Department of Primary Industries

Intensive Livestock Industry Development

What is the potential biosecurity risk if piggery pond effluent entered a waterway during a 1-in-25 year rain event?

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More information

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Summary

This document provides information regarding the likelihood and consequence of piggery effluent entering a waterway in a 1-in-25 year rainfall event.

The information in this document was prepared in response to a question raised in the community consultation process as part of a specific development application.

The likelihood of piggery effluent entering the waterway in a 1-in-25 year event will depend on the design of the piggery development and the effluent management system.

It is possible to design a system that will contain effluent in such an event but the specifics are beyond the scope of this document.

The consequence (with respect to biosecurity risks) in the rare event of piggery effluent entering the waterway will depend on a number of factors which are described in this document.

It is not possible to quantify these risks because they would depend heavily on conditions in the effluent system and in the environment at the time of such a pollution event; however this document aims to help the reader understand these risks.

If the effluent were prevented from reaching the waterway the biosecurity risk remains on farm and there is no biosecurity risk to the waterway.

Biosecurity

Biosecurity is the protection of our economy, environment and community from the negative impacts of pests, diseases, weeds and contaminants.

The NSW Biosecurity Act 2015 specifies that the principle of biosecurity is a shared responsibility. This means everyone has a responsibility to protect NSW from biosecurity risks to the best of their ability.

The general biosecurity duty under the Act requires that anyone who knows, or ought to reasonably know about a biosecurity risk has a duty to prevent, eliminate or minimise that risk as far as reasonably practicable. Therefore a farmer is expected to know about risks associated with their industry, business and day-to-day work and hobbies.

Development of a biosecurity plan requires a person to assess the biosecurity risks that could impact their business and its surrounds; and what actions they should reasonably take to prevent or minimise those risks.

Specific definitions from the Act for the terms 'biosecurity risk', 'biosecurity impact' and 'reasonably practicable' are included in Appendix 1.

What is a 1-in-25 year event?

This type of descriptor is commonly used to define the risk of extreme events at a location like rainfall and flooding. A 1-in-25 year rainfall event is one which would typically occur only one year in every 25.

These events can be predicted using the Design Rainfall Data System (2016) which is available on the Bureau of Meteorology (BOM) website. By entering the latitude and longitude of a specific location rainfall amounts can be predicted for infrequent rainfall events on a time period basis from minutes, hours and days (up to 7days).

This provides a guide to the amount of rainfall that might be expected within a time period for particular locations. Figure 1 gives the information for Harden NSW as an example.

Rainfall events are a combination of intensity, frequency and duration. A 24 hour 1-in-25 year event is generally the standard used for designing high risk activities (for example landfills). These events will vary from site to site according to normal weather patterns for that area.

One mm of rainfall delivers 1 litre of water per square metre; therefore 50 mm would deliver 50 L per m^2 or 0.5ML per hectare (50 L x 10,000 m^2).

The fate of all this water will depend on the soil type and environmental conditions at the time (wet or very dry) which will determine soil's capacity to absorb the water or whether the water escapes as runoff. Ground cover will slow the passage of water across the soil surface. Existing channels or waterways will concentrate the flow and speed of the water.

Pig effluent

Effluent characteristics are often grouped into physical, microbiological and chemical.

A pig voids approximately 6% of its body weight every day. Piggery waste typically has 20 to 50 times more degradable organic matter per unit of volume than municipal sewage waste.

Nutrients contained in pig effluent include nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, sodium, chloride, iron, manganese, boron, molybdenum, zinc, copper, cadmium, and lead (Kruger *et al* 1995). Pig effluent also includes waste water and feed.

Pigs like all animals (including humans) expel microorganisms with faecal matter. These organisms will include their gut microbiota, parasite eggs, and any disease organisms present in their system. The exact types of organisms will vary between farms and will be influenced by the health status of the pigs on that farm.

