Piggery Effluent Management Compliance Monitoring Procedures

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Introduction:

There are 61 authorised piggery operations in the Waikato Region. About 45% of the piggeries are considered as small operations (i.e. < 500 pig 50 kg equivalents) and 36% are large operations (> 1000 pig 50 kg equivalents) (Table 1).

Table 1. Piggery sizes and sites in the Waikato Region

Piggery size	Number of sites
<500 pe	28
<1000 pe	11
<1500 pe	13
>1500 pe	9
Total	61

Piggeries produce typically about 20 litres of effluent/50 pig eq./day. The effluent is generated when the piggery excreta in the shed is washed with water. Like many other effluents, piggery effluent has many contaminants (i.e. suspended solids, organic-C, ammoniacal-N, organic-N, phosphorus, sulphur, copper and faecal bacteria) (Table 2). Compared to dairy farm effluent, piggery effluent has very high amount of ammoniacal-N, total-P and copper.

The ammoniacal-N ($NH_3 + NH_4$) in raw effluent is generated from urea-N in urine. The ammoniacal-N build up from urea-N is an enzymic process and hence depends on temperature and moisture.

$CO(NH_2)_2$ + H_2O -urease→ $NH_3\uparrow$ + NH_4^+ + $CO_2\uparrow$
urea moisture ammonia ammonium

Ammoniacal-N builds-up rapidly during warm weather conditions. Although the peak ammoniacal-N build-up could take from 8-12 hours, ammoniacal-N could form within 1-2 hours of urination. The proportion of urine-N to faeces-N drives the proportion of ammoniacal-N to total-N. Generally, the quality of the diet dictates the amount of urine-N produced. Greater the amount of urine-N, greater the quantity of ammoniacal-N in the effluent. However, in some cases the frequency of shed washing can also affect the ammoniacal-N levels. Infrequent washings results in ammonia volatilisation from pig urine in the shed (which causes odour in the shed) hence the ammoniacal-N

levels may drop in the effluent. Conversely, frequent washings will result in reduced ammoniacal-N in raw effluent due to reduced breakdown of urea-N to ammoniacal-N. Consequently, the proportion of the ammoniacal-N in raw effluent can vary widely between piggeries (25% to 75%).

Table 2. Raw and treated piggery effluent quality from selected sites

Source	SS g/m^3	BOD5 g/m^3	NH4-N g/m^3	TKN g/m^3	TP g/m^3	S g/m^3	Cu g/m^3	K g/m^3
Farm 1 - Raw	10300	12800	720	1030	104	109	0.30	199
Farm 1 - Aerobic Pond	480	1650	780	727	38	14	0.04	188
Farm 2 - Raw	10700	7200	300	713	763	69	0.70	191
Farm 3 - Raw	28800	14100	360	1490	942	189	19.20	103
Farm 3 - Aerobic Pond	220	470	340	300	25	13	0.03	68

Table 3. Median quality of raw and treated farm dairy effluent

Variable	Units	Raw n=53	Pond 1 n=180	Pond 2 n=140	Pond 3 n=7	Ditch 1 n=14	Ditch 3 n=21
Temp	^oC	n.m.	18	16	16	18	16
pH	pH units	8.6	7.4	7.9	7.7	7.7	7.6
Cond	mS m^{-1}	261	260	171	117	323	174
DO	g m^{-3}	n.m.	1.5	4.0	2.7	1.3	4.1
BOD_5	g m^{-3}	n.m.	160	83	36	160	63
SS	g m^{-3}	4780	430	220	69	350	125
NH_4-N	g m^{-3}	130	150	69	42	170	80
NNN-N	g m^{-3}	n.m.	0.05	0.44	0.82	0.05	0.04
TKN	g m^{-3}	355	190	91	55	233	95
DRP	g m^{-3}	6.6	8.5	5.7	3.9	9.3	7.9
TP	g m^{-3}	49.1	29.7	20.0	9.4	50.0	22
DOC	g m^{-3}	369	115	68	45	161	100
TOC	g m^{-3}	567	176	87	54	241	105
COL	n/100 mL	n.m.	$1.1x10^6$	$2.5x10^5$	$6.3x10^4$	$2.4x10^6$	$2.3x10^5$
EC	n/100 mL	n.m.	$5.4x10^5$	$3.5x10^4$	$3.4x10^4$	$7.0x10^5$	$5.1x10^4$

