LEAP

Livestock Environmental and Planning

KBM: Proposed Munyabla 1200 Sow Farrow-to-Finish Piggery

Environmental Impact Statement

Private Bag 260 (110 Natimuk Road) Horsham Vic 3401

P: 03 5381 0530 F: 03 5381 0719 M: 0419 787 137

robyn@leap-consulting.com.au www.leap-consulting.com.au ABN: 48 557 393 171

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Notes:

Version 1 This is a draft report for client comment.
Version 2 This is a draft report for client comment.
Version 3 Pre-lodgement draft.
Version 4 Version for lodgement.

This report is an environmental impact statement that has been compiled to provide information to the Lockhart Shire, NSW EPA, NSW Office of Water, NSW Office of Environment and Heritage, NSW DPI, Department of Planning and Environment and other interested agencies to seek requirements for a development permit and Environment Protection Licence for a proposed 1200 sow farrow-to-finish piggery located at 553 Dick Knobels Road, Munyabla.

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Development Application made by:

Robyn Tucker of Talona Evermore Pty Ltd trading as Livestock Environmental and Planning (LEAP).

ACN: 600 322 736
M: 0419 787 137
Email: robyn@leap-consulting.com.au

RPD of Land included: Lot 1 on DP 1250489.
Note: additional land surrounding this lot, and farms at Urana and Yerong Creek owned by the owners of KBM Farms have been designated as reuse areas.

This EIS has been prepared to accompany a Development Application made to the Lockhart Shire Council as the consent authority.

1. A EXECUTIVE SUMMARY

Introduction

This Environmental Impact Statement (EIS) identifies and assesses the environmental issues associated with the construction and operation of a proposed 1200 sow piggery. Livestock Environmental and Planning has prepared the EIS on behalf of the proponent, KBM Farms.

This EIS has been prepared in accordance with Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) (State of New South Wales, 1979) and Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) (State of New South Wales, 2000). The structure and content of the EIS address the Secretary's Environmental Assessment Requirements (SEARs) 1217 provided by NSW Department of Planning and Environment (DPE) on 20th April 2018. The SEARs are provided as Appendix A. As per the SEARS, it follows the format of the Piggeries: EIS Guidelines (NSW Department of Urban Affairs and Planning, 1996).

The Proposal

The proponent is KBM Farms which is a partnership between Matt Klemke, Kym Bissett, James Male and Greg Male. The piggery will be situated on Lot 1 on DP 1250489, Shire of Lockhart which is owned by KBM Farms. Part of an adjacent Munyabla farm owned by Matt Klemke has been designated for reuse of piggery effluent, mortalities compost and some sludge, and other farms at Urana (owned by Greg Male and James Male) and Yerong Creek (owned by Greg Male and James Male) have been designated for reuse of sludge and manure compost, although it is expected that neighbours of the piggery may also be interested in using these products in their farming systems.

The objectives of the proposal are:

- to establish a state-of-the-art 1200 sow farrow-to-finish piggery that will deliver efficient pork production in a welfare friendly way.
- to operate in a way that protects the environment including air; water; land; biodiversity; items, and sites and places of Aboriginal cultural heritage sensitivity.
- to operate in a way that is compatible with surrounding land uses.
- to beneficially use the nutrients, water and carbon in composted manure and effluent and in pond sludge in farming systems operating on the Munyabla, Urana and Yerong Creek farms.
- to diversify the agricultural activities of the partners of KBM Farms.

It is proposed that the piggery will be built in three stages:

- stage 1 600 sows farrow-to-finish
- stage 2 900 sows farrow-to-finish
- stage 3 1200 sows farrow-to-finish

The projected life of the operation is 20 years.

Lactating sows, suckers, growers and finishers will be housed in conventional sheds, and gilts, dry sows, boars, weaners and porkers will be housed in deep litter sheds bedded with straw. Conventional housing accommodates pigs within steel-framed sheds with walls that are half solid and half nylon curtain, iron roofing and slatted flooring over concreted under-floor pits fitted with pull plugs. Cleaning water, manure, waste feed and spilt drinking water will make up the effluent stream captured in the under-floor pits.

The main "wastes" from the piggery are liquid effluent, spent bedding and mortalities.

The liquid effluent released from the conventional sheds will collect in a sump before being pumped to a screw press separator. This will remove large solids, reducing the organic load to the pond system. The liquid effluent will be directed to an anaerobic pond for primary treatment. At stages 1 and 2, an uncovered, heavily loaded, 2.7 ML anaerobic pond will be used. At stage 3, this pond will be extended and covered to allow for the collection of biogas that will be used to generate power and heat for use within the piggery. At all stages, the treated effluent will pass from the anaerobic pond into a 10 ML holding pond where it will be stored ahead of reuse in the manure composting process or by irrigation to land where it will provide a nutrient source for crops. At each stage, the pond has a designed spill frequency of less than 1 in 10-years and can contain the rainfall from a 1 in 20 year, 24-hour storm.

Over time, sludge will deposit in the floor of the anaerobic pond. This will be extracted using a vacuum tanker that will also spread this material onto land to provide for nutrient uptake by crops.

Spent bedding and solids separated using the screw press will be composted in a dedicated facility with a low permeability base and bunding to protect surface waters. Stormwater runoff caught within the pad will drain into the main piggery effluent holding pond. The material will be processed using an aerobic windrow composting method. It will be composted over a 12-week period consisting of an eight-week active management period and a four-week curing period. Additional space will be provided in this area to allow for mortalities composting. The manure and mortalities compost will be spread onto cropping land.

Careful management of reuse is important in protecting the environment. Buffers to sensitive land uses and natural resources will provide additional protection. The good management practices described in Use of Effluent for Irrigation (Department of Environment and Conservation (NSW), 2004) I and the National Environmental Guidelines for Indoor Piggeries (Tucker, 2018) will be adopted. Sustainable nutrient application rates have been determined based on expected crop rotations and conservative average yield data. In total, some 4454 ha of land has been allocated for reuse on the Munyabla (992 ha), Urana (1251 ha) and Yerong Creek (2210 ha) farms. This is more than enough land on which to safely reuse the nutrients. Soil testing will be regularly undertaken to check on nutrient levels and plan for future application rates. Crop rotations can also be varied to increase nutrient removal if necessary. However, it is expected that nearby farmers are likely to be interested in using the sludge and manure compost in their farming systems, so some of this may go off farm. Off-farm recipients of manure or sludge will be provided with a handout including good management principles, an analysis for the product they are receiving and a duty of care statement.

