. 2005).

A study of artificially dammed streams in the Auckland Region found that rural ponds had severely degraded temperature and dissolved oxygen and that invertebrate communities in these areas were more pollution-tolerant than those in associated streams (Maxted, McCready et al. 2005). Water temperature downstream of ponds was elevated for hundreds of meters indicating that a pond footprint extends beyond the pond area itself (Maxted, McCready et al. 2005).

Although water quality in ponds can be poor; trapping of sediment and nutrients and resulting levels of primary production can make dams an effective water quality management tool on farms (NIWA 2010). NIWA (2010) believes that downstream effects of pond water quality can be avoided by locating dams off-channel or in ephemeral streams. Dams can also be used to provide drinking water to troughs to help mitigate livestock access to streams (NIWA 2010).

Dams may also exacerbate erosion if they are not adequately designed to cope with flood conditions (Mulholland 1987).

The dam and damming PA rules are only considering small dams on the ephemeral waterways or existing legal dams. The biggest risk of contaminant loss from these dams is likely to be as a result of dam failure caused by overtopping or structural failure.

These small dams are likely to have beneficial outcomes for contaminant losses from agricultural land in that they will trap sediment and nutrients. Yet their contribution to other impacts such as temperature and fish passage would be negligible given the number, size and location on the ephemeral water bodies.

Summary Table – Contaminant Losses from Dams and Damming:

Contaminant	Main Sources
Sediment	- Dam failure or downstream scour - Erosion and sediment loss during construction - (Sediment losses from the catchment area can be

	reduce through capture in the dam pond)
N, P	- P could be lost with any downstream erosion and during construction - Not sure up or down?

3.5 Culverts

Overview of contaminant losses

Poorly designed culverts can increase sediment discharges by scouring of the stream bed and bank erosion caused by changes to channel morphology. They can also restrict fish and invertebrate passage (DEC 2006; Speirs and Ryan 2006; Kelly and Collier 2007; Jones 2008). The New Zealand native fish fauna comprises of a very high proportion of diadromous species, most of which need to migrate between freshwater habitat and estuary or ocean habitat in order to complete their life cycle (McDowall 2000). Poorly designed culverts present an impassable barrier for many fish and invertebrate species (Kelly and Collier 2007).

Problems with culverts include (from DEC 2006; Kelly and Collier 2007):

- Badly sited and aligned culverts can destroy important aquatic habitat and cause bank erosion because of changes to flow direction and turbulence.
- Build up of debris which restricts water flow and passage of aquatic species and causes over-topping and subsequent surface runoff of contaminants.
- Bed level of the culvert is raised (perched) above the stream surface and is therefore inaccessible to swimming and climbing species; perched outlets increase bed scouring
- An increase or decrease in water velocity leading to resistance for migrating species and scouring of the stream bed below the culvert outlet.

A survey of 1,614 culverts in the Waikato Region between 2000 and 2005 found that 30% of culverts presented a barrier to fish passage at most flows; 9% restricted passage at high flows and 13% restricted passage at low flows. Thames-Coromandel District ranked highest in terms of the number of culverts needing remediation work, with Waipa and Waikato Districts ranked second and third (Kelly and Collier 2007). Similarly, a survey of 60 randomly selected catchments in the Waikato Region found that nearly 60% of culverts restricted fish passage at all, low or high flow and therefore did not comply with the permitted activity rule (Jones 2008).

The scouring and bank erosion that can occur downstream of culverts can increase sediment, suspended solid and P loadings to waterways. There is no research to quantify this contribution relative to other on-farm losses. Culverts are however likely to have a net benefit for contaminant loss as they generally replace a stock crossing point and therefore mitigate the losses which can occur through livestock access to streams beds.

Summary Table – Contaminant Losses for Culverts:

Contaminant	Main Sources
Sediment	- Downstream erosion and scour - Culvert/embankment failures
Microbial, sediment, N, P	- (Can be reduced as a result of limiting stock access to water, also any ponding above a culvert will 'trap' some of these contaminants)

3.6 Dumps and Offal Holes

Overview of contaminant losses

Farm dumps and offal holes can act as point source discharges of contaminants (Russell, Monaghan et al. 2006; Wilson 2010). These discharges are localised but can have significant effects on water quality depending on the nature of leached contaminants and the proximity of the source to surface water or aquifers (Wilson 2010). Other adverse effects of poorly constructed and managed offal pits are odours, insects and vermin infestation and risks to domestic animals (DEC 2006). Farm dumps do not pose a risk to water quality providing hazardous material and dead stock are not disposed in them. Hazardous materials such as used batteries and chemical drums contain heavy metals such as lead and cadmium that can be harmful to aquatic life and human health (DEC 2006).

There is limited specific information available in the literature about the extent and types of contamination loss from farm dumps and offal holes. However, common sense principles should be applied to compliance based on the inextricable link between what goes into a dump or a hole will reflect in any discharges.

The underlying premise that these permitted activities are:

- Farm dumps only to receive "inert" waste
- Offal holes are used for food waste and animal waste and should be sealed to prevent run-off entering into them
- Sewage should be treated in a septic tank and not put into offal holes or dumps
- Hazardous materials (chemical, oils, detergents and the containers) are not put into the holes and need to be disposed of in an appropriate commercial facility.

The most significant issue with farm dumps and offal holes are the introduction of hazardous substances or contaminated material such as sewage, agrichemicals, solvents, detergent, or oil (or their empty containers).

Summary Table – Dumps and Offal Holes:

Contaminant	Main Sources
N, P, Bacteria	- Flooding of offal holes from surface run-off - High ground water tables directly accessing contaminants in offal holes or dumps
Hazardous chemicals	- Disposal of hazardous materials into dumps or offal holes

4 Risk Assessment of PA Areas

4.1 Dairy Effluent Discharge onto Land

How PA Rule Seeks to Minimise Contaminant Losses

The PA rule 3.5.5.1[2] minimises contaminant loss by:

- Requiring sufficient effluent storage to avoid discharge to water
- Requiring storage facilities to be sealed
- Restricting nitrogen load applied from effluent to 150kg/ha/yr
- Setting a maximum loading rate per application
- Prohibiting Overland flow and ponding of effluent

Environmental Risks from Non-Compliance

High	The most significant one-off risk from FDE is direct discharge of significant volumes of effluent to water as a result of system failure or excessive irrigation rates causing overland flow.
	Consequences of this can be: • High microbial contamination • Elevated N and P levels in receiving water • High ammonia levels in receiving water • Lowered DO in receiving water • Smothering of stream bed with organic matter
	The number and scale of these consequences is dependent on: • Volume discharged into water • Size of the receiving waterway • Quality of the receiving waterway • Strengths and composition of effluent.
Medium	The next highest risk is preferential flow of effluent to groundwater as a result of: • Leaking storage facilities • High effluent loading rate on porous soils • Irrigating saturated soils or irrigating to saturation • Ponding of effluent on the surface.
	Consequences of this can be: • High microbial discharges to groundwater • Increased groundwater nitrogen levels
	The number and scale of these consequences is dependent on: • Soil type and associated water holding characteristics • Depth to groundwater • Distance to surface water • Sensitivity of the receiving water, including users of the groundwater.

[2] See Appendix for details of this PA rule

Low	Another risk is from excessive application of N to soils from effluent.
	Consequences of this can be: • Elevated ground water N levels which in turn can lead to elevated surface water N levels
	The number and scale of these consequences is dependent on: • Sensitivity of the receiving water • Size and flow rates of groundwater resource • Intensity of land-use across the catchment.

For risk management of FDE the likelihood of an event is dependent on the system operator, type and quality of effluent irrigation system, and the time of year - particularly when soils are wet and there are significant rain events. However, when significant non-compliance events occur, such as a lack of storage or pump failure, then the frequency these events could be occurring daily.

The consequences of non-compliance for FDE can vary significantly. The direct discharge to water can have a large consequence and therefore would be higher on a risk matrix. If the consequence of non-compliance was lower risk such as high N loadings then the consequence would be lower on a risk matrix.

<u>FDE - Whole farm and catchment context</u>

Although FDE has potential to cause adverse effects as a result of significant non-compliance the impact of this is dependent on a range of site and event specific factors. Dairy farm losses of contaminants can already have a significant impact on water quality. Catchments with high levels of dairying are generally known to have poorer water quality (Vant 1999). It is still however important to focus on significant non-compliance issues as they can have localised detrimental effects on receiving waters. Further research is required to clarify the typical contribution of effluent treatment at a farm scale (Ritchie and Donnison 2010). Although the FDE represents about 10% of the total effluent load on farm the fact that this source is centralised and becomes a "point source" to manage raises the risk.

4.2 Livestock in Waterways

<u>How PA Rule Seeks to Minimise Contaminant Losses</u>

The PA rule 3.9.4.11[3] minimises contaminant loss by:

- Identifying priority areas where livestock access must be excluded
- Setting performance standards to minimise adverse effects from livestock access (suspended sediment standards, clarity < 10% change)
- Promotion of actions to minimise access and time in the area (stream crossings).

[3] See Appendix for details of this PA rule

Environmental Risks from Non-Compliance

High	The most significant one-off risk is from direct defecation by cattle into waterways
	Consequences of this can be: • Significant elevation of microbial levels • Increase the concentration of N and P
	The number and scale of these consequences is dependent on: • Stock type and stock density, or frequency of passage through a water body • Stream size • Quality of stream - sensitivity of receiving environment • Downstream users
Medium	The next a risk is direct run-off from riparian area into water way especially from trampled ground, camping areas and drainage from tracks and crossings
	Consequences of this can be: • Significant elevation of microbial levels • Increase the concentration of N and P • Increases in sediment loads
	The number and scale of these consequences is highly dependent on: • Stock type and stock density • Soil type • Topography of riparian area (slope, width) • Stream size and sensitivity • Rainfall intensity • Riparian vegetation (presence, type)
Low	Another risk is trampling and disturbance of banks, riparian vegetation and in the stream bed.
	Consequences of this can be: • Re-suspension and mobilisation of contaminants and the bid (microbial, P) • Increased sediment
	The number and scale of these consequences is dependent on: • Bank type and lithology • Stream bed material • Previous impacts

Where stock has unrestricted access to water bodies the likelihood of these impacts occurring is high, meaning stock would be causing effects at more than a daily frequency. The consequence of this would vary markedly depending on the factors outlined above.

Livestock in waterways – Whole farm and catchment context

The significance of livestock in waterways is most prominent for dairy farming and hence this issues has been the focus for recent industry and Council activities. Separating the effect of direct stock access to water bodies in hilly sheep and beef country from the effects of surface run-off from the farm is very complex. Research would indicate that there is a stocking rate factor at which impacts can be seen as adverse.