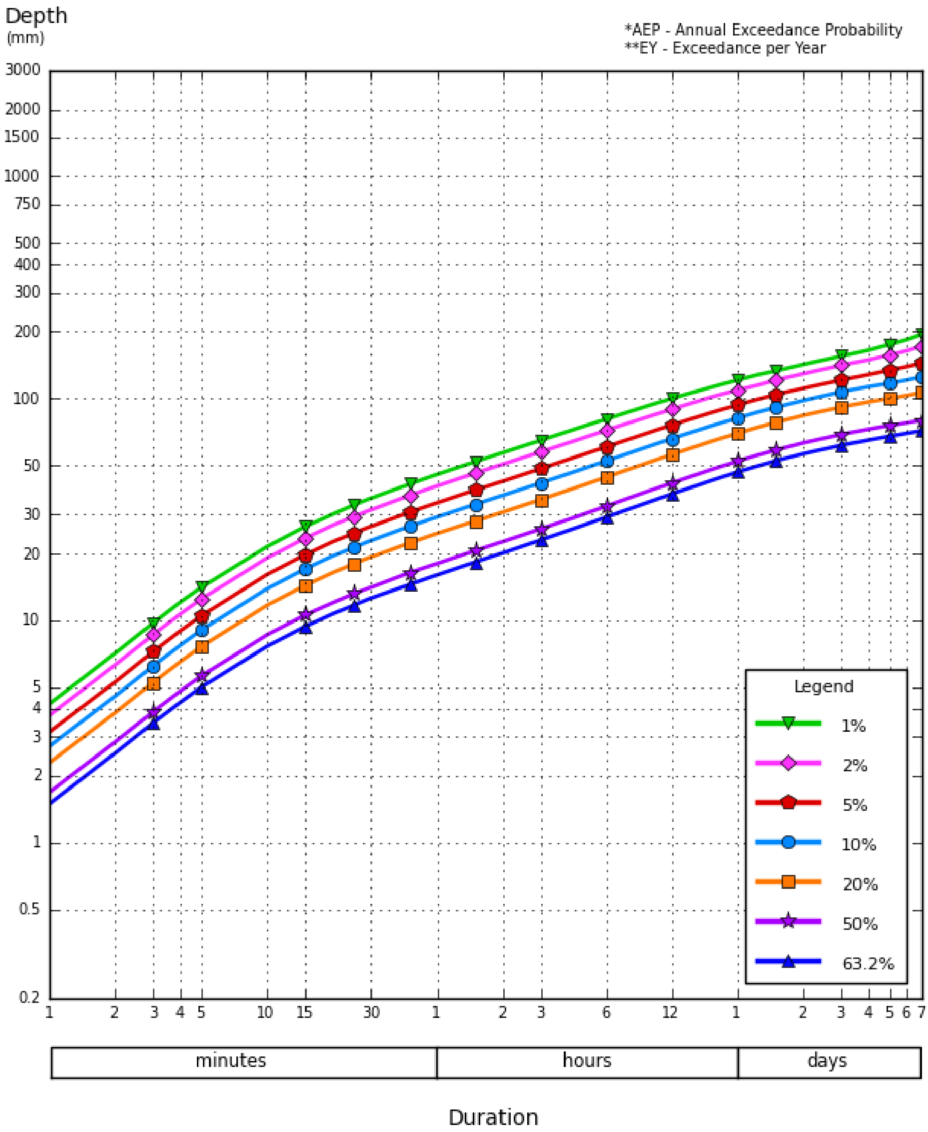
Figure 1: Annual Exceedance Probability (AEP) for Harden NSW. A 1-in-25 year event results in different amounts of rainfall for different time periods (hours or days) and is equivalent to a 4% AEP.

Location

Label: Harden NSW

Latitude: -34.5527 [Nearest grid cell: 34.5625 (S)]

Longitude: 148.3667 [Nearest grid cell: 148.3625 (E)]



What is the biosecurity risk of pond effluent?