Trucks will need to transport grain and prepared feed and straw for bedding to the site. Finished pigs, compost and sludge going off the Munyabla farm will represent exports that will generate new traffic. On average, there will be about:

- 4 truck movements in and 4 truck movements out each week at stage 1,
- 7 truck movements in and 7 truck movements out each week at stage 2, and
- 10-11 truck movements in and 10-11 truck movements out each week at stage 3.

These numbers could approximately double during the first few months of each year when compost will be transported from the site for spreading.

The property entry point will be off Dick Knobels Road with local access via Semlers Lane and possibly Dick Knobels Road. Both these roads are category 2 rural roads. Other roads that will be used include: Henty-Pleasant Hills Road, Alma Park Road, Walbundrie-Alma Park Road, Kywong-Howlong Road, the Riverina Highway and National Highway M31.

The primary power supply for the site will be mains electricity. This will need to be connected at the site. Solar power and diesel pumps will also be used. Diesel generators will provide power supply back-up. At stage 3, biogas captured under the cover of the anaerobic pond will be used to produce power and heat that can be used by the piggery.

Water is needed for pig consumption, cleaning the conventional sheds, topping up the underfloor pits and cooling the pigs. About 16.5 ML/yr will be needed at stage 1, 25 ML/yr at stage 2 and 33 ML/yr at stage 3. Groundwater will provide the primary water supply for the piggery. A recently-drilled bore appears likely to have sufficient yield to meet the total requirement. To utilise groundwater as a water supply for this proposed development KBM Farms will need to apply for water use approval (industrial), water access licence and available volumetric shares. Roof runoff will also be collected and some may be used for shed cleaning, which will reduce pumping pressure.

Initially, the piggery will be staffed by four full-time equivalents. It is expected that there will be six full-time equivalents at stage 2, and eight full-time equivalents will be required once the pig farm is fully constructed (stage 3). Operational activities will generally be restricted to 7 AM to 6 PM weekdays and 7 AM to 1 PM on weekends.

The Location

The proposed piggery will be sited on Lot 1 on DP 1250489, Shire of Lockhart. The subject property and all surrounding land, is zoned RU1 Primary Production. The Munyabla, Urana and Yerong Creek properties that are designated for reuse are zoned RU1, as is all surrounding land.

Intensive livestock agriculture is permitted in the RU1 zone, with consent. As the proposed piggery is designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, an EIS must be submitted with a development application.

The proposed development is subject to:

- Environmental Planning & Assessment Act NSW (1979) (NSW Government, 1979)
- Environmental Planning & Assessment Regulation NSW (2000) (NSW Government, 2000)
- Protection of the Environment Operations Act (1997) (NSW Government, 1997)
- Protection of the Environment Operations (General) Regulation NSW (2009) (NSW Government, 2009)
- NSW Department of Planning (1996) EIS Guideline Piggeries (NSW Department of Planning, 1996)
- Lockhart Local Environmental Plan (LEP) (2013) (Lockhart Shire Council, 2012)
- Lockhart Shire Development Control Plan (DCP) (2016) (Lockhart Shire Council, 2016).

Appraisal of the proposal suggests that the site is suitable for the proposed purpose. All of the land surrounding the piggery and reuse areas is zoned RU1 and used for cropping and grazing. A pig farm is an allowable use in the zone and will not restrict the use of surrounding land for agricultural purposes, unless someone wanted to operate their own piggery near the proposed development. It is intended that grain and straw will be sourced from surrounding land owners and others in the district, and there will be opportunities for nearby farmers to access compost or sludge for use as cropping system inputs. The proposed piggery will be adequately separated from nearby houses and other sensitive land uses to minimise the risk of odour, dust and noise nuisance. However, consultation with nearby neighbours has raised some concerns about possible impacts to amenity and land values. The closest residences are separated from the piggery complex by distances exceeding 1.5 km. Because the piggery site is close to the property boundary, it is visible from nearby roads. Because the surrounding land has relatively flat terrain that has been cleared for farming, the site will also be visible from some of the nearby houses. This EIS provides detailed information about the proposed land use change and the associated reuse activities along with appropriate risk reduction and mitigation techniques.

The Lockhart LEP does not identify any heritage areas on or near the pig farm or designated reuse areas on the Munyabla farm. Nor are there any known Aboriginal objects or declared Aboriginal places located within the area of the proposed activity. However, an investigation into Aboriginal cultural heritage matters revealed that the area was quite culturally sensitive. Land in the district has been inhabited by the Wiradjuri people for over 60,000 years. The Wiradjuri people still use these places today to connect to their culture. To minimise the risk of damage to artefacts, the piggery complex will be sited away from old and current waterways. Additionally, KBM Farms will commit to the Piggery Manager and excavation contractor undertaking cultural awareness training. Any artefacts found during construction will be protected and reported to the Office of Environment and Heritage. A range of other measures will also be used to protect culturally sensitive areas.

The piggery site and the surrounding Munyabla farm are flat to gently sloping. This land is located within the Bullenbong Creek catchment. The closest waterways are the ephemeral Mittagong Creek, which runs through the Munyabla Farm, and Mundawaddery Creek which is an ephemeral stream with irregular waterholes situated to the north-east of the Munyabla farm. Mundawaddery Creek is identified as a Riparian Lands Watercourse in the Lockhart Environmental Plan 2012. These creeks drain via Bullenbong Creek to the Murrumbidgee River which itself drains to the Murray River.

The soils of the Munyabla farm are primarily chromosols and sodosols. These soils have a moderately deep, friable clay loam organic topsoil over a harder clayey, structured subsoil. In the sodosols, the subsoils are sodic. The soils have suitable physical and chemical properties for the intended reuse.

Groundwater within the vicinity of the piggery site is mainly found within unconfined fractured rock aquifers, with groundwater moving through fractured basalt or fresh bedrock. A review of a number of bore logs in close proximity to the site suggest that shallow groundwater is unlikely to be present beneath the site and is likely to be protected by thick clay layers in the upper stratum.

The location has warm summers and cool to cold winters. The median rainfall is about 540 mm per annum, distributed fairly equally over the full 12 months with a slight winter dominance. At 9 AM winds are predominantly from the east to north-east in summer and the east in winter while at 3 PM winds are predominantly from the west to south-west throughout the year.

The native vegetation in the vicinity of the piggery property mostly includes white, yellow or western grey box and white cypress pine woodlands and grasslands. The majority of the piggery site, and the Munyabla, Urana and Yerong Creek farms have been cleared for cropping for decades with very little native vegetation remaining. Some scattered paddock trees remain on the farm. These are mostly white cypress pines with some grey box. None will be removed. While the proposed piggery site is not covered by vulnerable vegetation as shown by the NVR mapping, there are areas of vulnerable vegetation close to some of the reuse areas. These have been protected by the provision of buffers. As no native vegetation at all will be removed as part of this development, a Biodiversity Development Assessment Report (BDAR) has not been included with this EIS

The Urana farm is flat with a low elevation. The main waterway associated with the Urana farm is Billabong Creek. Drainage lines from this creek pass through the property and most of the farm is subject to occasional flooding, likely to be well less than 1 in 5 years. The soils are predominantly vertosols. These are productive soils often used to grow winter cereal crops and fodder. They are very suitable for reuse of compost and their structure would benefit from the addition of organic matter.