4.3 Soil Disturbance and Vegetation Clearance

How PA Rule Seeks to Minimise Contaminant Losses

The PA rule 5.1.4.11[4] minimises contaminant loss by:

- Requiring erosion /sediment controls to be installed and maintained
- Requiring cut-offs and culverts to prevent scour and erosion
- Settings suspended sediment discharge standards
- Requiring disturbed material to be contained

Environmental Risks from Non-Compliance

High	The most significant one-off risk is from large-scale erosion of disturbed soil during heavy rainfall event.
	Consequences of this can be: • Deposition of large quantities of sediment into or adjacent to waterways • Discolouration of waterways • Aggradation of the streambed • Destruction of in-stream habitat
	The number and scale of these consequences is dependent on: • Soil type/geology • Proximity to waterway • Size and sensitivity of waterway • Rainfall event/time of year • Types and effectiveness of erosion and sediment controls
Medium	The next a risk is mass movement of subsoil or relocated spoil
	Consequences of this can be: • Rapid infilling of drainage network • Creating a larger area of disturbed material that can be re-worked and eroded • Discolouration of waterways • Aggradation of the streambed • Destruction of in-stream habitat

[4] See Appendix for details of PA rules

	The number and scale of these consequences is highly dependent on: • Soil type/geology • Scale of cut faces • Extent and management of spoil • Types and effectiveness of erosion and sediment controls • Proximity to waterway
Low	Another risk is that increased run-off from additional tracks and races created
	Consequences of this can be: • Increased contaminant loads direct into waterways
	The number and scale of these consequences is dependent on: • Stock type and number • Erosion and sediment controls

From a risk perspective the likelihood of soil disturbance and vegetation clearance activity occurring is low, being undertaken at intervals greater than a year. The significance of a consequence of any non-compliance is very difficult to quantify as it can vary markedly from small elevation is in sediment discharges to mass movement.

Soil Disturbance and context with whole farm and catchment losses

The impacts from soil disturbance and vegetation clearance have the potential to be significant when a large number of these activities are being undertaken in a short period of time, particularly where near waterways. Such is the case when farms are redeveloping or intensifying. The issue with these soil disturbance and vegetation clearance activities is that they involve a significant component of risk management. In that the activity can be undertaken with minimal impact by following conditions under the PA rule or under different climatic inputs and yet following the PA conditions the activity could result in significant discharges to water bodies.

In hill country areas the risk is greater for an adverse outcome however in this terrain background erosion levels are also higher and during high rainfall events many streams from this type of landscape already have significantly elevated sediment and other contaminant levels.

4.4 Dams and Damming

How PA Rule Seeks to Minimise Contaminant Losses

The PA rule 3.6.4.4 and 3.6.4.5[5] minimises contaminant loss by:

- Limiting new permitted activity dams to ephemeral waterways or off-stream
- Requiring any erosion or scour to be rectified
- Restricting the size of dam and the volume of the pond
- Requiring a spillway to ensure stability of the dam

[5] See appendix for PA rule details

- Requiring the construction to meet suspended sediment standards

Environmental Risks from Non-Compliance

Medium	A one off risk is dam failure
	Consequences of this can be: • Deposition of potentially large quantities of sediment into waterways or drainage network • Scour and erosion the stream bed downstream • Discolouration of waterways • Destruction of in-stream habitat
	The number and scale of these consequences is highly dependent on: • Dam size and pond volume • Topography and soil type • Existing hydrological conditions - i.e. if drainage network is in flood.
Low	Another risk is that of sediment discharge from downstream scour or during construction.
	Consequences of this can be: • Increased sediment load to drainage network • Aggradation of the bed
	The number and scale of these consequences is dependent on: • Size the dam • Soil type and topography • Climatic conditions during construction

Existing permitted activity dams would also face these risks outlined but because they could be on a perennial water way they are likely to have other effects during summer such as increasing temperature and decreasing clarity (algae growth).

Damming and context with whole farm and catchment losses

Small dam's effect on contaminant loads and water quality in the farm system and on a catchment basis are likely to be beneficial. Such dams would perform a role of sinks for contaminants throughout small to medium run-off events. Any failures that might occur during large rainfall events may not add substantially to existing catchment loads from a flood event.

4.5 Culverts

How PA Rule Seeks to Minimise Contaminant Losses

The PA rule 4.2.9.1 and 4.2.9.2 minimises contaminant loss by:

- Ensuring culverts can pass high flows (1 in 50 yr)

- Culverts should be able to overtop without failure
- Restricting the size of culvert structures
- Setting suspended sediment standards for construction

<u>Environmental Risks from Non-Compliance</u>

<table>
<tr><td rowspan="3">Medium</td><td>A risk is failure of the culvert embankment due to overtopping or eroding</td></tr>
<tr><td>Consequences of this can be:
• Deposition of potentially large quantities of sediment into waterways or drainage network
• Scour and erosion the stream bed downstream
• Discolouration of waterways
• Aggradation of the streambed
• Destruction of in-stream habitat</td></tr>
<tr><td>The number and scale of these consequences is highly dependent on:
• Size of the culvert and embankment structure
• Slope of the catchment
• Soil type and topography
• Sensitivity of the downstream environment.</td></tr>
<tr><td rowspan="3">Low</td><td>The other risk is downstream scour and erosion</td></tr>
<tr><td>Consequences of this can be:
• Aggradation of the downstream network
• Undercutting of culvert increasing risk of failure
• Loss of fish passage</td></tr>
<tr><td>The number and scale of these consequences is dependent on:
• Slope of the catchment
• Soil type and topography
• Sensitivity of the downstream environment.</td></tr>
</table>

The likelihood of culverts contributing contaminants has a low frequency as culverts would be installed or retrofitted less than annually or during redevelopment. The consequences that could occur can vary depending on the specific circumstances but in most cases for the PA the range would not be great.

<u>Culverts and context with whole farm and catchment losses</u>

Although culverts may have some negative impacts on contaminant loads the net effect would be beneficial as their use means a restriction or reduction in stock access to the streambed. So unless culverts are clearly outside the parameter of a permitted activity rule and pose a significant risk through failure they are of low concern for contaminant losses.

The outcome for fish passage is quite a different issue as farm culverts can be significant barriers within the catchment. Especially where natural state areas exist above farmland in a catchment.

4.6 Dumps and Offal Holes

How PA Rule Seeks to Minimise Contaminant Losses

The PA rule 5.2.6.1 and 5.2.6.2 minimises contaminant loss by:
- Limiting the source and types of waste
- Sitting conditions to ensure treatment before leachate enters groundwater
- Restricting locations and providing buffer distances to significant features or habitat

Environmental Risks from Non-Compliance

High	The most significant one-off risk from the introduction of hazardous materials
	Consequences of this can be: • Significant pollution of the receiving environment • Residual and on-going pollution problem
	The number and scale of these consequences is highly dependent on: • Type and volume of hazardous substance • Distance to groundwater • Sensitivity of receiving environment - including downstream users • Time between deposition of material and discovery.
Low	The other risk is from flooding through either surface run-off or elevation of the ground water table.
	Consequences of this can be: • Discharge of contaminants directly to groundwater without any treatment in the soil. • This could include high microbial discharges and effluents high in BOD
	The number and scale of these consequences is dependent on: • Extent and duration of flooding • Sensitivity of the downstream receiving environment • Users of any groundwater

Farm dumps and offal holes are features that are likely to be used at a weekly to monthly frequency. However the likelihood of the introduction of hazardous material or a flooding event is likely to be a lot lower frequency. Given the other contributors of contaminants on farm the impact of flooding on the offal hole for microbial contamination would be low. The consequence of any introduction of hazardous material could be significant and long-lasting. This is one behaviour that poses the risk of a significant adverse effect.

4.7 Risk Matrix for PA Areas

The potential water quality impacts of non-compliance with permitted activity rules on farm can be evaluated through a risk matrix (Figure 3). This matrix looks at the likelihood with which the activity can occur (i.e. daily, weekly, and monthly) against potential level of impact from contaminant discharges as a result of non-compliance with the rule. In this matrix likelihood is taken to be the same frequency (i.e. how often this activity would occur if a regular behaviour was the cause of non-compliance.

Activities such as FDE discharge to land can occur on a frequent (daily) basis and any non-compliance can have the potential for significant impact on water quality. But the consequences could vary markedly depending on the type and scale of non-compliance.

Activities such as culverts and dams, which are generally put in during farm development or improvement and occur at a period greater than annually, can have less of an impact on water quality compared with other catchment activities across this timeframe such as normal surface run-off and erosion from a farm.