n.m. not measured

Since the introduction of the Dairy Shed Operative Plan by Environment Waikato in 1993 and its successful implementation, land treatment has become the preferred effluent treatment system. Increasing number of pig farmers are using land treatment system to treat piggery effluent. Majority of them are applying effluent up to 150 kg N/ha/year onto grazed pasture. Nevertheless, a high number of farmers are continuing to discharge treated effluent into waterways. Due to the high level of ammoniacal-N in treated effluent discharge (e.g. 340 to 780 mg ammoniacal-N/litre) and its immediate adverse impacts on fish as a toxicant and downstream impact as a source of nutrient for aquatic plants, preferably, piggery effluent discharge should not be allowed into waterways.

Compared to dairy farm effluent compliance monitoring, piggery compliance monitoring has been performed on an ad hoc basis by Environment Waikato. The objective of the document is to clearly define the principles and methods of piggery compliance monitoring.

Objective:

To minimise or avoid adverse environmental effects caused by piggeries in the Waikato Region.

Procedures:

(1) Audit all operative piggery sites within the Waikato Region at least once a year for compliance including odour management.
(2) Audit all non-operative piggery sites annually during early summer.
(3) Effects of individual piggeries on surface water and ground water will be monitored using information obtained from compliance monitoring. Where possible the information gap for effects monitoring will be narrowed through further monitoring at council's cost.
(4) Justifiable complaints will be dealt with seriously.
(5) Where appropriate, strong link will be made between the Consent Processing Officer and Compliance Monitoring Officer.
(6) Regular liaison with the Pork Industry and piggery farmers on regulatory and environmental education approaches to piggery impacts.
(7) Where appropriate, and as a last resort, recommendations will be made to the council's Regulatory Committee to take legal action against non-complying piggery owners.
(8) Where appropriate policy recommendations will be made by the Agriculture and Forestry Programme (Resource Use Group) to policy makers (i.e. MfE, MAF Policy and EW) with regard to the management of piggery operation effects on the environment.

Classification of piggeries:

Classification of piggeries is vital for ease of management of compliance and effects monitoring. Classification is made on the basis of potential environmental impacts. It is considered that large piggeries will have greater *potential* for adverse effects on the environment due to high mass of effluent and contaminants compared with small piggeries. However, small piggeries could cause adverse effects (particularly odour) when they are not managed properly. Moreover, environmental risks are also associated with the media into which the contaminants are released regardless of the size of the operation. Generally, treated effluent discharges to waterways have greater environmental risks compared to land treatment systems. Within land treatment systems environmental risk is related mainly to nitrogen loading rates. Higher the loading rates greater the environmental risks. The environmental risks must also include emission of contaminants to atmosphere and potential for surface run-off of effluent into surface water.

The following factors must be considered to assess environmental risks:
1. Discharge media:

I. Land
- a. Hydraulic loading
- b. Nitrogen loading
- c. Other contaminant loadings (e.g. phosphorus and copper)
- d. Odour of the effluent
- e. Methods of application (e.g. soil injection, spray irrigation)
- f. Land use (i.e. grazed pasture, silage or hay production, other crops)
- g. Slope and soil types
- h. Hydrogeology
- i. Buffer zones from waterways and dwellings

II. Ground water (applicable only for treatment ponds)
- a. Hydrogeology
- b. Ground water use
- c. Volume and quality of discharge

III. Surface water
- a. Water flow
- b. Water use
- c. Water quality (chemistry and biology)
- d. Volume of discharge
- e. Quality of discharge (e.g. BOD, Suspended solids, odour, ammonia, nutrients, faecal coliforms)
- f. Duration of discharge (seasons, hours/day)

IV. Air
- a. Objections from neighbours
- b. Wind direction
- c. Type of operation (e.g. treatment ponds, spray irrigation, pig rearing)
- d. Management efficiency of treatment systems and the sheds
- e. Type of contaminants (e.g. odour causing chemicals, spray drift)

2. Discharge duration (i.e. number of years, days/year)

Piggery Size classification:
(a) Small (< 500 fifty kg equivalents)
(b) Medium (500-1000 fifty kg equivalents)
(c) Large (> 1000 fifty kg equivalents).