The topography of the Yerong Creek farm varies from relatively flat to gently undulating. The main watercourse through the property is Wattle Creek which runs in a south-westerly direction. The soils include kurosols, sodosols, chromosols and kandosols. The land on the farm has been used for growing cereal and oilseed crops for many years. The land is suitable for reuse of sludge and compost and the farming system would benefit from the addition of nutrients and organic matter.

Identification and Prioritisation of Issues

The process used to identify and prioritise issues included:

- a preliminary site meeting between the proponents and representatives of Lockhart Shire Council and EPA.
- a review of federal, state and local government acts, regulations, policies and plans.
- a review of applicable industry and environmental guidelines and recent NSW piggery EIS.
- site investigations by various consultants, and representatives of Wagga Wagga Aboriginal Land Council and Bundiyi Aboriginal Cultural Knowledge.
- the engagement of Water Technology to undertake a hydrogeological review and McMahon Earth Sciences to undertake soil testing.
- consultation with various agencies, Lockhart Shire Council and other relevant bodies.
- following the Secretary's Environmental Assessment Requirements.

Consultation with all nearby neighbours was undertaken through informal discussions. Several neighbours raised concerns about odour, potential impacts to property values, the standard of Semler's Lane for carrying increased numbers of heavy vehicles, impacts to groundwater supply and the financial viability of the farm and whether corners would be cut during construction and management. Other neighbours were very supporting of the proposal and interested in working with the piggery to provide grain and straw and to take spent bedding compost. The proposed development has been carefully investigated and planned. It is proposed to construct a state-of-the-art facility and to operate it accordingly. Additionally, the staged nature of the proposed development means that the risk is able to be minimised.

The identified issues and their priority are summarised below:

Issues identified	Priority
Cumulative impacts	Low
Odour Impact	High
Waste management	Medium-high
Water quality & catchment protection	Medium
Land capability & protection	Medium
Drainage and stormwater management	Medium
Flooding	Low
Traffic and road impacts	Medium
Noise	Medium
Dust	Medium
Visual impacts	Medium
Pest & insect control	Low
Flora and fauna	Medium
Heritage	Medium-high
Hazardous chemicals	Low
Animal welfare	Medium
Economic and social effects	Low

Because it is a sensitive issue and a concern raised by some neighbours, odour is a high priority. Like any intensive animal facility, the proposed piggery will create some odour. The most effective way of protecting amenity is by implementing good design, good management practices and appropriate separation distances. The adequacy of separation distances has been testing using two methods:

- Technical Notes Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Department of Environment and Conservation NSW, 2006)
- National Environmental Guidelines for Indoor Piggeries (Tucker, 2018)

For both methods, there was a clear pass at level 1 suggesting a low risk of nuisance for the community. The application of various sensitivity tests confirmed this. Careful mitigation, management and monitoring are also warranted. The piggery will be a modern facility incorporating best management practices and design which will optimise hygiene and mitigate odour from the piggery complex. An odour management process will be implemented at the piggery, whereby complaints will be thoroughly recorded and investigated with corrective and preventative action taken. Liaison with council and EPA will also be important in resolving odour nuisance issues. As many odour nuisance incidents are closely related to weather conditions, it is proposed that an on-site automatic weather station will be installed at stage 3 to assist in complaints investigation.

Another relatively high priority is Aboriginal cultural heritage sensitivity. Munyabla and the surrounding area include many Wiradjuri scar trees, sources of bush tucker and wildlife refuges for native animals. The construction of the piggery, particularly excavation for shed bases, and the effluent ponds, pose a risk of damaging Aboriginal artefacts if these are present. There is also a risk of effluent and manure reuse affect native vegetation and wildlife, and Wiradjuri special places and items if these are not carefully managed. To minimise risks, the piggery will be sited away from old and current waterways. Additionally, KBM Farms will commit to the Piggery Manager and the excavation sub-consultant undertaking cultural awareness training and education. If any Aboriginal items are recorded in the future on land used for the piggery or its reuse areas, these will remain at the property and will only be moved in the presence of an Elder or Wiradjuri community member. Where items cannot be moved (e.g. scar trees, if any), suitable buffers will be placed around them.

Animal welfare is a sensitive societal issue. It is in the proponent's interests to optimise animal welfare, so all facilities and management will meet or exceed the standards. Persons responsible for the care of the pigs will be skilled in piggery work and competent to ensure the health and welfare of the animals, or will be under the direct supervision of skilled personnel. Strict quarantine rules will apply. It is intended that the new pig farm will be accredited under the APIQ✓® industry quality assurance program, which includes a module on animal welfare.

List of Approvals and Licences
The piggery will require the following approvals and licences:

- Lockhart Shire Council — Development Consent
- NSW EPA — License and approval to operate a piggery under Protection of the Environment Operations Act 1997
- NSW Office of Water — Bore licences

Compilation of Mitigation Measures
Mitigation measures have been summarised above. These will be supported by regular environmental monitoring. This will include:

- complaints recording and investigation
- continuous weather monitoring (at stage 3)
- testing of effluent, compost and sludge at least annually ahead of the main reuse period
- annual testing of the soils of any reuse areas receiving effluent, sludge or compost in a given year
- recording of all reuse details
- recording the details of any sales or transfers of compost or sludge to others
- continuous recording of groundwater usage
- annual testing of groundwater quality

Justification of Proposal
This proposal does not involve any threat of serious or irreversible environmental damage. Hence it poses no threat to inter-generational equity or conservation of biological diversity and ecological integrity. The proponents will bear the cost of managing the effluent, manure and mortalities arising from their activities including monitoring for impacts and reporting on environmental outcomes. However, they will also reap the benefits of the nutrients and carbon that will improve the agronomic properties of their soils.

2. B. THE PROPOSAL

2.1. B.1. OBJECTIVES AND CHARACTERISTICS

KBM Farms is a partnership between Matt Klemke, Kym Bissett, James Male and Greg Male. KBM Farms proposes to construct a 1200 sow farrow-to-finish pig farm on land owned by KBM Farms and located at Munyabla ("piggery site"). It is proposed that effluent will be irrigated onto an adjacent farm ("Munyabla farm") owned by Matt Klemke. Mortalities compost and sludge extracted from the effluent treatment ponds will also be spread on parts of this farm not allocated for effluent reuse. Surplus sludge, compost produced from spent bedding and separated manure solids may also be spread on the Munyabla farm, but also on a "Urana farm" owned by James Male and Greg Male and on a "Yerong Creek farm" owned by James Male. Neighbours of the piggery may also be offered the opportunity to use these products in their farming systems.