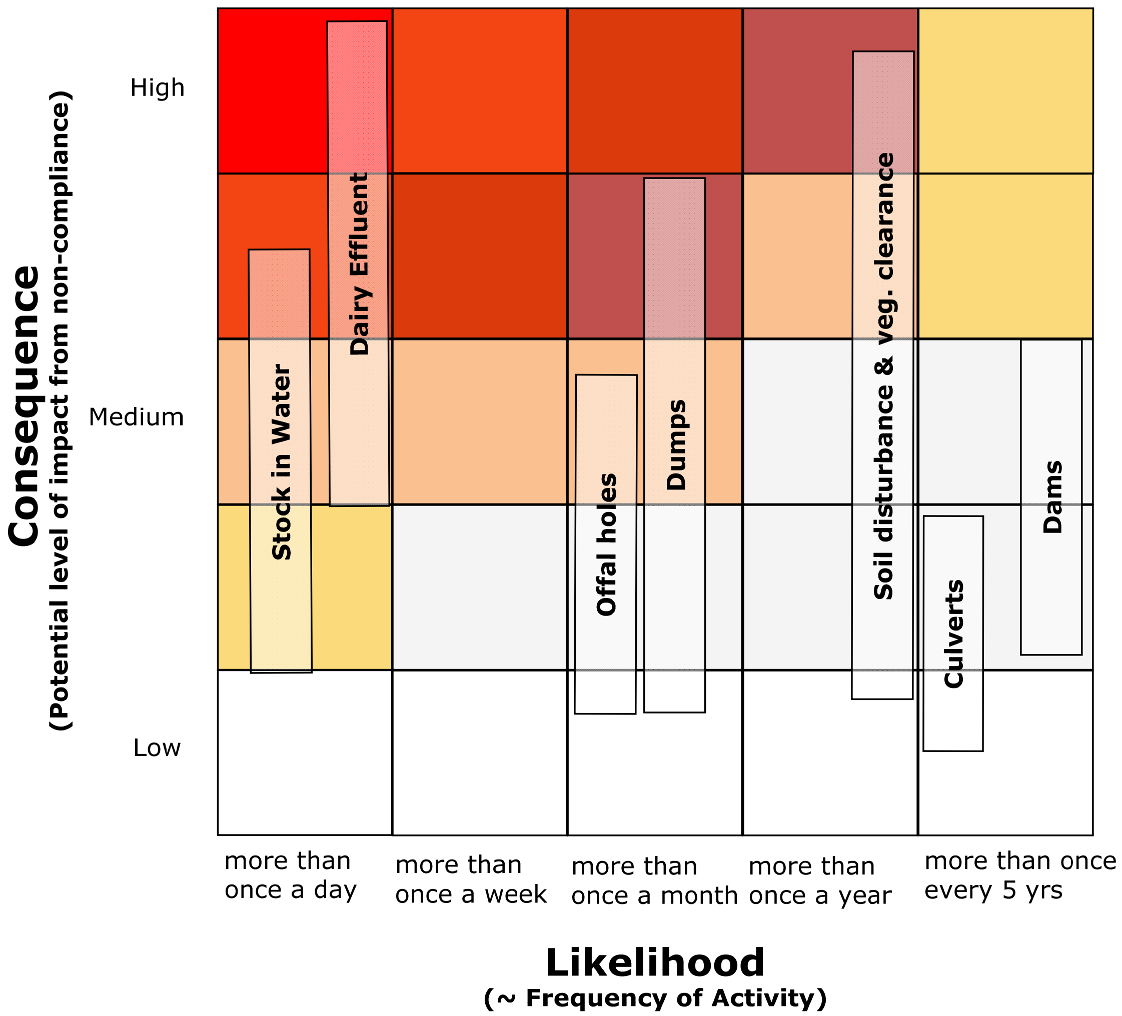


Figure 3: Risk Matrix – Consequence and likelihood of outcomes for PA rules

A number of these permitted activities such as soil disturbance and vegetation clearance and farm dumps/offal holes, have risk profiles which depend on the form of non-compliance or its location in the Region. Because of this, the potential impact of non-compliance can vary markedly.

The risk matrix outcomes can be re-evaluated by attributing numerical values of one to five along each of the X and Y axis. The permitted activity rules can then be distributed along a priority risk profile (Figure 4). This profile then makes it clear about where monitoring effort should be focused for permitted activity compliance to ensure that the best environment outcome there can be achieved.

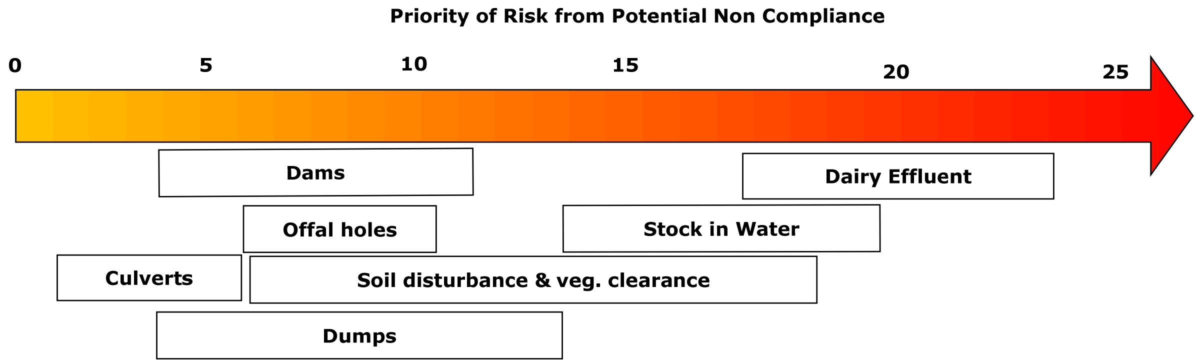


Figure 4: Priorities of risk from potential non-compliance with permitted activity rules

5 Field Evaluation of Permitted Activity Rules

5.1 Evaluation Practices – Overview

This section of the report provides guidance notes to assist monitoring and compliance staff in the identification and evaluation of non-compliance with the key PA rules and their potential impact on water quality.

These guidelines follow an assessment framework that considers three aspects of evaluation:

1. Current compliance assessment
2. Evaluation of the risks for future compliance
3. Encouraging the adoption of best management practices

The process for this assessment framework is outlined in Figure 5.

The guidance for each PA rule is provided in the form of tables in Section 5.5. The tables identify unacceptable outcomes, risks that could lead to unacceptable outcomes and areas where improvements could be made in practices.

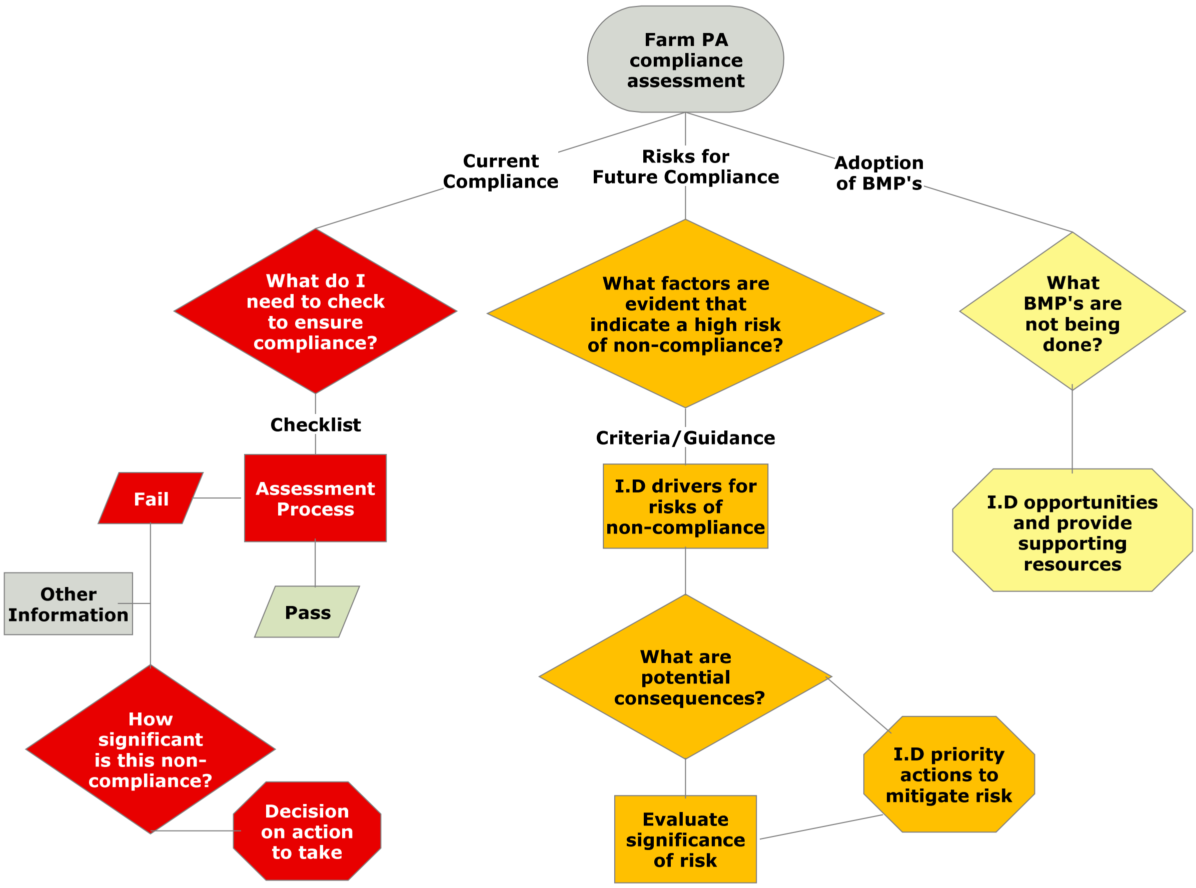


Figure 5: Compliance assessment framework

PA compliance assessment is primarily involved with assessing whether a resource user is complying with the conditions of a PA rule. The process involves assessing current farm practices against the conditions of the rules to determine if they comply. As compliance can only be assessed at that instant in time it is also useful to assess the relative risk that non-compliance might occur at some other time or under changed circumstances.

5.2 Assessment of Compliance

As the assessment process is subjective it is helpful to provide a consistent approach and assessment criteria for existing and new staff to use. The Resource Use Group at Waikato Regional Council has established an existing guideline for assessing compliance status (DOC# 767804). This approach assesses compliance status on individual conditions and then compliance status for an individual consent or entire site (see Appendix 2). It provides definitions for significance of non-compliance and priority levels of non-compliance.

This assessment framework focuses on what are the key compliance criteria to pay attention to when assessing permitted activity rules. These criteria are chosen as they could be strongly indicative of an unacceptable compliance outcome. These criteria are only aiming to identify high and medium priority non-compliances.

5.3 Assessment of Risk

Understanding a risk assessment for contaminant loss from the six permitted activity areas can provide staff with an increased understanding of high risk areas that should be the focus on when undertaking monitoring and compliance. It will also highlight areas where uncertainty means more subjective decisions are required

The tables in Section 4 have identified what the important risks are. This step of the field assessment process is about looking into the probability of any risks and identifying ways to minimise their occurrence and possible significance of any impact should they occur (Figure 6).

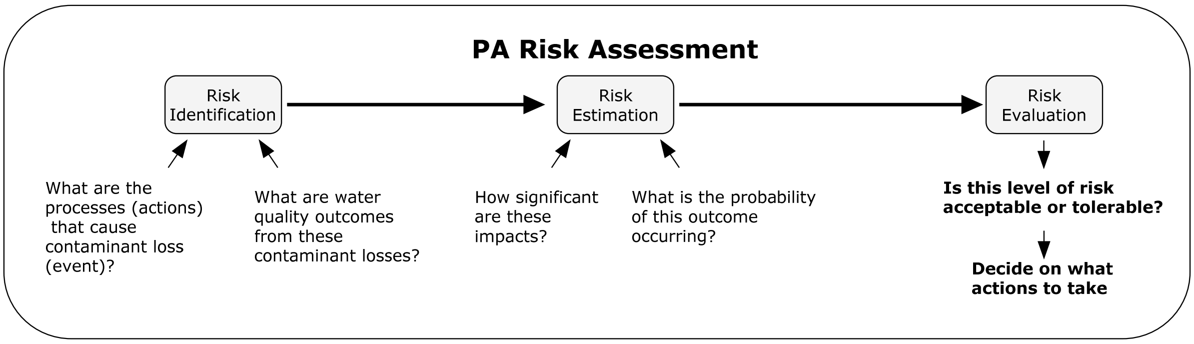


Figure 6: Applying risk assessment process to permitted activity areas

The Tables in Section 5.5 identifies drivers of risk for each PA area, describes potential outcomes that could result, and suggests mitigation options.