Effluent discharge option:
(a) Pond systems with discharge to waterways
(b) Discharge to land
- 1. < 150 kg N/ha/year
- 2. > 150 kg N/ha/year

(c) Seasonal discharges to land and waterways
(d) Deep litter

Monitoring Procedures:

Procedure 1 *Audit all operative piggery sites within the Waikato Region at least once a year for compliance including odour management.*

(A) Discharge to land (< 150 kgN/ha/year)

Principles

Site inspection: Piggery effluent or sludge discharged to clover based grazed pasture or any other crops < 150 kg N/ha/year is likely to cause minimal effects on ground water and soil quality. In this case piggery effluent is used as a manure for food (or coppice) production. Consequently, such sites require only minimal auditing. Site auditing is generally visual inspection for good irrigation practices.

Effluent quality assessment: Piggery effluent is either applied raw or from treatment ponds onto land. A representative sample from an appropriate effluent source should be assessed for the followings:

1. Total kjeldahl nitrogen (TKN): Since piggery effluent (treated or raw) has little or no nitrate TKN analysis is sufficient to monitor the N loading.
2. Total copper (Cu): Piggery effluent contains a high level of Cu and hence should be monitored for loading rates.
3. Total phosphorus (P): Total P should be measured for long term accumulation of P in soil.
4. Potassium (K): Effluent with high content of K applied to pasture will result in reduced levels of magnesium (Mg) and calcium (Ca) in plant. K should be monitored for plant and animal health purposes.

Methods

1. Site visit - Small and medium - once a year, Large - twice a year.
2. Site inspection for method of irrigation, volume of effluent, sludge or solid waste management, treatment pond or storage system management, odour, piggery shed management including pig numbers crop and soil conditions and management.
3. Effluent volume and quality assessment (once a year for small and medium sites, twice a year for large sites) for
   - TKN (at the owner's cost)
   - total copper and zinc (at the owner's cost)
   - total phosphorus (council)
   - potassium (council)

(B) Discharge to land (> 150 kgN/ha/year)

Principles

A substantial amount of research is required to evaluate the adverse effects of high N loadings onto land. However, according to the detailed N modelling (Selvarajah, 1996) and more recent research on N transformation, it is clear that N applied > 150

kg N/ha/year particularly to grazed pasture has greater environmental risks. Nevertheless, it could be argued that certain other land uses (e.g. 'cut & carry pasture', maize, coppice) could use applied N more efficiently than grazed pasture and hence greater N loadings could be justifiable. In these cases land is used as a waste treatment and a production system. The following criteria are used for N loading rate > 150 kg N/ha/year.

1. 150-300 kg N/ha/year to clover based grazed pasture
2. 300-400 kg N/ha/year to non-clover based grazed pasture
3. 300-400 kg N/ha/year to 'cut & carry clover based pasture'
4. 500-600 kg N/ha/year to 'cut & carry non-clover pasture'
5. 150-300 kg N/ha/year to other crops (e.g. maize, coppice Eucalyptus)

All land treatment sites receiving effluent > 150 kg N/ha/year will have ground water monitoring sites (i.e. piezometers) depending on land size and spatial variability. Minimum sampling sites required are 3 including a control site. Soil will be assessed for quality. Effluent and crop (where appropriate) will be monitored for quality and quantity.

Methods

Table 3. Monitoring programme for land treatment systems

Land use	**Crop analyses**	**Ground water analyses**	**River / stream analyses**	**Soil analyses (0-20 cm)**	**Effluent analyses**
Clover pasture (150-300 N)	TKN Mg Dry matter Copper/Zinc *All annually*	Nitrate *monthly* DRP *annually*	Nitrate *March and September upstream and downstream*	Mineralisable-N potassium Olsen-P copper/zinc magnesium calcium *annually 15 soil cores composited*	TKN total-P potassium copper/zinc *monthly from composite samples*
'cut & carry clover pasture' (300-400 N)	TKN Dry matter *Following each harvest* copper/zinc magnesium *Annually from composite samples*	Nitrate *Monthly* DRP *Annually*	Nitrate *March and September upstream and downstream*	Mineralisable-N potassium Olsen-P copper magnesium calcium *annually 15 soil cores composited*	TKN total-P potassium copper/zinc *monthly from composite samples*
'cut & carry non-clover pasture' (500-600 N)	TKN Dry matter *Following each harvest* copper/zinc	Nitrate *Monthly* DRP *Annually*	Nitrate *March and September upstream and downstream*	Mineralisable-N potassium Olsen-P copper/zinc magnesium	TKN total-P potassium copper/zinc *monthly from composite*