The objectives of the proposal are:

- to establish a state-of-the-art 1200 sow farrow-to-finish piggery that will deliver efficient pork production in a welfare friendly way.
- to operate in a way that protects the environment including air; water; land; biodiversity; items, and sites and places of Aboriginal cultural heritage sensitivity.
- to operate in a way that is compatible with surrounding land uses.
- to beneficially use the nutrients, water and carbon in composted manure and effluent and in pond sludge in farming systems operating on the Munyabla, Urana and Yerong Creek farms.
- to diversify the agricultural activities of the partners of KBM Farms.

B.1.a Pig Numbers

It is proposed that the piggery will be built in three stages:

- stage 1 600 sows farrow-to-finish
- stage 2 900 sows farrow-to-finish
- stage 3 1200 sows farrow-to-finish

Table 1 provides a summary of the proposed herd composition for the fully developed piggery (stage 3) and the type of pig housing to be used by each class. The number of standard pig units (SPU) has been estimated using standard multipliers from the Australian Pork Ltd National Environmental Guidelines for Indoor Piggeries (Tucker, 2018) for the breeding stock, and a liveweight regression formula included in the PIGBAL 4 model (Queensland Department of Agriculture and Fisheries, 2019) for growing stock which is an accepted methodology in the national guidelines. Standard pig units (SPU) is a unit for defining piggery capacity by manure production where the manure and waste feed produced by one SPU contains the amount of volatile solids (VS) equivalent to that typically produced by one average sized grower pig (90 kg VS/yr).

It is proposed that lactating sows, suckers, growers and finishers will be housed in conventional sheds, and gilts, dry sows, boars, weaners and porkers will be housed in deep litter sheds bedded with straw.

After start-up, the piggery will operate as a closed herd. Breeding will be through artificial insemination, with no pigs brought in.

Table 1 – Herd Composition and Housing – Stage 3

Pig Class	Head	SPU	Typical weight range (kg)	Housing
Gilts	83	149	-	Deep litter
Boars	8	13	-	Deep litter
Dry sows	1012	1619	-	Deep litter
Lactating sows	187	468	-	Conventional
Suckers (0-26 days)	2065	220	1.4-7.3	Conventional
Weaners to 10 wks	3302	1885	7.3-33.6	Deep litter
Porkers to 14wks	2072	2226	33.6-51.3	Deep litter
Growers to 18 wks	2049	3023	51.3-83.5	Conventional
Finishers to 22 wks	2034	3527	83.5-108	Conventional
Total	12,812	13,130		7238 SPU in conv. sheds 5892 SPU in deep litter

Table 2 – Herd Composition by Stage

Pig Class	Stage 1 – 600 sows		Stage 2 – 900 sows		Stage 3 – 1200 sows	
	Head	SPU	Head	SPU	Head	SPU
Gilts	41	75	62	112	83	149
Boars	4	6	6	10	8	13
Dry sows	506	810	759	1214	1012	1619
Lactating sows	94	234	140	351	187	469
Suckers (0-26 days)	1033	110	1549	165	2065	220
Weaners to 10 wks	1651	942	2477	1414	3302	1885
Porkers to 14 wks	1036	1174	1554	1761	2072	2348
Growers to 18 wks	1024	1551	1537	2326	2049	3101
Finishers to 22 wks	1017	1764	1526	2645	2034	3527
Total	6406	6666	9610	9848	12,812	13,331

2.1.1. B.1.b Method of Production

At all stages, the piggery will operate as a farrow-to-finish piggery. Sows will be mated using artificial insemination. The piglets will stay with their mothers until 26 days of age when they will be weaned then raised to sale weight, leaving the piggery at about 22 weeks of age.

The pigs will be raised using a combination of conventional farrowing sheds, and deep litter sheds. The classes of pig that will utilise each type of shed is shown in Table 1. Figure 1 shows the layout of the piggery, including each type of shed.

Figure 1 – Layout of Fully-Developed Piggery

Conventional housing accommodates pigs within steel-framed sheds with walls that are half solid and half nylon curtain, iron roofing and slatted flooring over concreted under-floor pits fitted with pull plugs. Photograph 1 shows an example of this type of housing. The farrowing sheds and grower and finisher sheds will be cross-ventilated, with heat pads in the farrowing areas to keep the sucker pigs warm. These sheds produce liquid effluent made up of cleaning water, manure, waste feed and spilt drinking water that is captured in the under-floor pits. The pull plugs on the pits will be opened weekly to release the effluent for treatment in a pond-based system. After the plugs have been replaced, the pits will be recharged with ~5 cm of fresh water from shed pressure washing. Recharging the pits stops manure from sticking to the base and reduces ammonia emissions. A pond-based effluent treatment system will treat and store the effluent from the conventional sheds. Section 2.1.3 provides details of the expected quantity and composition of the effluent properties. Sections 2.1.4, 2.2.3 and 2.3.3 provide details of effluent treatment and reuse.

Deep litter housing accommodates pigs in sheds or shelters with concreted floors that are covered with straw bedding (or similar absorptive material) to keep the pigs warm and absorb manure and spilt feed and water. Hence, these sheds produce spent bedding but no liquid effluent. Two types of deep litter housing will be used. The gilts, boars and dry sow housing will be accommodated in steel-framed sheds with walls that are half solid and half nylon curtain with iron roofing. From the outside, these sheds will resemble the conventional sheds described above. However, the flooring will be solid concrete with no effluent collection pits. The weaners will be kept in hooped structures similar to the plastic greenhouses used in horticulture. Photograph 2 shows an example of this type of housing. Straw for bedding will be sourced from the proponents' own farms, and from other local farmers. A good layer of straw will cover the floor of the sheds at all times and this will be topped up as needed. On average, about 700 g/SCU/day of bedding will be needed, or about 4 t/day (1505 t/yr) at stage 3. Spent bedding will be removed and replaced as needed, but at least every 7 weeks, to provide dry, low odour bedding for the pigs to lie on. The removed bedding will be composted on a hard-stand, bunded area. Details of the quantity and composition of the spent bedding are provided in section 2.1.3. Details of the management of the composting process and the proposed reuse of the compost are provided in section 2.1.4. The compost will be spread on cropping land managed by the proponents, and possibly on nearby land owned by others.