5.4 Identifying Opportunities

Although not strictly part of compliance assessment, it is useful for monitoring and compliance staff to understand and identify opportunities for practice improvements. Doing this could help to reduce the future risk for contaminant losses, but also assist farmers to improve their systems. Where possible ideas for improvement opportunities have been identified and linked to available resources.

5.5 Permitted Activity Areas

5.5.1 Farm Animal Effluent onto Land – WRP 3.5.5.1

<u>Evaluation of Farm Dairy Effluent – Guidance Tables</u>

ASSESSING COMPLIANCE

	Compliance criteria	**Further enquiry**
Presence of unacceptable outcomes	Evidence of overland flow - Can observe overland flow occurring - See evidence that is has been flowing across paddocks or into waterway	• Has discharge or is discharge reaching surface water? • Type and status of receiving waterbody • What is the source – storage facility, irrigation system, over irrigation? • Estimate volume of flow • How long has it taken place? – check state of grass under and around flow • Current level of soil saturation • Did operator have prior knowledge of issue? • Has any action been taken to stop flow?
	Evidence of ponding - Can observe ponding of effluent on paddocks - See evidence in paddocks that ponding has been present	• What is the source – storage facility, irrigation system, over irrigation? • Estimate size of ponding – area and depth • How long has it taken place? – check state of grass under and around ponding • Soil type and current level of soil saturation • Did operator have prior knowledge of issue? • Has any action been taken to stop flow that is creating ponding?
	Evidence of overloading soils - There are signs of waterlogging after irrigation - See evidence that irrigation is causing overland flow or ponding	• Has irrigator been calibrated for loading calculations • What are soil type/characteristics • What loading rate has been applied? • Does the loading rate match soil conditions? • Does area have subsurface drainage?
	Evidence of pond leakage - There are signs of effluent leaving pond - Apparent miss-match between herd size and irrigation records	• Does irrigation records match expected effluent volumes? • Is pond very low in summer? • Check for seepage or wet areas around the base of pond

ASSESSING RISK

	Drivers of risk	Potential outcomes
Risks that could lead to unacceptable outcomes	Low levels of available storage	- Irrigates when too wet – get overland flow - Storage overflows
	Water logged soils	- Overland flow risk – especially if combined with limited storage
	Inadequate equipment – irrigator type to match soils, sufficient hose/pump	- Overloading soils with water and nutrients
	Increased effluent volume (introduction of feedpad, change in herd size)	- Storage and irrigation systems/area become inadequate
	Operator knowledge – equipment/systems, loadings, soil types/status	- Substandard performance of effluent management and risk of system failure

PROMOTING GOOD PRACTICE

	Improvement opportunities	Available Resources
Areas for attention	Planning for deferred irrigation Low application rate tools Irrigator calibration/performance	- DairyNZ – A guide to managing farm Dairy Effluent - DairyNZ Farmfacts: Effluent irrigation management (6-18) - WRC Effluent management – For the health of our waterways and groundwater
	Adequate storage	- DairyNZ Farmfacts: Land application planning and selection (6-8)
	Nutrient budgeting	- DairyNZ Farmfacts: Fertiliser value of effluent (6-15), Nutrient budgets and Overseer (7-11), - Fert Research Code of Practice for nutrient management

5.5.2 Livestock in Waterways – WRP 4.3.5.4

Evaluation of Livestock in Waterways – Guidance Table

ASSESSING COMPLIANCE

	Compliance criteria	Further enquiry
Presence of unacceptable outcomes	Stock exclusion area - priority one	• Is the waterway a priority 1 in the WRP? • Have stock been effectively excluded from the waterway? – define exclusion methods (type and extent of fencing) • Describe stock type present, current state of stream bank and river bed.

	High farm stocking rates – especially cattle/deer	• What type and numbers of stock are present • How long are they in area for? (transiting or fenced in paddock) • What measures have been taken to minimise their time in stream? (supplementary feeding away from riparian area, alternate water supply or shade) • Nature and sensitivity of stream
	Erosion and vegetation loss in of riparian area	• Shape and slope of riparian area • Extent and status of any riparian vegetation • Condition of soil in riparian areas • Condition of stream banks • Nature and sensitivity of stream
	Number and state of stream at crossing points	• Define density of stock crossing points • Describe condition of bed at crossing points

ASSESSING RISK

	Drivers of risk	Potential outcomes
Risks that could lead to unacceptable outcomes	No alternate water supply	- Stock must access streams to drink
	No shade in paddocks	- Stock move to water to cool off
	Lack of formed crossings	- All stock movements must be through stream bed
	Level of free access to streams	- Can create multiple crossing points and damage to banks
	Stream bank shape and structure, and stream bed substrate	- Steep banks or soft lithology's are more prone to damage. Finer bed substrates are more fragile than rocky

PROMOTING GOOD PRACTICE

	Improvement opportunities	Available Resources
Areas for attention	Crossings – culverts and bridges	- WRC Best practice guidelines for waterway crossings - MfE Culvert and Bridge construction – guidelines for farmers
	Fencing streams	- WRC Clean Streams booklet
	Waterways management	- NZFEA Managing waterways booklet
	Alternate water supplies	- WRC Clean Streams booklet
	Riparian planting	- WRC Clean Streams booklet - DairyNZ Farmfacts: Riparian Management (5-7)

5.5.3 Soil Disturbance and Vegetation Clearance – WRP 5.1.4.11

Evaluation of Soil Disturbance and Vegetation Clearance – Guidance Table

ASSESSING COMPLIANCE

	Compliance criteria	**Further enquiry**
Presence of unacceptable outcomes	Evidence of sediment movement into waterways	• Where has the sediment sourced from? • What measures were taken to prevent/mitigate erosion occurring? – did these represent BMP's • What actions have been taken to mitigate or fix the problem? • Describe sediment type (sand/silt/clay, vegetation present, wet/dry) • Define extent of sediment movement – distance, volumes • How significant was the rainfall event that caused erosion? • Nature of the receiving water? • Define impacts that have occurred on waterway – aggradation, discolouration
	Slope or Spoil failures/movement	• Describe size and nature of sediment movement • Location of sediment deposition, risk of further movement • Identify triggers/causes for failure • Likelihood of further movement or additional failures • Define sediment type and state • Proximity of sediment to waterways, sensitivity of waterway • Actions taken to mitigate occurrence • Nature of any recent climatic events

ASSESSING RISK

	Drivers of risk	**Potential outcomes**
Risks that could lead to unacceptable outcomes	Steep and/or high cutting faces	- Mass movement from bank collapse
	Extent of BMP's in onsite practices – i.e. Inadequate water control	- Erosion of disturbed soil by concentrated water flow
	Time of year – rainfall risk, ability to vegetate area	- Higher risk of erosion
	Behavioural history – previous practices and responses	- BMP's not followed with negative outcomes

PROMOTING GOOD PRACTICE

	Improvement opportunities	Available Resources
Areas for attention	Water management BMP's Site rehabilitation	- WRC Erosion and sediment control guidelines - DairyNZ Farmfacts: Erosion control (5-6) - WRC Design guidelines for earthworks, tracking and crossing - DairyNZ – Dairy and Environment – Chapter 4 – Waterways, natural features and planting - NZFEA – Tracks and races
	Crossings – bridges/culverts	- WRC Best practice guidelines for waterway crossings - MfE Culvert and Bridge construction – guidelines for farmers

5.5.4 Dams and Damming – WRP 3.6.4.4 & 3.6.4.5

<u>Evaluation of Dams and Damming – Guidance Tables</u>

ASSESSING COMPLIANCE

	Compliance criteria	Further enquiry
Presence of unacceptable outcomes	Discharge of sediment downstream from dam failure	• Size and shape of dam – was it within PA rule • Did it have suitable spillway – size and construction • Material used and method of dam construction • Evidence for cause of failure – overtop, spillway failure, internal collapse • Define degree of downstream impact – extent of sedimentation, any secondary erosion, did it reach a perennial waterway, sensitivity of waterway, observed impacts •

ASSESSING RISK

	Drivers of risk	Potential outcomes
Risks that could lead to unacceptable outcomes	Spillway size and construction	- Spillway not sufficient to resist erosion and failure
	Erosion of dam face	- Loss of structural integrity of dam
	Undercutting of dam toe	- Loss of structural integrity of dam
	Seepage from downstream face	- Risk of internal erosion, piping and dam failure
	Downstream scour of stream bed	- Increase seepage under dam or potential loss of structural integrity of dam

PROMOTING GOOD PRACTICE

	Improvement opportunities	Available Resources
Areas for attention	Siting of small dams Construction and maintenance of small dams	- WRC General guidelines for the design of small homogeneous earthfill dams - Dams, safety requirements and building consents – Set of Brochures (WRC website)

5.5.5 Culverts – WRP 4.2.9.1 & 4.2.9.2

Evaluation of Culverts – Guidance Table

ASSESSING COMPLIANCE

	Compliance criteria	Further enquiry
Presence of unacceptable outcomes	Downstream discharge of sediment – culvert failure	• What type of failure occurred – overtopping, undermining? • Was culvert sized accordingly • Was material and construction suitable? – fill strength and compaction, alignment with stream bed

ASSESSING RISK

	Drivers of risk	Potential outcomes
Risks that could lead to unacceptable outcomes	Culvert partly full of sediment	- Culvert will not deal with high flows and will overtop
	Undersized culvert	- Culvert will not deal with high flows and will overtop
	Soft infill material	- Seepage and erosion around the culvert - Erodes readily if overtopped
	Undercutting of culvert downstream	- Destabilises embankment - Enhanced erosion if overtopped

PROMOTING GOOD PRACTICE

	Improvement opportunities	Available Resources
Areas for attention	Siting and construction Fish passage	- WRC Best practice guidelines for waterway crossings - MfE Culvert and Bridge construction – guidelines for farmers