Environmental concerns about piggery effluent have tended to be focussed on the potential for pollution from nutrients such as nitrogen and phosphorus, or odour problems and air quality. There is however growing community concern about all animal effluent treatment and disposal systems based on the potential for pathogenic organism contamination of human food and water systems.

Research in Queensland examined effluent from 13 piggeries (Chinivasagam *et al* 2004). The aim of the work was to determine the level of selected pathogens and indicator organisms and so assist in the development of safe piggery effluent re-use guidelines.

The organisms studied included *Salmonella spp., Campylobacter spp., Erysipelothrix rhusiopathiae, Escherichia coli,* and rotavirus. Findings included:

- All farms were different both in respect to the effluent management systems and the microorganisms in the effluent ponds.
- *Campylobacter* was detectable in all primary/sump material and is evidence of the high prevalence of the organism. It appeared to survive in the anaerobic condition of ponds on some farms but the organism numbers were reduced via the pond system on other farms.
- *Salmonella* was present in some but not all effluent samples from all piggeries. No piggery had *Salmonella* disease in their pigs. It was speculated that detections of Salmonella in piggery effluent in 'minimal disease' piggeries were the result of higher feed use and the organism coming in via the feed.
- *Erysipelothrix rhusiopathiae* the cause of erysipelas disease in pigs and arthritis in lambs was not present in any effluent sample, although other non-pathogenic members of the *Erysipelothrix* group were present.
- Anaerobic ponding systems can achieve marked reduction in indicator and pathogenic bacteria levels

The relevance of this work is that piggery effluent can contain zoonotic pathogens such as *Salmonella* or *Campylobacter* but anaerobic ponding systems managed to best practice guidelines will achieve a reduction in bacteria levels.

An extract from the 'Effluent and manure management database for the Australian Dairy Industry', provides a good summary overview of the biosecurity risks of effluent.

"Although there is a body of research into pathogen survival in municipal wastewater treatment, the efficacy of animal wastewater management systems at reducing pathogen viability requires more research (Birchall et al 2008).

However, Sobsey et al (2006) suggest that:

- *Salmonella can be detected in liquid manure after 140 days at 10°C, and Listeria after 106 days during winter (durations longer than the hydraulic residence time of some pond systems)*

- *Anaerobic ponds at **piggeries** may reduce bacterial and viral indicator organisms by 1 to 2 log (90%-99%), but faecal coliform concentrations of ~100 000 cfu per 100ml remain*
- *Pond efficacy is not consistent and is affected by ambient temperature*
- *Pathogen reduction is consistently improved by the use of multiple ponds in series rather than one large pond of the same volume (minimising short-circuiting)*
- *Pathogen reductions following land application are 'highly variable and largely unknown; potentially high."*

"Generally, pathogen numbers are reduced by sunlight (UV radiation), drying, high temperatures and high or low pH. Pathogen viability, or more importantly die-off, depends on climate and is therefore difficult to pinpoint. In addition, under given conditions, different pathogens have varying levels of resistance to environmental stresses. Guan and Holley 2003 suggest that the time required for pathogen numbers to return to background levels under dark incubation conditions ranged from 3 days (Campylobacter) to 56 days (E.coli) under warm conditions (20°C-37°C), and longer under cold conditions."

"Some factors are contradictory. Although rainfall favours bacterial survival, it may also physically remove (wash) the residues of effluent from the vegetation before any subsequent grazing and reduce the likelihood of ingestion and infection. Vegetation density and height also determine the microclimate into which the pathogens are placed upon reuse."

"Given the range of manure storage and treatment practices available to farmers, it is advisable to assume that a significant number of organisms remain viable at reuse and are applied to crop or pasture, and that a withholding or exclusion period is needed to prevent repeated herd infection".

These dairy guidelines suggest the exclusion of stock from grazing effluent reuse areas for 2 to 5 weeks. This recommendation was based partially on the stock's willingness to graze the pastures in the reuse areas and the allowance for the environment – sunlight, ground microorganisms and grass growth to further reduce any risk of contamination.