	magnesium *Annually from composite samples*			calcium *annually 15 soil cores composited*	*samples*
Other crops (150-300 N)	TKN Dry matter *Following each harvest* copper/zinc magnesium *Annually from composite samples*	Nitrate *Monthly* DRP *Annually*	Nitrate *March and September upstream and downstream*	Mineralisable-N potassium Olsen-P copper/zinc magnesium calcium *annually 15 soil cores composited*	TKN total-P potassium copper/zinc *monthly from composite samples*

1. Site visit - Quarterly
2. Site assessment for general compliance.
3. Annual reporting

Annual Environmental (i.e. effluent, crop, soil, and water quality) and site management reporting by the owner or owner's consultant

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Technical assessment and comments to the owner by EW

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Meeting at the site to discuss compliance, environmental effects and future directions

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Meeting minutes sent to the EW Resource Officer

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Follow-up by the EW Resource Officer

C. Discharge to waterways

Principles

Discharges to waterways are generally discouraged. However, if discharges to waterways are allowed the following factors will be considered to determine the extent of the monitoring:

1. Farm size (this is generally related to discharge volume)
2. Effluent quality (generally depends on the treatment systems)
3. Receiving environment (this depends on effluent quality and water flow combined). A dilution factor of 100 fold is used for both ammoniacal-N and enterococci.

The frequency of sampling and the extent of effluent/water quality monitoring depend on the environmental risks associated with the system.

Table 4. Monitoring programme for discharges to surface water

Farm size	Receiving environment	Sampling frequency	Effluent analysis	Water analysis (upstream & downstream)
Small	High/medium flow (i.e. > 100 fold dilution for Enterococci and ammoniacal-N)	Annual *Early March*	BOD, Enterococci, SS, Ammoniacal-N, TKN, DRP Volume/day	Nil
Small	Low flow (i.e. < 100 fold dilution for Enterococci and ammoniacal-N)	Annual *Early March*	Nil	BOD SS Enterococci Temperature (field) pH (field) DO (field) Ammoniacal-N DRP
Medium	High/medium flow (i.e. > 100 fold dilution for Enterococci and ammoniacal-N)	Annual *Early March*	Nil	BOD SS Enterococci Temperature (field) pH (field) DO (field) Ammoniacal-N DRP
Medium	Low flow (i.e. < 100 fold dilution for Enterococci and ammoniacal-N)	Twice a year *January and March*	Nil	BOD SS Enterococci Temperature (field) pH (field) DO (field) Ammoniacal-N DRP
Large	High/medium flow (i.e. > 100 fold dilution for Enterococci and ammoniacal-N)	Thrice a year *November, January and March*	Nil	**Biota (field)** BOD SS Enterococci Temperature (field) pH (field) DO (field) Ammoniacal-N DRP
Large	Low flow (i.e. < 100 fold dilution for Enterococci and ammoniacal-N)	Four per year *September, November, January and March*	Nil	**Biota (field)** Water flow BOD SS Enterococci Temperature (field) pH (field) DO (field) Ammoniacal-N DRP

Large piggery sites audit:

1. Site visit - Quarterly
2. Site assessment for general compliance.
3. Annual reporting

Annual Environmental (i.e. effluent, crop, soil, and water quality) and site management reporting by the owner or owner's consultant

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Technical assessment and comments to the owner by EW

↓

Meeting at the site to discuss compliance, environmental effects and future directions

↓

Meeting minutes sent to the EW Resource Officer

↓

Follow-up by the EW Resource Officer

(C) All sites -Odour management

Principles

Odour is generated from the following sources:

1. Anaerobic effluent treatment ponds
2. Piggery sheds
3. Offal pits
4. Solids separated from effluent
5. Composting solids separated from raw effluent
6. Desludging effluent treatment ponds
7. Effluent or sludge application to land
8. Feed storage (e.g. whey)

Generally poor management of all the above will cause offensive odour. Occasional odours are expected from most piggery operations. Odour compliance depends on the frequency of *justifiable* complaints.