5.5.6 Dumps and Offal Holes – WRP 5.2.6.1 & 5.2.6.2

Evaluation of Dumps/Offal Holes – Guidance Table

ASSESSING COMPLIANCE

	Compliance criteria	Further enquiry
Presence of unacceptable outcomes	Presence of Hazardous material (Batteries, chemicals, chemical containers, oils)	• Type of waste • Location of waste (dump or offal hole) • How much material is present • How long has been in place • Integrity of containers holding waste • Prior knowledge of land owner
	Presence of non-appropriate waste (sewage, rubbish in offal hole)	• More waste present than generated by farm • Non organic water in offal hole • Evidence of sewage added to offal hole
	Flooding potential	• Water runoff can enter offal hole • Water runoff is focused into farm dump
	Contamination of Groundwater	• Water tables are near surface and not at minimum 1m for offal hole •

ASSESSING RISK

	Drivers of risk	Potential outcomes
Risks that could lead to unacceptable outcomes	Poor water management	- Flooding risk and leaching to groundwater

PROMOTING GOOD PRACTICE

	Improvement opportunities	Available Resources
Areas for attention	Siting of offal holes and dumps	DairyNZ Farmfacts: Farm dumps and offal holes (5-5)

6 Appendices

6.1 Appendix 1 - Classification guidelines used to assess compliance status

Based on EW Doc# 767804

Compliance status for individual conditions

Compliance Status	Description
Not assessed	• Monitoring of this condition was not undertaken during this monitoring event
High priority non-compliance	• The non-compliance has the potential for, or has resulted in, significant adverse effects on the environment.
Medium priority non-compliance	• There is non compliance with limits or other direct controls on adverse effects; and • The non-compliance has the potential for, or has resulted in, a greater than minor increase in the level of effects authorised.
Low priority non-compliance	• There is non compliance with limits or other direct controls on adverse effects; and • The non-compliance has the potential for, or has resulted in, a less than minor increase in the level of effects authorised; and/or • There has been a significant technical non-compliance such as a failure to collect or supply self monitoring data.
Minor technical non-compliance	• There is non compliance with a condition, or part of a condition, that does not directly control adverse effects; and • The non-compliance was not significant in the management of effects. For example a short delay in supplying data or meeting a deadline for a report
Full compliance	• The condition has been complied with

Compliance status for individual consents and the entire site

Compliance Status	Description
Not assessed	• Monitoring has not been undertaken at this site during the current financial year
Significant non-compliance	• There has been a high priority non-compliance; and/or • There have been several medium priority non-compliances.
Partial compliance	• There has been a medium priority non-compliance; and/or • There have been several low priority non-compliances.
High level of compliance	• There has been a low priority non-compliance; and/or • There have been several minor technical non-compliances.
Full compliance	• All conditions that include limits or other direct controls on adverse effects have been complied with. • A small number of minor technical non-compliances may have occurred.

6.2 Appendix 2 - Waikato Regional Plan - Permitted Activity Rules

Section 3.5 Discharges

3.5.5.1 Permitted Activity Rule – Discharge of Farm Animal Effluent onto Land

The discharge of contaminants onto land from the application of farm animal effluent, (excluding pig farm effluent), and the subsequent discharge of contaminants into air or water, is a **permitted activity** subject to the following conditions:

a. No discharge of effluent to water shall occur from any effluent holding facilities.
b. Storage facilities and associated facilities shall be installed to ensure compliance with condition a).
c. All effluent treatment or storage facilities (e.g. sumps or ponds) shall be sealed so as to restrict seepage of effluent. The permeability of the sealing layer shall not exceed $1x10^{-9}$ metres per second.
d. The total effluent loading shall not exceed the limited as specified in Table 3-7, including any loading made under Rules 3.5.5.2 and 3.5.5.3, 3.5.6.2, 3.5.6.3 or 3.5.6.4.
e. The maximum loading rate of effluent onto any part of the irrigated land shall not exceed 25 millimetres depth per application.
f. Effluent shall not enter surface water by way of overland flow, or pond on the land surface following the application.
g. Any discharge of contaminants into air arising from this activity shall comply with permitted activity conditions in Section 6.1.8 of this Plan.
h. The discharger shall provide information to show how the requirements of conditions a) to g) are being met, if requested by the Waikato Regional Council.
i. The discharge does not occur within 20 metres of a Significant Geothermal Feature*.
j. Where fertiliser is applied onto the same land on which farm animal effluent has been disposed of in the preceding 12 months, the application must be in accordance with Rule 3.9.4.11.

Advisory Notes:

- Dischargers should note that many territorial authorities have specific rules which set minimum separation distances between treatment or disposal systems, adjoining properties, roadways and houses.
- In relation to sealing effluent treatment or storage facilities as referred to in condition c), the permeability requirement of $1x10^{-9}$ metres per second can generally be met through standard compaction procedures on soils with more than 8 percent clay. If the soil has less clay than this, special measures may be required (e.g. an artificial liner). Also, clays may not be suitable for storage facilities that are regularly emptied or are left dry for some time. Environment Waikato can provide advice on soil types and sealing requirements.
- Effluent treatment and storage facilities should be constructed in accordance with the publication 'Dairying and the Environment – Managing Farm Dairy Effluent' (1996) by the Dairying and the Environment Committee. Copies of this guideline are available from the New Zealand Dairy Research Institute, Private Bag 11029, Palmerston North.
- With regard to the effluent application rate in condition d), the standard of 150 kilograms of nitrogen per hectare per year can be converted into a minimum irrigation area and a maximum depth of effluent that can be applied each year. To do this for farm dairy effluent the following factors must be known or estimated:

a. The amount of nitrogen excreted by the cow – this can vary greatly (depending upon the composition of pasture, fertiliser use and animal management in the milking shed), but generally averages about 20 grams per cow per day.
b. The volume of nitrogen excreted by the cow – this can vary greatly (depending upon the amount of water used for washing down the yard), but averages a volume of 50 litres per cow per day.
c. The average lactation period – this is the average number of days that the cows are milked per season. It depends upon the potential of an area for dairy farming, and pasture management practices. A typical lactation period for cows in the Waikato Region is about 270 days, and can range from 190 days up to 300 days. It is important that each farmer consider their individual situation when estimating lactation period.

- Using the average values as specified, 150 kilograms of nitrogen per hectare per year equated to both:
    a. a land area requirement of 360 square metres per cow (i.e. about one hectare per 27 cows)
    b. an annual effluent loading rate of 75 millimetres per year.
- Discharges of contaminants into or onto land within 20 metres of a Significant Geothermal Feature are addressed by the Rules 7.2.6.1 and 7.2.6.2 of this Plan.
- To comply with condition f) application rates need to be adjusted for soil and seasonal climatic conditions. Generally, ponding should not occur if the application depth requirements in condition e) are complied with and the instantaneous application rates (per second) are appropriate to these conditions. In practice, implementation of this condition will acknowledge that some minor ponding on the land, for short durations may occur where there are areas of soil compaction.

Table 3-3 Nitrogen Loading Rate Calculations For Grazed Pasture

Total N/cow/year	= =	20 g/cow/day x 270 5.4 kg
Nitrogen loading rate Land area required/cow	= = = =	150 kg N/ha/year 5.4/150 0.036 ha 360 m2
Nitrogen loading rate land area required/ 100 cows	= = =	150 kg N/ha/year 5.4 100/150 3.6 ha

Sources of Data/Assumptions (Dairy Farm Effluent Management, 1995. Environment Waikato)

1. Total N/cow/day = 20 g
2. Nitrogen loading rate = 150 kg N/ha/year.
3. Typical lactation period = 270 days.

For the avoidance of doubt, Rule 3.5.5.2 is deemed to cover the periodic desludging of pond and barrier ditch systems and land application of sludge provided that the effluent application rate is less than 150 kilograms of nitrogen per hectare per year. Sludge can be applied to land at a higher rate than 150 kilograms per hectare of nitrogen but this would then be a discretionary activity subject to Rule 3.5.5.4.

Section 3.6 Damming and Diverting

3.6.4.4 Permitted Activity Rule - Small Dams and Damming Water

1. The damming of water and its diversion, taking, and discharging related to its passage through, past or over the dam, in any off-stream area or ephemeral river or stream or artificial watercourse, and
2. The use, erection, reconstruction, placement, alteration or extension of any associated structure in or on the bed of an ephemeral river or stream, where:
   i. the catchment area is less than one square kilometre (100 hectares), and
   ii. the maximum water depth of the pond is less than three metres, and/or
   iii. the dam retains not more than 20,000 cubic metres of water except that:
      a. the damming shall not affect Significant Geothermal Features
      b. the dam shall not occur in a cave system;

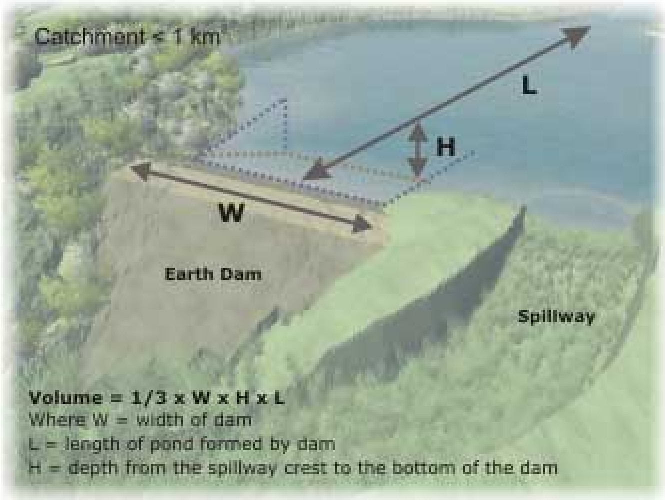
is a **permitted activity** subject to the following conditions:

a. The dammed water is not a Natural State Water Body as identified in the Water Management Class Maps.
b. The dammed water shall not raise water levels on neighbouring properties.
c. Any erosion or scour as a result of the dam and associated discharges shall be remedied as soon as practicable.
d. The damming or discharge of water from the dam shall not increase the potential for land instability.
e. A spillway must be constructed to prevent the dam being overtopped, and the spillway shall be designed to pass the probable maximum flood.
f. The spillway shall be constructed on underlying parent material.
g. The activity shall not disturb any archaeological site or waahi tapu as identified at the date of notification of this Plan, in any district plan, in the NZ Archaeological Association's Site Recording Scheme or by the Historic Places Trust except where Historic Places Trust approval has been obtained.
h. In the event of any waahi tapu that is not subject to condition g) being identified by the Waikato Regional Council to the person undertaking the activity, the activity shall cease insofar as it may affect the waahi tapu. The activity shall not be recommenced without the approval of the Waikato Regional Council.
i. The structure shall be maintained in a structurally sound condition at all times.
j. Any discharge from construction works associated with the structure shall comply with the suspended solid standards as set out in Section 4.2.21.