Flood waters generally are considered as contaminated so the practice of similar exclusion periods for stock from flood zones after a flood and reducing access to potentially contaminated waters during and after a flood would also be recommended.

Effluent pond design and operation

Most conventional piggeries in Australia use uncovered anaerobic ponds to treat effluent. These ponds provide a convenient and simple method for stabilising organic matter into less reactive compounds and gases. They can reduce the volatile solids content of the effluent by up to 70 per cent using a two-stage process:

1. The organic matter in effluent is broken down to Volatile Fatty Acids (VFAs)
2. The VFAs are converted to inoffensive (no odour) methane and carbon dioxide.

Anaerobic ponds require careful management to maintain a healthy population of the microorganisms which degrade the manure. Regular effluent inflows provide a constant food supply for the microorganisms and assists in maintaining the pH in the desired 6.8-8.0 pH range.

A purple colour in anaerobic ponds indicates the presence of bacteria that reduce hydrogen sulphide to elemental sulphur thereby reducing odour.

It should be noted that effluent management systems in today's piggeries are not based on single ponds in isolation. There may be a primary pond which receives the untreated effluent from the pig sheds and a secondary pond for the liquid portion of the effluent which can be recycled for flushing purposes in the pig sheds or used for irrigation.

Another component of some systems is the Sedimentation and Evaporation Pond Systems (SEPS) which are designed to account for a 1-in-10 year flood event on average.

Some systems include covered ponds for the collection and production of methane (biogas) for electricity production and use on farm.

Effluent storage ponds are generally designed based on daily water balance modelling using historical climatic records for the piggery site to simulate the pond operation over an extended period (typically at least 50 years).

Depending on the sensitivity of the surrounding environment, ponds may be designed to spill at intervals not less than 10 years, on average, over the analysis period. These models realistically account for inflows from shed cleaning, manure, waste feed, waste drinking water, rainfall and runoff. Pond outflows include the use of recycled effluent for shed cleaning and irrigation onto crop or pasture and evaporation. Most models use a daily soil-water balance in the effluent irrigation area to trigger effluent irrigation, when the soil has dried out sufficiently to effectively utilise the effluent.

Generally a pond should be isolated from overland flows so that they only deal with the immediate impacted piggery area where the manure and effluent are generated. This reduces the level of extra water coming into the specific piggery waste water system.

Risk of waterway contamination in a pond overflow event

The risk of an effluent pond overflow would depend upon factors such as:

- the effluent pond capacity,
- the effluent storage level already in the pond,
- the catchment area of the pond, and
- the management of the pond.

Environmental factors such as the condition of the surrounding land at the time of this event would also have impact. For example is the land bare and dry or is there vegetative cover which would filter the liquid (of any solids) and hinder progress of the effluent to some degree? What is the soil type? Does the soil have capacity to absorb this moisture or is it at capacity already? What is the distance and slope of the land between pond and waterway? Is the overflow able to spread out or is it concentrated into channels?

Management factors by the farmer will also impact the risk associated with an effluent overflow. For example a commitment by the farmer to operate the piggery effluent management system to industry best practice as outlined in the Australian Pork Limited

Piggery Manure and Effluent Management and Reuse Guidelines 2015 and within EPA guidelines will reduce the risk.

Other factors such as any extra farm mitigation strategies to prepare for such an incident would also reduce the risk. For example the amount of freeboard (extra capacity) in the pond, vegetative buffers outside the pond and/ or secondary banks or seasonal wetland areas designed to capture overflow will help to contain the overflow on farm.

These strategies may not always prevent an overflow incident but would localise any potential impacts by keeping the effluent on farm reducing the risk of the effluent entering the waterway.

Weather event characteristics would also determine outcomes. For example is this a local storm or is this a regional weather event? A regional event may mean a greater dilution effect if effluent did reach a waterway. This does not mean the flow of effluent into the waterway is any less serious but rather that the effects may be less obvious and effluent contaminated water may spread further down the catchment.