Most of the feed for the piggery will be milled and mixed on-site, with feed for young pigs purchased. Grain produced by the proponents, or sourced from local farmers, will be used as ingredients. Feed types used in the piggery will include:

- mash for the breeding herd – manufactured on-site
- creep pellets for the suckers – purchased
- pellets for the weaners – purchased
- liquid feed for growers and finishers with the mash manufactured on-site

Photograph 1 – Conventional Shed

Photograph 2 – Deep Litter Housing for Weaners

Table 3 shows a breakdown of expected feed type by class of pig for each stage of the development. Diets will be carefully formulated to match production requirements for the different classes of pigs. Feed presentation has also been carefully considered; pellets will be used for the suckers and weaners which tend to waste mash and liquid feed for the growers and finishers will also minimise wastage. Low wastage feeder designs will be selected.

Table 3 – Expected Feed Usage by Pig Class

Pig Class	Daily Feed Usage (kg/pig/day)	Annual feed fed (t/yr)			Feed type / source
		Stage 1	Stage 2	Stage 3	
Gilt	2.63	40	60	80	Mash made on-farm
Boar	2.42	4	5	7	Mash made on-farm
Gestating sow	2.42	447	671	894	Mash made on-farm
Lactating sow	4.84	166	248	331	Mash made on-farm
Sucker	0.02	8	11	15	Pellets purchased
Weaner	0.94	569	853	1137	Pellets purchased
Porker	1.88	709	1064	1418	Liquid feed, mash made on-farm
Grower	2.60	972	1458	1944	Liquid feed, mash made on-farm
Finisher	3.13	1161	1742	2322	Liquid feed, mash made on-farm
Total	-	4074	6112	8149	

The pigs will have continuous access to clean drinking water. Low wastage drinkers will be installed; bowls for sows and bite (rather than push) nipple drinkers for other stock. Table 35 includes an estimate of drinking water usage.

Pig sales will include finished pigs, but also sows that have finished their productive life. Expected pig sales for each stage are summarised in Table 4.

Table 4 – Weekly and Annual Pig Sales

Pig Class and Item	Pig Sales						
	Stage 1	Stage 2		Stage 3			
	Number	Number	Weight (t)	Number	Weight (t)	Number	Weight (t)
Weekly							
Finishers	126	252	27.2	378	40.8	504	54.4
Sows	3	6	1.0	10	1.5	13	2.1
Total	129	258	28.2	388	42.3	517	56.5
Annually							
Finishers	6,568	13,135	1419	19,703	2,128	26,270	2837
Sows	167	335	53.8	502	80.6	669	107.5
Total	6,735	13,470	1472	20,205	2208	26,939	2945

Some mortalities are inevitable for any livestock operation. At this piggery, most mortalities will be young piglets. Table 5 shows the expected annual number and mass of mortalities. For the fully developed piggery, there will be approximately 93 t/yr of mortalities to manage.

Table 5 – Expected Annual Mortalities by Stage

Mortalities	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Number (pigs/yr)	2073	3110	4146
Mass (t/yr)	46.4	69.6	92.8

An office with staff facilities (lunch room, and showers and toilets, a feed milling shed and a machinery and maintenance shed will also be required.

B.1.c The Hours of Operational Activities

Operational activities will generally be restricted to 7 AM to 6 PM weekdays and 7 AM to 1 PM on weekends. There will be occasions when it may be necessary to operate outside these hours, for example, pigs may need to be loaded and transported in the early hours of the morning in very hot weather for welfare reasons. However, extraordinary work hours will only be used as a contingency to unusual events.

2.1.2. B.1.d The Number of Employees

Initially, the piggery will be staffed by four full-time equivalents. It is expected that eight full-time equivalents will be required once the pig farm is fully constructed (stage 3).

Contractors equivalent to approximately eight full-time equivalents will be required for a limited time to undertake each stage of construction.

2.1.3. B.1.e The Volume and Nature of Wastes, including Water, Nutrient & Salt Balances

The main "wastes" from the piggery are liquid effluent, spent bedding and mortalities all of which will be treated for reuse in farming systems.

Liquid Effluent

The conventional sheds will produce liquid effluent consisting of shed pressure washing water, drinking water wastage, waste feed and manure. The conventional pig sheds will be pressure-washed weekly to ensure a high standard of hygiene is maintained. The water, waste feed and manure will fall through the slatted shed flooring and collect in concreted under-floor pits. The effluent will be regularly released from the pits by the opening of pull plugs. The stream will be directed to an effluent treatment system that will be constructed progressively as each stage of the piggery is developed. The PigBal 4 model developed by the Queensland Department of Agriculture and Fisheries (2019) for Australian Pork Ltd was used to estimate the properties of the raw liquid effluent stream. PigBal 4 is a validated model that uses herd composition, feed usage, diet composition and water usage to provide a good estimate of the properties of the effluent stream.

In-shed losses are also accounted for; for sheds with pull plug systems these are: 10% of total solids, 12% of volatile solids and 10% of nitrogen.

Table 6 shows the volume of effluent that will be discharged from the conventional sheds for each stage of development. Table 7 shows the solids and macro-nutrients contained in the effluent ex-sheds by stage. PigBal does not estimate the salt content of effluent. However, the National Environmental Guidelines for indoor Piggeries (Tucker, National Environmental Guidelines for Indoor Piggeries, 2018) provide tabulated data showing an electrical conductivity (EC) range of 2.5-11.7 dS/m with a mean of 6.4 dS/m for effluent for irrigation. EC levels depend on the EC of the water used, the level of salt inclusion in the diet, whether effluent is recycled as cleaning water, and evaporation and rainfall rates. It is not intended that effluent will be recycled as cleaning water and salt levels in the diets will be kept low to ensure the effluent does not become too saline. Reverse osmosis treatment of the bore water will also be considered if necessary.

Table 6 – Liquid Effluent Volume Discharged from Sheds by Stages

Item	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Water (L/d)	2,400	3,600	4,800
Manure + waste feed (L/d)	11,105	16,656	22,208
Drinker waste water (L/d)	4365	6551	8,734
Total (L/d)	17,870	26,810	35,740
Total (ML/yr)	6.52	9.78	13.05

Table 7 – Composition of Liquid Effluent Discharged from Sheds

Item	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Total solids (t/yr)	405	608	810
Volatile solids (t/yr)	323	484	646
Nitrogen (t/yr)	38.7	57.8	77.0
Phosphorus (t/yr)	10.6	15.9	21.2
Potassium (t/yr)	9.9	14.8	19.7
Total solids (kg/d)	1110	1664	2219
Volatile solids (kg/d)	885	1327	1769
Nitrogen (kg/d)	106	158	211
Phosphorus (kg/d)	29	44	58
Potassium (kg/d)	27	41	54

Spent Bedding

The deep litter housing will produce spent bedding consisting of a mixture of bedding, waste feed and manure. PigBal 4 was used to estimate the composition of the spent bedding including nutrients added by feed and bedding, and in-shed losses of 20% of total solids, 25% of volatile solids and 17% of nitrogen.