Advisory Notes:

- Dam construction guidelines are available from Environment Waikato (Guidelines for the Construction of Small, Homogenous Earthfill Dams).
- This Rule does not permit the extractive taking of water from a river or stream (including any dam). Extractive taking of water is addressed in Chapter 3.3.
- All dams are also required to comply with the requirements of the Building Act 1991 as specified in the Building Code and administered by territorial authorities.
- <u>Damming that affects Significant Geothermal Features is addressed in Rule 7.6.6.1. Significant Geothermal Features are defined in the Glossary and in Development and Limited Development Geothermal Systems, identified on maps in Section 7.10 of this Plan.</u>

- Small dams in perennial waters for creation and enhancement are enabled by Rule 3.6.4.16.
- The probable maximum flood needs to be determined on case-by-case basis but generally can be determined by taking the one percent exceedance probability and multiplying the flow by a factor of 1.6.
- Guidelines for the construction of spillways and dams are contained in Section 3.6.7.
- Where a waahi tapu site is identified whilst undertaking the activity, the process that Environment Waikato will follow in order to implement condition h) is set out in Section 2.3.4.22 of this Plan.
- To measure the depth and volume of water contained in the dam use the following equation.



3.6.4.5 Permitted Activity Rule - Existing Lawfully Established Damming of Perennial Water Bodies

The damming of water and its diversion, taking and discharging related to its passage through, past or over the dam; and the use or alteration of any associated structure, that was lawfully established or authorised before the date of notification of this Plan, where:

1. The catchment area is less than one square kilometre (100 hectares), and
2. The maximum water depth is les than three metres measured from the upstream toe of the dam structure, and/or
3. The dam retains not more than 20,000 cubic metres of water, and
4. The damming shall not affect Significant Geothermal Features;

is a **permitted activity** subject to the following conditions:

a. The dammed water shall not raise water levels on neighbouring properties.
b. The structure shall provide for the safe passage of fish both upstream and downstream.
c. A spillway must be constructed to prevent the dam being overtopped, and the spillway shall be designed to pass the probable maximum flood.
d. Any erosion or scour as a result of the dam and associated discharges shall be remedied as soon as practicable.
e. The structure shall be maintained in a structurally sound condition at all times.
f. Any discharge from construction works associated with the structure shall comply with the suspended solid standards as set out in Section 4.2.21.

g. The activity shall comply with any conditions that are part of a resource consent for an activity granted before the date of notification of this Plan other than conditions relating to review or expiry.
h. Any change in the activity shall not change the character or increase the scale or intensity of any adverse effects of the activity on the environment.
i. The activity shall not disturb any archaeological site or waahi tapu as identified at the date of notification of this Plan, in any district plan, in the NZ Archaeological Association's Site Recording Scheme or by the Historic Places Trust except where Historic Places Trust approval has been obtained.
j. In the event of any waahi tapu that is not subject to condition i) being identified by the Waikato Regional Council to the person undertaking the activity, the activity shall cease insofar as it may affect the waahi tapu. The activity shall not be recommenced without the approval of the Waikato Regional Council.

Advisory Notes:

- Any person or persons damming flowing water bodies should liaise with DoC regarding the requirements of the Freshwater Fish Regulations 1983.
- The probable maximum flood needs to be determined on a case-by-case basis but generally can be determined by taking the one percent exceedance probability and multiplying the flow by a fact of 1.6
- Guidelines for the construction of spillways and dams are contained in Section 3.6.7.
- This rule does not permit the extractive taking of water from a river or stream (including any dam). Extractive taking of water is addressed in Chapter 3.3.
- If any of these conditions are not complied with, then the activity is a controlled activity in accordance with Rule 3.6.4.10. If the activity is a new dam it is subject to Rule 3.6.4.14.
- All dams are also required to comply with the requirements of the Building Act 1991 as specified in the Building Code and administered by territorial authorities.
- Damming that affects Significant Geothermal Features is addressed in Rule 7.6.6.1. Significant Geothermal Features are defined in the Glossary and in Development and Limited Development Geothermal Systems, identified on maps in Section 7.10 of this Plan.
- Small dams in perennial waters for creation and enhancement are enabled by Rule 3.6.4.16.
- Where a waahi tapu site is identified whilst undertaking the activity, the process that Environment Waikato will follow in order to implement condition j) is set out in Section 2.3.4.22 of this Plan.

Section 4.2 River and Lake Bed Structures

Please note, there are consequential amendments to this River and Lake Bed Module (Module 4) as part of a Proposed Variation No.2 Geothermal that replaces the Geothermal Module (Module 7) of the Proposed Waikato Regional Plan. For details see Appendix IV to the Proposed Variation.

4.2.9 Culverts

Text appearing in green identifies those parts of the plan that are the subject of references to the Environment Court. Please email us for further information on legal status.

4.2.9.1 Permitted Activity Rule - Catchments Not Exceeding Five Hectares

Unless controlled by Rule 4.2.5.1 the following activities:

1. The use, erection, reconstruction, placement, alteration or extension of a culvert, and associated bed disturbances, in or on the bed of a river for catchments not exceeding five hectares upstream of the culvert, and
2. The subsequent diversion and discharge of water through the culvert, and
3. Any discharge of sediment associated with construction activities; and
4. Any associated deposition of construction materials

are **permitted activities** subject to the following conditions:

a. Any such culvert shall be designed so that a two percent annual exceedance probability (1 in 50 year) flood event shall not cause any increase in upstream water levels which causes flooding on neighbouring properties.

b. Culverts shall be designed to safely overtop without causing structural failure, or include a spillway, to ensure safe passage of flood flows where the two percent annual exceedance probability flood flow will overtop the embankment over the culvert.

c. The structure shall not cause:

   i. water depth upstream to exceed three metres, and
   ii. the water level immediately upstream to exceed the water level immediately downstream by more than three metres

d. The structure shall not be located in any permanently flowing water body or in the headwaters of any river identified for Natural State purposes in the Water Management Class Maps of this Plan.

e. The activity shall not disturb any archaeological site or waahi tapu as identified at the date of notification of this Plan, in any district plan, in the NZ Archaeological Association's Site Recording Scheme, or by the Historic Places Trust except where Historic Places Trust approval has been obtained.

f. In the event of any archaeological site or waahi tapu that is not subject to condition e) being identified while undertaking the use, erection, reconstruction, placement, alteration or extension, the activity shall cease insofar as it may affect the archaeological site or waahi tapu and the Waikato Regional Council shall be notified as soon as practicable. The activity shall not be recommenced without the approval of the Waikato Regional Council.

g. The construction works shall comply with the suspended solids discharge standards as set out in Section 4.2.21.

h. Any erosion occurring as a result of the structure, or diversion and discharge of water shall be remedied as soon as practicable.

i. No discharge shall be made outside of the natural catchment.

j. This rule shall not apply to activities located in, on, under or over the bed of a river or lake that is a significant geothermal feature that is regulated by Rules 7.2.6.1 and 7.2.6.2.

4.2.9.2 Permitted Activity Rule - Culverts for Catchments Not Exceeding 100 Hectares

Unless controlled by Rule 4.2.9.1 and Rule 4.2.5.1 the following activities:

1. The use, erection, reconstruction, placement, alteration or extension of a culvert, and associated bed disturbance, in or on the bed of a river or lake for a catchment area not exceeding one square kilometre (100 hectares) upstream of the culvert, and
2. The subsequent diversion and discharge of water through the culvert, and
3. Any discharge of sediment associated with construction activities; and
4. Any associated deposition of construction materials

are **permitted activities** subject to the following conditions:

a. Any such culvert shall be designed so that a two percent annual exceedance probability (1 in 50 year) flood event shall not cause any increase in upstream water levels which causes flooding on neighbouring properties.

b. The structure shall provide for the safe passage of fish both upstream and downstream.

c. There shall be no obstruction of debris that causes flooding on neighbouring properties.

d. The culvert invert shall be submerged when water is flowing.

e. Culverts shall be designed to safely overtop without causing structural failure, or include a spillway, to ensure safe passage of flood flows where the two percent annual exceedance probability flood flow will overtop the embankment over the culvert.

f. The structure shall not cause:

    i. water depth upstream to exceed three metres, and
    ii. the water level immediately upstream to exceed the water level immediately downstream by more than three metres

g. The construction works shall comply with the suspended solids discharge standards as set out in Section 4.2.21.

h. This rule does not apply within a Natural State water body as identified in the Water Management Class Maps of this Plan.

i. All equipment and surplus construction materials shall be removed from the river or lake bed and the floodplain on the completion of that activity.

j. No contaminants (including, but not limited to, oil, hydraulic fluids, petrol, diesel, other fuels, paint or solvents, but excluding sediment) shall be discharged to water from the activity.

k. The owner of the structure shall inform the Waikato Regional Council in writing, at least 10 working days prior to commencing construction, of the location of the structure and whether that structure is located within a flood control or drainage scheme managed by the Waikato Regional Council or a territorial authority.

l. The activity shall not disturb any archaeological site or waahi tapu as identified at the date of notification of this Plan, in any district plan, in the NZ Archaeological Association's Site Recording Scheme, or by the Historic Places Trust except where Historic Places Trust approval has been obtained.

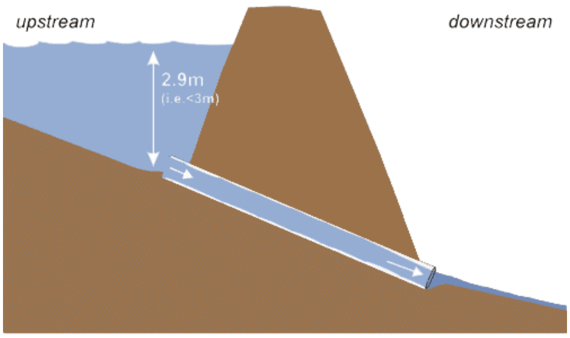
m. In the event of any archaeological site or waahi tapu that is not subject to condition l) being identified while undertaking the use, erection, reconstruction, placement, alteration or extension, the activity shall cease insofar as it may affect the archaeological site or waahi tapu and the Waikato Regional Council shall be notified as soon as practicable. The activity shall not be recommenced without the approval of the Waikato Regional Council.