The recent (February 2019) Townsville floods provide a sobering reminder that flood waters in themselves pose a biosecurity risk. Bacterial pathogens from the environment, melioidosis and leptospirosis can be present in contaminated soil and water.

Conclusion

There are many factors which can contribute to a potential overflow of effluent from a pond into the environment and subsequently into a waterway. For this reason it is impossible to definitively state what the outcome would be for effluent reaching a waterway but it should be avoided.

The effectiveness of the design of the drainage system of the piggery, the amount of rain and subsequent runoff, the area involved, potential dilution of the effluent by sheer volume of water, human impacts such as management of the system and /or human error are all unknowns.

All animals (and humans) expel microorganisms with faecal matter. Therefore, it must be assumed there could potentially be pathogens released into the waterway from an effluent spill should it occur. The exact outcome will depend on the incident circumstance.

It is recommended that a farmer would:

- **develop a communications plan to inform neighbours, local council and the EPA were such an event to occur, and**
- **do everything that is 'reasonably practicable' to prevent pond effluent from reaching the waterway.**

There is information on the NSW Health website about maintaining health during and after floods and storms if you have personal concerns.

Stock exclusion from flood zones would also be recommended as a biosecurity measure.

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References:

'Effluent and manure management database for the Australian Dairy Industry' Section 3.11 Microbial risks page 147

Chinivasagam HM, Thomas RJ, Casey K, McGahan E, Gardner EA, Rafiee M, and Blackall PJ, 2004 'Microbiological status of piggery effluent from 13 piggeries in the south east Queensland region of Australia' Journal of Applied Microbiology 97:883-891.

Kruger I, Taylor G, Ferrier M 1995 Australian Pig Housing Series Effluent at Work ©Copyright 1995 by NSW Agriculture, RMB 944, Calala Lane, Tamworth, New South Wales, 2340, Australia.

Appendix 1

The following definitions are from the NSW *Biosecurity Act 2015*.

Part 2>Division 2>Section 14 Biosecurity risk

A biosecurity risk *means the risk of a biosecurity impact occurring.*

Part 2>Division 2>Section 13 Biosecurity Impact

1) *A* biosecurity impact *means an adverse effect on the economy, the environment or the community that arises, or has the potential to arise, from biosecurity matter, a carrier or dealing with biosecurity matter or a carrier, being an adverse effect that is related to:*
   a) *The introduction, presence, spread or increase of a disease or disease agent into or within the State or any part of the State, or*
   b) *The introduction, presence, spread or increase of a pest into or within the State or any part of the State, or*
   c) *Stock food or fertilisers, or*
   d) *Animals, plants or animal products becoming chemically affected, or*
   e) *Public nuisance caused by bees, or*
   f) *A risk to public safety caused by bees or non-indigenous animals, or*
   g) *Anything declared by the regulations to be a biosecurity impact.*
2) *An animal or plant, or a product of an animal or plant, is chemically affected if it contains a contaminant and, as a result:*
   a) *It is or is likely to become unfit for sale or export for human consumption, or*
   b) *It is or is likely to pose a danger to human health or to the environment, or*
   c) *It is or is likely to be detrimental to export or other trade.*

Part 2>Division 2>Section 16 Reasonably practicable

Reasonably practicable, *in relation to the prevention elimination or minimisation of a biosecurity risk, means that which is, or was at a particular time, reasonably able to be done, taking into account and weighing up all relevant matters including:*

   a) *the biosecurity risk concerned, and*
   b) *the degree of biosecurity impact that arises, or might arise from the biosecurity risk, and*
   c) *what the person concerned knows, or ought reasonably to know, about the biosecurity risk and the ways of preventing, eliminating or minimising the risk, and*
   d) *the availability and suitability of ways to prevent, eliminate or minimise the biosecurity risk, and*
   e) *the cost associated with available ways of preventing, eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.*