The spent bedding will be regularly removed from the shelters and replaced as needed to provide dry, low odour bedding for the pigs to lie on.

Table 9 provides an estimate of the mass and volume of spent bedding removed annually assuming a moisture content ex-sheds of 50% and a bulk density of 0.6 t/m^3. The removed bedding will be composted on a hard-stand, bunded area (see section 2.1.4 for details).

Table 8 – Composition of Spent Bedding Removed from Sheds

Item	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Total solids (t/yr)	823	1234	1645
Volatile solids (t/yr)	695	1043	1390
Nitrogen (t/yr)	28.9	43.3	57.7
Phosphorus (t/yr)	6.6	9.8	13.1
Potassium (t/yr)	23.5	35.3	47.0

Table 9 – Estimated Mass and Volume of Spent Bedding

Item	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Wet Mass (t/yr)*	1645	2470	3290
Volume (m^3/yr)#	2740	4110	5480

* assuming a moisture content of 50% ex-sheds   # assuming a bulk density of 0.6 t/m^3

2.1.4. B.1.f Waste Handling, Treatment & Utilisation

This section describes the handling, treatment and reuse of effluent, spent bedding, separated manure solids and sludge removed from the floor of the anerobic effluent treatment pond.

Effluent Treatment

Overview of Effluent Treatment Process

The effluent treatment process will be similar for each stage, with the general treatment process summarised in Figure 2. Differences in treatment between the stages are detailed below.

Effluent Release from Sheds

For all stages, the effluent will be released from the shed under-floor pits by pulling the plugs on the pits weekly. The pits of different sheds will be released on different days of the week to keep the flow of effluent relatively constant. This is important in ensuring a regular feed supply for the microorganisms in the anaerobic effluent pond that are responsible for treating the effluent. The released effluent will be detained in an in-ground sump with a capacity of 100,000 L similar to the one shown in Photograph 3. A stirrer on the sump will keep solids suspended in the effluent stream.

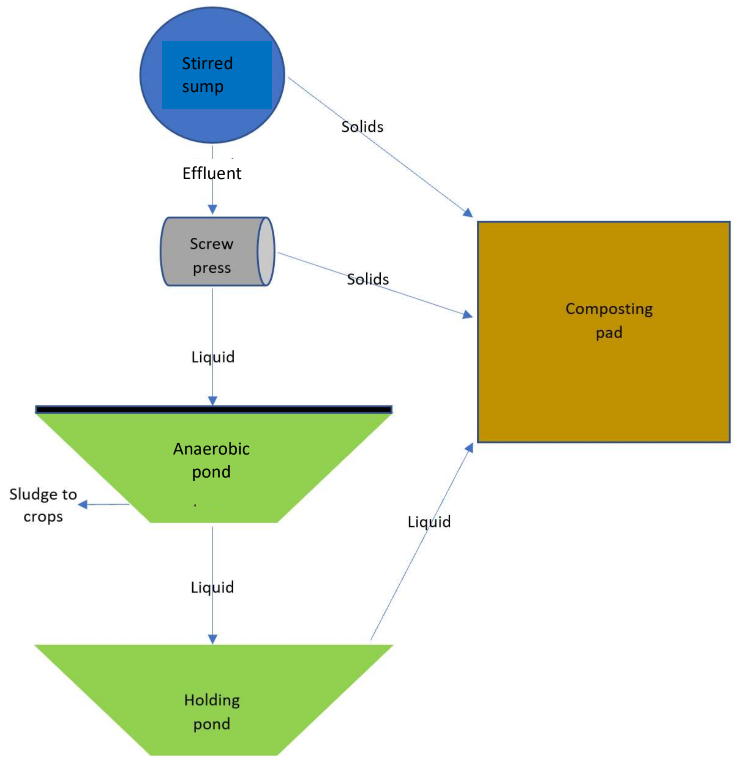


Figure 2 – General Effluent Treatment Process

Photograph 3 – Sump and Screw Press Separator

Solids Separation

For all stages, the effluent will be pumped from the sump to a screw press separator that will remove solids from the stream. Removing solids reduces the organic load to the pond system, meaning that smaller ponds with less odour-emitting surface area can be used. Taking out large, light solids such as husks also reduces the likelihood of a crust forming over the anaerobic pond that can block the biogas collection pipework that will be installed at stage 3 (see below). The screw press will sit above a bunded, concreted area designed to prevent any leaching or drainage of nutrient-rich leachate to the surrounds. The configuration will be very similar to that shown in the background of Photograph 3. The separated solids removed by the screw press will accumulate on the pad while drainage from this area will be diverted back to the sump via a drain. Effluent with solids removed will be directed to the anaerobic pond via a pipe.

PigBal 4 includes a screw press solids separation option. The default solids and nutrient removal rates, which are used here, are:

- total solids 32%
- volatile solids 37%
- nitrogen 37%
- 41% phosphorus
- 8% potassium.

The composition of the liquid effluent discharged from the screw press, and that retained in the solids for each stage, is shown in Table 10.

Table 10 – Composition of Liquid Effluent Discharged from Screw Press and Retained in Solids

Item	Stage 1 – 600 sows		Stage 2 – 900 sows		Stage 3 – 1200 sows	
	Liquid	Solids	Liquid	Solids	Liquid	Solids
Total solids (t/yr)	275	130	413	194	551	259
Volatile solids (t/yr)	203	119	305	179	407	239
Nitrogen (t/yr)	24.4	14.3	36.4	21.4	48.5	28.5
Phosphorus (t/yr)	6.2	4.3	9.4	6.5	12.5	8.7
Potassium (t/yr)	9.1	0.8	13.6	1.2	18.1	1.6
Total solids (kg/d)	755	355	1132	533	1509	710
Volatile solids (kg/d)	557	327	836	491	1114	655
Nitrogen (kg/d)	66.8	39.2	99.7	58.6	132.9	78.1
Phosphorus (kg/d)	17.1	11.9	25.7	17.8	34.2	23.8
Potassium (kg/d)	24.8	2.2	37.3	3.2	49.7	4.3

Anaerobic Pond

For all stages, an anaerobic pond will provide primary effluent treatment. Anaerobic ponds use microorganisms that can function in the absence of free oxygen to reduce the organic matter of effluent. Anaerobic decomposition is a multi-stage process. First, enzymes degrade the organic matter into soluble molecules. Next, acid-forming bacteria break these down into volatile fatty acids (VFAs). Finally, they are converted into low odour methane and carbon dioxide. To minimise odours, it is important that the process is complete. The methane-formers are pH sensitive and also slowgrowing, so excessive production of VFAs can result in incomplete breakdown and increased odour. To promote stable treatment bacteria populations, at each stage the anaerobic pond will be sized to ensure there is sufficient treatment capacity, the pond effluent volume will be kept relatively stable, and the feed to the pond will be kept regular by releasing pull plugs throughout the week.