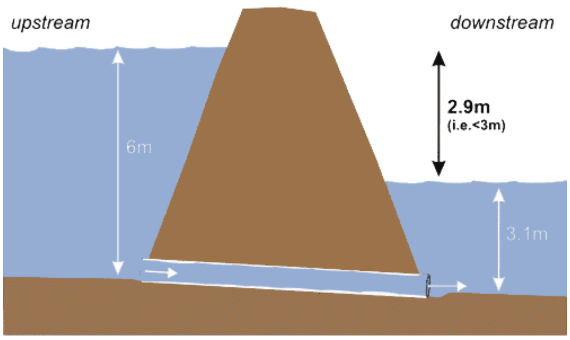
n. Any erosion occurring as a result of the structure, or diversion and discharge of water shall be remedied as soon as practicable.

o. No discharge shall be made outside of the natural catchment.

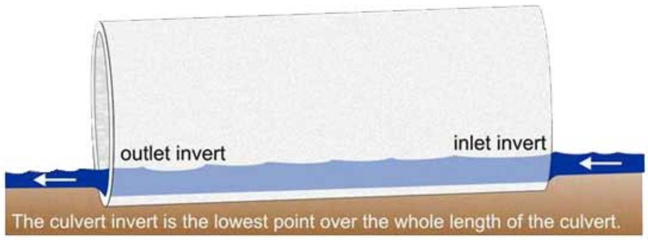
p. This rule shall not apply to activities located in, on, under or over the bed of a river or lake that is a significant geothermal feature that is regulated by Rules 7.2.6.1 and 7.2.6.2.

Upstream water depth not to exceed 3.0m and difference in water level across embankment not to exceed 3.0m.

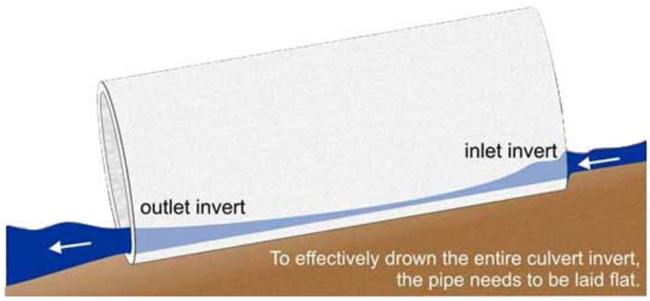




This culvert is drowned over the entire invert and complies with Rule 4.2.9.2 condition d)



This culvert is only drowned at the outlet invert. The upper portion of the culvert invert has rapidly flowing water on it and still acts as a barrier to fish. This culvert does not meet Rule 4.2.9.2 condition d)



Section 4.3

4.3.5.4 Livestock on the Beds and Banks of Rivers and Lakes

Except on the beds and banks of any water body mapped in the Livestock Exclusion Layer in the Waikato Regional Plan Maps:

1. Livestock entering or crossing part of the bed or bank of a river or lake, and
2. Any associated discharge of suspended solids;

are **permitted activities** subject to the following conditions:

a. The activity shall

   i. comply with the suspended solids discharge standards as set out in Section 3.2.4.5 of this Plan; and
   ii. not cause a reduction in visual clarity of more than 10 percent measured at the point of compliance specified in Section 3.2.4.5 of this Plan

b. Any erosion occurring that leads to a breach condition a) of this Rule as a result of livestock entering or crossing the bed or banks of a river or lake shall be remedied as soon as practicable.
c. The amount of time livestock spend crossing water bodies shall be minimised by providing crossing sites.
d. In a grazing situation, the amount of time that livestock spend in the bed or on the banks of lakes and rivers shall be minimised.

Advisory Notes:

If conditions a) – d) are not complied with, then the activity is a non-complying activity in accordance with Rule 4.3.5.6.

- Refer to Method 4.3.5.2 as to how Environment Waikato will enforce this Rule.
- Practical means of compliance with Rule 4.3.5.4 include, but are not limited to:

  a. the use of bridges or culverts
  b. fencing of riparian areas
  c. the use of gates in conjunction with fencing
  d. provision of troughs for livestock watering in adjacent fenced pasture areas
  e. construction of crossings so as to be as direct a route across the bed of the river or lake as is practicable
  f. construction of hard entry and exit points at livestock crossing sites. Also refer to Rule 4.2.11.1 in respect of fords.

- Compliance with condition a) ii) will be assessed by measurement of horizontal water clarity using a black disc or measurement of turbidity.
- Erosion in the context of this Rule means banks being broken down, and the river bed being disturbed to the extent that there are adverse effects such as the widening or shallowing of the river channel.
- When livestock are crossing river beds it is desirable to ensure that:

  a. effective steps are taken to prevent livestock loafing
  b. grazing of bank side vegetation is avoided

c. trampling of aquatic habitat, or livestock defecating directly into the water or onto the immediate bank is minimised.

- The actions required to comply with condition d) will vary depending on the intensity of the farming operation. Where stocking rates alongside water bodies are high (for example under rotational grazing systems of mob stocking) the following types of actions will probably be necessary to ensure compliance:

  a. use of permanent or temporary fences along the banks to deter livestock loafing in the stream bed, grazing of bank side vegetation, trampling aquatic habitat or defecating directly into the water or onto the immediate bank.
  b. provision of alternative water supplies so that stock do not need to access the bed of the waterbody.
  c. provision of shade so stock do not need to cool themselves by standing in water.

- Rule 4.3.5.4 has relatively narrow application and may be difficult to comply with. In circumstances where the bed of a river or lake has a soft or silty substrate, where large herds of livestock are crossing frequently or where stock have unrestricted access, it is unlikely that conditions a) and b) can be satisfied.

<u>Lake and River definitions (taken from Waikato Regional Plan Glossary)</u>

River: A continually or intermittently flowing body of fresh water, and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal).

Lake: A body of fresh water which is entirely or nearly surrounded by land.

List of Live Stock Exclusion waterbodies (from Proposed Waikato Regional Plan)

4.3.5.3 Livestock Access

In addition to using a mixture of non regulatory methods and rules with effects based performance standards that must be met where livestock have access to water bodies, Environment Waikato will require that livestock be excluded from mapped portions of water bodies identified as priority 1 water bodies in Table 4-1. At Plan review and when allocating funding as part of its Long Term Council Community Plan, Environment Waikato will consider the need to extend this requirement for livestock exclusion to those water bodies identified as Priority 2 in Table 4-1.

Table 4-1

Water Body Type	Priority 1 – to be mapped as Stock Exclusion Areas in the Regional Plan Maps	Priority 2
Margins of Small, Shallow Lakes (includes peat lakes and other lakes, excluding Lake Taupo)	• Rotongaro • Okowhao • Whangape • Waikare • Serpentine • Kuratau • Taharoa • Rotomanuka • Mangakaware • Ohinewai • Waahi • Rotokawau	• Ngaroto • Matahura Catchment • Whangape Catchment • Waahi Catchment • Lake Harihari
Wetlands	• Whangamarino wetland • Kopuatai peat dome • Wetlands listed in Waikato Regional Plan 3.7.7 • Opuatia	• Mangatawhiri Wetlands • Tauhua Wetland • Wetlands of the Upper Mokau Basin
Spring-fed dominated surface water	Waihou River and tributaries above Whites Rd bridge.	Waipa River and tributaries above Toa Bridge Mokau River and Tributaries North East of SH4
Natural state water bodies	Natural State water bodies	
High value rivers Rivers and their tributaries upstream of long term water quality monitoring	• Kauaeranga • Waiwawa	

sites listed.		
Habitat fringes (banks of flow stable tidally influenced waterways)	Sites within about 2 km upstream and 2 km downstream of saltwater intrusion OR if unknown 2 km upstream from Mean High Water Spring. • Known: • Waikato River Mouth • Waihou • Kawhia • Raglan • Mokau • Awakino River Mouth	Waikawau River Mouth Sites and areas of significant conservation value (ASCV), excluding off-shore islands.
Coromandel streams	• Waiharekeke • Te Puru • Huakitoetoe • Whareroa • Mataiterangi • Potiki Bay • Whenuakite • Horseshoe Bay • Sandy Bay • Fantail Bay • Awaroa Stream • Whauwhau Stream • Waiwawa • Kauaeranga	
Lake Taupo and tributaries	Banks of Lake Taupo All tributaries into Lake Taupo including the Tongariro, Tauranga-Taupo, Waihaha, Hinemaiaia and Waitahanui Rivers	
Other Rivers		Maramarua River Catchment Whangamarino River Mangatawhiri River Lower Waikato River Banks Waikato River above Karapiro Dam

Section 5.1

5.1.4.11 Permitted Activity Rule – Soil Disturbance, Roading and Tracking and Vegetation Clearance

d. Unless otherwise provided for by Rules 5.1.4.14, 5.1.4.15, 5.1.4.16 or 5.1.4.17, soil disturbance, roading and tracking, and vegetation clearance and any associated deposition of slash into or onto the beds of rivers and any subsequent discharge of contaminants into water or air;
e. Any roading and tracking activities associated with the installation of bridges or culverts permitted by Rules 4.2.8.1, 4.2.9.1 and 4.2.9.2, within 20 metres of that bridge or culvert and any associated deposition of slash into or onto the beds of rivers and any subsequent discharge of contaminants into water or air;
f. Vegetation clearance of planted production forest as planted at the date upon which this Plan becomes operative;

are **permitted activities** subject to the conditions in Section 5.1.5. In addition 5.1.4.11(3) is subject to the following conditions:

- Provided that replanting of planted production forest does not occur within:
  - five metres, on either side, of the bed of a water body excluding an ephemeral stream (except on the Coromandel Peninsula); and
  - ten metres, on either side of the bed of a water body excluding an ephemeral stream on the Coromandel Peninsula streams greater than 50 hectares
  - five metres on either side of the bed of water bodies between 20 and 50 hectares on the Coromandel Peninsula regardless of slope;

b. On the Coromandel Peninsula where wilding pines are present at a density of greater than 50 stems per kilometre of riparian margin they will all be removed at first thinning so long as practicable from a safety perspective.

Advisory Notes:

- District plans may have rules which restrict land disturbance and vegetation clearance in areas outside of high risk erosion areas.
- Grazing and cultivation are excluded from the requirements of this Rule.