Methods

1. Identify the source of odour.
2. Discuss the issue with the piggery owner and recommend remedial actions.
3. A deadline for action should be specified and adhered to.

e.g. 1. Treatment ponds -

(a) Desludge if appropriate.

(b) Mechanical aeration of oxidation ponds and the aerated effluent discharged into the anaerobic pond.

(c) Efficient use of feeds (check with a pig feed expert).

(d) Solid separation from raw effluent if appropriate.

(e) If odour persists after following the above steps recommend the owner to hire an expert to minimise the odour.

2. Piggery sheds

(a) Wash sheds twice daily.
(b) Avoid feed wastage.
(c) Check for feed quality and/or additives.
(d) Check for stocking rate.
(e) Ventilation.

3. Offal pits

(a) Pit lids.
(b) Rotate offal pits.
(c) Use rendering plants for dead animal disposal more frequently.

4. Solid separated from effluent

(a) Solids well drained.
(b) Avoid decomposition of solids (i.e. rapid removal without solid piling).

5. Composting solid separated from raw effluent

(a) Proper composting management.
(b) Preferably obtain approval from the neighbours.

6. Desludging effluent treatment ponds

(a) Inform neighbours prior to desludging.
(b) Inform adjacent land owners before land application.
(c) Spread thinly over the pasture or apply onto other crops.
(d) If objected by neighbours consider soil injection.

7. Effluent or sludge application onto land

(a) As for 6 (b), (c) and (d).

8. Feed storage

(a) Avoid storage of feeds (e.g. whey) that are likely to cause offensive odour.

Procedure 2 *Audit all non-operative piggery sites annually during early summer.*

Principles

Non-operative piggeries have the potential to operate without a resource consent. There are several such sites requiring regular site visits. Generally a rule of thumb is used to not to require a resource consent for a piggery site with less than fifty 50 kg pig eq. as long as it is managed well.

Methods

1. Annual site visit to non-operative piggeries between November and December.
2. If the sites are operative the piggery owner(s) with more than fifty 50 kg pig eq. should apply for a consent.

3. If piggery sites with less than fifty 50 kg pig eq. are causing (or likely to cause) adverse effects (e.g. surface water discharge or objectionable odour) the owner should apply for a consent.

Procedure 3 *Effects of piggeries on surface water, ground water and soil quality will be monitored using information obtained from compliance monitoring. Where possible the information gap for effects monitoring will be narrowed through further monitoring at council's cost.*

Principles
Currently there is little or no effects monitoring performed by Environment Waikato on the effects of piggery operations on the environment. Where practicable effects monitoring should be performed by the consent holder. To facilitate this process, future consent conditions should require effects monitoring as practicable as possible. Where appropriate Environment Waikato will perform cumulative effects of point discharges on selected waterways.

Methods
The methods for monitoring are given in **Method 1**. The Resource Officer must check consent conditions for the prescribed monitoring methods. If these methods are absent or deficient in the existing consent conditions, additional monitoring (according to this piggery monitoring guidelines) should be performed at council's cost.

Where appropriate the Resource Officer will liaise with the Resource Information Group with regard to any cumulative impact monitoring.

Procedure 4 *Complaints will be responded readily*

Principles
Generally the piggery complaints are odour related. For the purpose of effective compliance monitoring and potential legal action ready response is essential.

Methods
1. All complaints recorded and responded as soon as possible but not later than 24 hours. Odour complaints will be responded to within 12 hours.
2. Visit the complainant(s) first and record details.
3. Assess the cause(s) and effects at the site.
4. Give remedial options (if possible, according to Method 1.C) and deadline for remedial action for the owner or operator of the piggery.
5. Re-affirm the recommendations in writing within 24 hours of the site visit. If it is the first complaint no charges levied, however, indicate in the letter that further justifiable site visit will be charged.
6. Follow Table 2 in Method 1.

Procedure 5 *Where appropriate, strong link will be made between the Consent Processing Officer and Compliance Monitoring Officer*

Principles
Consent conditions should

a. Promote sustainable management of natural resources.
b. Be effects based and scientifically and technically defensible.
c. Be simple, clear and enforceable.
d. Facilitate effective monitoring.