In sizing an anaerobic pond, there is a need to provide treatment capacity but also space to store the less digestible matter that is a by-product of the digestion process and accumulates as sludge on the floor of the pond. The volatile solids (VS) and total solids (TS) loads in the effluent stream are used to size the active volume and sludge storage volume, respectively. For stages 1 and 2, the pond will be designed to be a heavily loaded, uncovered anaerobic pond. At stage 3, the pond will be expanded and converted into a covered anaerobic pond (CAP); the cover will capture biogas that can be used as a heat and power source for the piggery.

During the treatment process, the liquid effluent will slowly move from one end of the pond to the other where it will spill into a holding pond. The sludge will deposit on the floor of the pond. It is intended that the sludge accumulating over the base of the anaerobic pond will be extracted annually using a vacuum tanker. This method of desludging has been selected as it allows for sludge removal without pond dewatering which, maintains the function of the pond. It is also one of few options available for the stage 3 covered anaerobic pond (O'Keefe, MF, McDonald, SA, Yan, MJ, Davis, RJ, Watts, PJ, McGahan, EJ and Tucker, RW, 2013).

Anaerobic Pond Sizing – Stage 1

At stage 1, the anaerobic pond will function as an uncovered heavily loaded anaerobic pond, as described in the National Environmental Guidelines for Indoor Piggeries (Tucker, 2018). Pigbal 4 includes a pond sizing component, with various pond sizing options included. For a heavily loaded, uncovered anaerobic pond, the baseline VS loading rate for the treatment capacity is 750 g VS/m^3/day. Yerong Creek is approximately 15 km east of the piggery site. Taking the Yerong Creek climate into account, a pond activity ratio of 0.7142 is suggested. Hence, the adjusted VS loading rate is 536 g VS/m^3/day (750 g VS/m^3/day X 0.7142). With 557 kg VS/d entering the pond at stage 1, the minimum required treatment capacity is 1041 m^3. The sludge accumulation factor in PigBal 4 is 0.00137 m^3/kg TS which is taken from "Design of Anaerobic Lagoons for Animal Waste Management" (ASABE Standards, 2011). Although it is proposed to desludge the anaerobic pond annually, for all stages, storage capacity for two years sludge accumulation will be allocated to provide for contingency situations. With 275 t TS/yr entering the pond, this equates to 753 m^3. Hence, the minimum required pond capacity is 1795 m^3. However, it is proposed to build a 2.7 ML pond that will be large enough to work at stage 2 as well. With 17,870 L/d of effluent for treatment, and an available active volume of at least 1947 m^3 (i.e. 2700 m^3 less sludge storage of 753 m^3), the hydraulic retention time of the active part of the pond is at least 109 days, which significantly exceeds the 30-day minimum recommended for effective anaerobic digestion.

Based on the work of Skerman et al. (2008) cited by Tucker (2015), heavily loaded anaerobic ponds perform as well as traditional rational design standard ponds, removing at least 70% of volatile solids. However, this could be as high as 90% or more. Taking the mid-range value (80%), the volatile solids load exiting the anaerobic pond at stage 2 will be about 111 kg VS/d.

As a result of pond treatment, the nutrients in effluent will be distributed between gaseous losses, liquid and sludge. Volatilisation is likely to be responsible for the loss of at least 40% of the nitrogen.

Of the remaining nutrients, some 23.5% of nitrogen, 90% of phosphorus and 5% of potassium will deposit to sludge with the remainder staying in the liquid fraction (McGahan E, Willis S and Skerman A, 2010). Table 11 shows the estimated partitioning of nutrients between liquid and sludge.

Table 11 – Effluent Partitioning Between Gaseous Losses, Liquid and Sludge in the Anaerobic Pond – Stage 1

Item	Initial mass	Gaseous losses	Liquid	Sludge
Nitrogen (t/yr)	24.4	9.8	11.2	3.4
Phosphorus (t/yr)	6.2	-	0.6	5.6
Potassium (t/yr)	9.1	-	8.6	0.5

It is intended that the sludge accumulating over the base of the anaerobic pond will be extracted with a vacuum tanker annually. This will be done by lowering the tanker suction pipe over the bank of the pond. The extracted sludge will be directly spread onto paddocks ahead of planting.

Anaerobic Pond Sizing – Stage 2

The uncovered, heavily loaded anaerobic pond built for stage 1 will also service stage 2. Again, the target maximum VS loading rate for the active volume is 536 g VS/m^3/day. With 836 kg VS/d entering the pond, the minimum required treatment capacity is 1560 m^3. With 413 t TS/yr entering the pond, two years sludge storage volume with a sludge accumulation factor of 0.00137 m^3/kg TS, is 1132 m^3. Hence, the minimum total volume needed is 2692 m^3 or 2.7 ML, which is the volume that will be provided.

For this stage, the inflow of effluent into the anaerobic pond is estimated at 26,810 L/d or 9,780 m^3/yr. The available active pond capacity of at least 1560 m^3 provides for a minimum hydraulic retention time of at least 58 days, which is a generous treatment capacity. Assuming treatment removes 80% of VS, some 223 kg VS/d will exit the pond at stage 2. Using the Pigbal 4 default values, Table 12 shows the quantities of solids and nutrients allocated to gaseous losses, and to liquid and solids within the pond.

Table 12 – Effluent Partitioning Between Gaseous Losses, Liquid and Sludge in the Anaerobic Pond – Stage 2

Item	Initial mass	Gaseous losses	Liquid	Sludge
Nitrogen (t/yr)	36.4	14.6	16.7	5.1
Phosphorus (t/yr)	9.4	-	0.9	8.4
Potassium (t/yr)	13.6	-	12.9	0.7

Anaerobic Pond Sizing – Stage 3

It is proposed that at stage 3, the anaerobic pond will be converted into a covered anaerobic pond or CAP. CAP's are a mainstream effluent treatment option for larger Australian piggeries, providing a means to significantly reduce odour and greenhouse gas (GHG) emissions, while also providing an energy source (biogas) for the generation of power and / or heat that can be used within the piggery or elsewhere. This represents environmental best practice for piggeries with a capacity of ~5000 SPU or more in conventional sheds when the technology generally becomes economically viable.