Table 5.1.5 - Conditions for Permitted Activity Rule 5.1.4.11 and Standards and Terms for Controlled Activity Rules

a. Organic material shall not be placed in fill where its subsequent decomposition will lead to land instability.
b. Erosion/sediment controls shall be installed and maintained on all earthworks during and on completion of the works to avoid the adverse effects of sediment on water bodies.
c. Cut-offs or culverts shall be designed and installed to prevent scour, gullying or other erosion.
d. Any erosion or instability of the coastal environment, or the beds of rivers and lakes or wetlands shall be avoided or remedied if it does occur.
e. The activity shall not result in neighbouring land becoming subject to flooding.

f. All disturbed vegetation, soil or debris shall be deposited or contained to prevent the movement of disturbed matter so that it does not result in:

   i. the diversion, damming or blockage of any river or stream, or
   ii. the passage of fish being impeded, or
   iii. the destruction of any habitat in a water body or coastal water, or
   iv. flooding or erosion.

g. The activity shall not disturb any archaeological site or waahi tapu as identified at the date of notification of this Plan, in any district plan, in the New Zealand Archaeological Association's Site Recording Scheme, or by the Historic Places Trust except where Historic Places Trust approval has been obtained.
h. The concentration of suspended solids in any point source discharge arising from the activity shall comply with the suspended solids standards as set out in Method 3.2.4.6. This condition applies only to permitted activity rules and excludes any non-point source discharges from roading, tracking and vegetation clearance activities (refer condition o) below).
i. Any discharge of contaminants into air arising from the activity shall comply with the permitted activity conditions in Section 6.1.8 except where the matters addressed in Section 6.1.8 are already addressed by conditions on resource consents for the site.
j. In the event of any waahi tapu that is not subject to g) above being identified by the Waikato Regional Council to the person undertaking the activity, the activity shall cease insofar as it may affect the waahi tapu. The activity shall not be recommenced without the approval of the Waikato Regional Council.
k. No storage or mixing of fuels, oils, or agrichemicals shall be undertaken in areas where deliberate or inadvertent discharge is likely to enter any permanent natural surface water body.
l. All vegetation that is being felled within five metres of a perennial water body shall be felled away from the water body, except edge vegetation, or vegetation leaning over a water body, which if necessary may be felled in accordance with safety practices.
m. All exposed areas of soil resulting from the activity shall be stabilised against erosion by vegetative cover or other methods as soon as practical following completion of the activity and no later than six to twelve months from the date of disturbance to avoid the adverse effects of sediment on water bodies.
n. The activity shall not be located within 20 metres of a significant geothermal feature that is regulated by Rules 7.2.6.1 and 7.2.6.2.
o. The concentration of suspended solids in any non-point discharges from roading, tracking and vegetation clearance activities shall meet the following standards;

i. The activity or discharge shall not result in any of the following receiving water standards being breached:
ii. in Waikato Region Surface class waters - 100 grams per cubic metre suspended solids concentration
iii. in Indigenous Fisheries and Fish Habitat class waters - 80 grams per cubic metre suspended solids concentration
iv. in Trout Fisheries and Trout Spawning Habitat class waters - 25 grams per cubic metre suspended solids concentration
v. in Contact Recreation class waters - black disc horizontal visibility greater than 1.6 metres
vi. in Natural State class waters - the activity or discharge shall not increase the concentration of suspended solids in the receiving water by more than 10 percent

Standard a) shall apply, except where the suspended solids concentration or black disc horizontal visibility in the receiving water is greater than the standards specified, at the time and location of discharge or of undertaking the activity. Then there shall not be any increase (i.e. further deterioration) in the receiving water suspended solids concentration or black disc horizontal visibility of more than 20% as a result of the activity or discharge.

The point at which compliance with this standard shall be measured is after reasonable mixing has occurred which in any instance does not exceed 200 metres from the point of discharge.

p. Soil disturbance associated with the construction of a road or track within 20 metres of a culvert or bridge provided for in Rules 4.2.8.1, 4.2.8.2, 4.2.9.1, 4.2.9.2 and 4.2.9.3;

i. Shall not occur adjacent to Significant Indigenous Fisheries and Fish Habitat Class waters during August to December inclusive and Significant Trout Fisheries and Trout Habitat class waters during May to September inclusive; and,
ii. Shall be stabilised against erosion by vegetative cover or other methods as soon as practical following completion of the activity and no later than two months from the date of disturbance to avoid the adverse effects of sediment on water bodies; and
iii. The location of the proposed soil disturbance shall be notified to the Waikato Regional Council in writing at least 10 working days prior to commencing construction.

Advisory Note:

- Where a waahi tapu site is identified whilst undertaking the activity, the process that Environment Waikato will follow in order to implement condition/standard and term j) is set out in Section 2.3.4.22 of this Plan.

Section 5.2 Discharges Onto or Into Land

5.2.6.1 Permitted Activity Rule - Dumps on Production Land[1]

The discharge of solid waste into or onto land as part of the operation of a dump on production land where the contaminants are sourced only from the property on which the dump occurs, outside of:

1. The catchment of, or within 10 metres of, whichever is the lesser, a sink hole* or cave entrance
2. A floodplain of a river
3. Any wetlands[2] that are areas of significant indigenous vegetation and/or significant habitats of indigenous fauna
4. A significant geothermal feature

is a **permitted activity** subject to the following conditions:

a. The waste shall not contain:
    i. hazardous substances*, including residues in empty agrichemical, detergent and oil containers
    ii. sewage, offal or animal carcasses.
b. No contaminants from the dump on production land shall be discharged into water.
c. The activity shall not disturb any archaeological site or waahi tapu as identified at the date of notification of this Plan (28 September 1998), in any district plan, in the NZ

Archaeological Association's Site Recording Scheme, or by the Historic Places Trust except where Historic Places Trust approval has been obtained.

d. In the event of any waahi tapu that is not subject to condition c) being identified by the Waikato Regional Council to the person undertaking the activity, the activity shall cease insofar as it may affect the waahi tapu. The activity shall not be recommenced without approval of the Waikato Regional Council.

Advisory Notes:

- Guidance on suitable locations for dumps on production land is provided in Section 5.2.12.
- Where the dump on production land receives waste from more than one property, it is subject to the rules for landfills in Section 5.2.7.
- Land use consents for dumps on production land may also be required by district plans. These will address issues such as amenity effects, noise, protection of identified areas of significant indigenous vegetation[2] and outstanding landscapes and future uses of the site. The thresholds at which resource consents are required vary within each territorial authority area.
- Discharges of contaminants into land that affect Significant Geothermal Features are addressed in Rule 7.6.6.1. Significant Geothermal Features are defined in the Glossary, and in Development and Limited Development Geothermal Systems, identified on maps in Section 7.10 of this Plan.
- Where a waahi tapu site is identified whilst undertaking the activity, the process that Environment Waikato will follow in order to implement condition d) is set out in Section 2.3.4.22 of this Plan.

5.2.6.2 Permitted Activity Rule - Offal Holes on Production Land

The discharge of contaminants into or onto land as part of the operation of an offal hole on production land where the contaminants are sourced from the property on which the offal hole is sited and any subsequent discharge to air that does not comply with Rule 5.2.6.1 when occurring outside of:

1. The catchment of, or within 10 metres of, whichever is the lesser, a sink hole* or cave entrance
2. A floodplain of a river
3. Any wetlands[3] that are areas of significant indigenous vegetation and/or significant habitats of indigenous fauna
4. A significant geothermal feature

is a **permitted activity** subject to the following conditions:

a. Only dead animal matter and perishable household waste shall be disposed of into the offal hole.

b. The waste shall not contain:

    i. hazardous substances or material contaminated by hazardous substances (including residues in empty agrichemical, detergent and oil containers)

    ii. sewage.

c. The lowest point of the offal hole shall be at least one metre above the level of the seasonally shallowest water table.

d. Where the offal hole was in use prior to this Plan becoming operative and the lowest point of the offal hole was less than one metre above the seasonally shallowest water table, there must be no discharge of contaminants to water.

e. The offal hole shall be covered to prevent surface water from entering the offal hole and prevent pests from gaining access to the waste.

f. The activity shall not disturb any archaeological site or waahi tapu as identified at the date of notification of this Plan (28 September 1998), in any district plan, in the NZ Archaeological Association's Site Recording Scheme, or by the Historic Places Trust except where Historic Places Trust approval has been obtained.
g. In the event of any waahi tapu that is not subject to condition f) being identified by the Waikato Regional Council to the person undertaking the activity, the activity shall cease insofar as it may affect the waahi tapu. The activity shall not be recommenced without approval of the Waikato Regional Council.
h. There are no objectionable effects as a result of odour beyond the property boundary.
i. The offal hole shall not be within 100 metres of any water supply bore or water body.

Advisory Notes:

- Guidance on good practice for the suitable location of offal holes is provided in Section 5.2.12.
- Where the offal hole, on production land, receives waste from more than one property, it is subject to the rules for landfills in Section 5.2.7.
- Land use consents for offal holes may also be required by district plans. These will address issues such as amenity effects, noise, protection of identified areas of significant indigenous vegetation[2] and outstanding landscapes and future uses of the site. The thresholds at which resource consents are required vary within each territorial authority area.
- Soil disturbance activities and the discharge of contaminants into or onto land within 20 metres of any Significant Geothermal Feature is a discretionary activity under Rule 7.6.6.1. Significant Geothermal Features are defined in the Glossary, and in Development and Limited Development Geothermal Systems, identified on maps in Section 7.10 of this Plan.
- Where a waahi tapu site is identified whilst undertaking the activity, the process that Environment Waikato will follow in order to implement condition g) is set out in Section 2.3.4.22 of this Plan.

5.2.12 Good Practice Guide on Location of Dumps and Offal Holes on Production Land

The following good practice guide provides some initial guidance on the best locations for dumps and offal holes on production land. It should be read with the rules in Section 5.2.6.

a. To prevent or minimise the risk of adverse effects associated with dumps and offal holes on production land such facilities shall not be located within:
    i. 100 metres of any water supply bore, water body or area identified by a district plan as being a significant habitat of indigenous flora and fauna[1] .
    ii. A coastal sand dune system or within 100 metres of the coastal marine area.
    iii. 10 metres of a cave entrance or stream sink.
    iv. 20 metres of a significant geothermal feature.
    v. 50 metres of a property boundary.
    vi. 300 metres from a marae, residential zone, hall or a public reserve.
    vii. High risk erosion areas.
    viii. Floodplains of rivers or streams.
    ix. Any wetland area.

b. In soils where water tables are very close to the surface, consideration should be given to composting of offal material or the use of commercial animal carcass collection services as an alternative waste disposal means.
c. Under no circumstances should the base of the disposal area come into contact with the ground water table.
d. When offal holes or dumps are closed, their location should be clearly identified so that future users or owners of the farm do not accidentally disturb the site.
e. Offal holes should be covered with an impermeable concrete or metal manhole cover which is in kept place whenever the offal hole is not in use.

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