Effluent loading exceeding 150 kg N/ha/year is likely to have adverse effects on the environment depending on the land use. Currently, when industrial effluent is applied in excess of 150 kg N/ha/year the consent application is publicly notified and piggery effluent should not be treated differently.

Similarly, discharge of treated effluent into waterways will be publicly notified since the adverse effects of piggery effluent discharges on waterways are significant.

It can be argued that every consent application, either new or renewal, must be assessed according to its merits and the information provided by the applicant. Nevertheless, for renewal of a consent, compliance history of the site gives a good indication of the issues related to the piggery operation. Consequently, consent renewal process provides an ideal opportunity to address and alleviate major issues. Although such an approach is cost effective in the short-term, servicing a high number of non-complying piggery operations could be expensive in the long-term due to a high proportion of staff time spent on addressing complaints. The preferred option is a balanced one where enforcement action is taken against continuous offenders and using consent process to educate the occasional offenders.

Methods
The following applications will be publicly notified:

a. Discharges to water.
b. Land treatment systems with > 150 kg N/ha/year loading.
c. An operation with poor environmental management history.
d. Piggery expansions (> 25% increase).
e. New operations.

Procedure 6 *Regular liaison with the Pork Industry and piggery farmers on regulatory and environmental education approaches to piggery impacts.*

Principles
Regular feedback to the pork industry about compliance and effects monitoring is important to improve the industry's code of practices to minimise adverse effects of

piggeries on the environment. Such feedbacks by the council will also provide the industry with certainties or uncertainties associated with the environmental risks of piggery activities. The process will also help improve council's relationship with the industry and encourage industry's feedback on compliance monitoring.

Methods
Agriculture and Forestry Programme will provide the pork industry (i.e. farming, research and processing) with annual report of the compliance and effects monitoring and for piggeries in the Waikato Region. The reporting could be performed through the existing Pork Industry Liaison Group (quarterly meetings)or other methods.

Procedure 7	*Where appropriate, and as a last resort, recommendations will be made by the Agriculture and Forestry Programme to the council's Regulatory Committee to take legal action against non-complying piggery farmers.*

Principles
Legal actions are effective tools to deter continuous offenders. This will help remove or manage piggery operators who will be a nuisance to the industry and the council by causing adverse effects on the environment.

Methods
Continuous non-compliance causing adverse effects on air, soil and water quality despite sufficient warnings will initially receive abatement notice and later enforcement order. If remedial actions are not taken to the satisfaction of the council the case will be reported to the Regulatory Committee of the council with recommendations to prosecute. All costs associated with legal actions will be charged to the offender.

<u>Air quality non-compliance/complaints</u>
It has been debated that the piggery farms which had been operative prior to the enactment of the RMA may not require air discharge consents unless required through a Regional Plan. Whilst Environment Waikato may consider air discharge rules to regulate odour from the piggeries in the Regional Plan (which is being developed), the current policy is that justifiable complaints will be viewed seriously resulting in prosecution regardless of the status of the 'existing user rights'.

Table 5. Odour complaint/non-compliance action programme

Offensive odour	No. of complaints /non-compliances month	Maximum No. of non-compliances/ complaints	Action
High	> 1	12	a. A warning letter for the first visit and direct charges after the second.. b. Liaison with the Pork Industry after 3 visits. c. Legal action after 12 consecutive visits.
Medium	< 1	6	a. A warning letter after 2 visits and direct charges after the 3rd visit. b. Liaison with the Pork Industry after 6 visits. c. Legal action after 12 visits or 2 years.
Low	0	1	

Site classification:

High- > 1 justifiable complaints and/or non-compliance per month
Medium- < 1 justifiable complaint and/or non-compliance per month
Low- 0 complaint and/or non-compliance per month

Procedure 8 *Where appropriate policy recommendations will be made by the Agriculture and Forestry Programme (Resource Use Group) to policy makers (i.e. MfE, MAF Policy and EW) with regard to the management of piggery operation effects on the environment.*

Principles
An effective compliance and effects monitoring should help review policies and implementation methods with regard to piggery operations. It is important to review policies and implementation methods to minimise bureaucracy and focus on high risk activities.

Methods
When required annual reporting on compliance and effects monitoring will be used to provide feedback to all policy makers during policy development.