As mentioned earlier, the pond activity ratio is 0.7142 for an anaerobic pond at Yerong Creek. From PigBal 4, the recommended baseline VS loading rate for a covered anaerobic pond is 300 g VS/m^3/day. Hence, the adjusted VS loading rate for the stage 3 CAP at this site is 214 g VS/m^3/day (i.e. 300 g VS/m^3/day X 0.7142). From Table 10, the volatile solids load to the anaerobic pond is 1114 kg VS/d. Hence, the required treatment volume is 5,206 m^3. Some 551 t of total solids enter the pond annually. Using the PigBal 4 sludge accumulation factor of 0.00137 m^3/kg TS (ASABE Standards, 2011), and providing for two years sludge storage adds a volume of 1,510 m^3. Hence, the calculated pond volume is 6,715 m^3 or 6.715 ML and this is what will be provided. Further details are given in section 2.3.6.

For stage 3, the inflow of effluent into the anaerobic pond is estimated at 35,740 L/d or 13,050 m^3/yr. As the pond will be covered, this will also be the outflow. This provides for a hydraulic retention time of at least 146 days at stage 3, which greatly exceeds the 30-day minimum recommended for effective anaerobic digestion and biogas production. Assuming treatment removes 80% of VS, some 223 kg VS/d will exit the pond at stage 3.

For stage 3, a number of permanent sludge extraction pipelines will be installed through the bank of the pond, pointing downwards towards the base. When sludge extraction is due, the tanker suction pipe will be threaded through these portals to access the sludge (see Photograph 4)

Significant nitrogen losses will still occur during pond treatment (~40% of the incoming nitrogen) but when the primary pond is covered, these will be from the holding pond. In the absence of data specific to CAPs, we have assumed that 40% of nitrogen will be lost by volatilisation and that 23.5% of nitrogen, 90% of phosphorus and 5% of potassium of the remaining nitrogen will deposit to sludge with the balance staying in the liquid fraction (based on the work of McGahan et al (2010)). Table 11 shows the estimated partitioning of nutrients between liquid and sludge.

Table 13 – Effluent Partitioning Between Gaseous Losses, Liquid and Sludge in the Pond System – Stage 3

Item	Initial mass	Gaseous losses	Liquid	Sludge
Nitrogen (t/yr)*	48.5	19.4	22.3	6.8
Phosphorus (t/yr)	12.5	-	1.25	11.25
Potassium (t/yr)	18.1	-	17.2	0.9

* Assumptions re nitrogen losses are the same except that these will be from the holding pond.

Holding Pond
At each stage, the effluent will slowly move from one end of the anaerobic pond to the other, eventually spilling into a 10 ML holding pond via a pipeline or weir. It will be detained in this pond ahead of reuse. At each stage, the pond has a designed spill frequency of less than 1 in 10-years and will also be able to contain the 1 in 20 year, 24-hour storm. Further details are provided in section 2.3.3 and 2.3.6.

Treated effluent will be sprayed onto the spent bedding and separated solids undergoing composting when extra moisture is needed to optimise their moisture content. It will also add further nutrients, enhancing the value of the end-product. Effluent that is not needed for this process will be irrigated onto land used to grow crops.

Composting of Spent Bedding and Separated Manure Solids with Effluent

Spent bedding and separated solids will be composted in a dedicated area shown on Figure 1. The composting facility will be designed in accordance with the environmental guidelines for "Composting and Related Organics Processing Facilities" (Department of Environment and Conservation (NSW), 2004). The area will be constructed to provide a durable all-weather surface to prevent leaching to groundwater. It will be bunded with a 0.3 m high bank to contain contaminated leachate and runoff and prevent the entry of extraneous stormwater runoff. The area will be graded to have a slope of 2% towards a drain that will convey the runoff to the piggery wet weather pond which has been sized to manage this inflow. It is proposed that a pad able to handle the solids from stage 1 of the piggery will be built initially and that this would be expanded to full size (stage 3 solids) at stage 2.

Composting Process

The composting facility will operate generally in accordance with the environmental guidelines for "Composting and Related Organics Processing Facilities" (Department of Environment and Conservation (NSW), 2004).

An aerobic windrow composting method will be used to ensure odour emissions are minimal. It is expected that material will be composted over a 12-week period consisting of an eight-week active management period and a four-week curing period. The material will be intensively managed during the eight-week active phase to optimise the process and ensure it is completed quickly. To begin the process, the raw materials will be blended and formed into low windrows with a triangular cross section (~2 m high, 4 m wide at base, 4 m^3 of material stored for every metre of length). A pad will be constructed to managed the manure from stage 1 and this will be expanded for stages 2 & 3.

The windrows will run down the slope of the pad to promote free drainage of the area. Low windrows will be used as these have a lower combustion risk than taller windrows. A triangular cross-section will promote drainage of surplus rainfall. The heating and turning during the process will result in significant water losses. To address this, soaker hoses will be used to apply treated effluent to the windrow twice a week before turning of the windrows. Additions of effluent will be carefully managed to ensure the manure is wet enough to heat up during the active phase, but not become anaerobic. Optimising the moisture content of the composting material will also minimise the risk of dust emissions on turning and handling. Initially, a telehandler will be used to turn the material but it is expected that a BearCat will eventually be purchased and used in the future.

The material will also be turned weekly during the four-week aging period to ensure the composting process is complete and to thoroughly mix the product. At the end of the curing phase, the finished compost will be formed into a stockpile. The finished material will be kept completely separate from the active or curing piles to prevent cross-contamination.

Area Required

The area required for the composting process depends on the quantities of raw materials but also the windrow configuration. The masses and volumes of spent bedding ex-sheds expected at each stage are shown in Table 14. These figures have been calculated based on the data in Table 10 and assumptions for moisture content and bulk density.

As screw presses typically produce stackable solids with a TS concentration of 20-30% (Watts PJ, Tucker RW, Pittaway PA, McGahan EJ, Kruger IR and Lott SC, 2002), a TS content of 25% (moisture content of 75%) has been assumed for the calculations. Given the relatively high moisture content of the material, a bulk density of 0.9 t/m^3 has been adopted.

Table 14 – Estimated Mass and Volume of Separated Manure Solids

Item	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Mass (t/yr)	518	778	1037
Volume (m^3/yr)	576	864	1152

The estimated mass and volume of spent bedding is shown in Table 9.

Table 15 shows the estimated wet mass, volume and composition of the combined raw products.

Table 15 – Composition of Separated Manure Solids + Spent Bedding

Item	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Wet mass (t/yr)	2166	3245	4327
Volume (m^3/yr)	3321	4977	6636
Moisture content (%)*	56%	56%	56%
Total solids (t/yr)	953	1428	1904
Volatile solids (t/yr)	814	1222	1629
Nitrogen (t/yr)	43.2	64.7	86.2
Phosphorus (t/yr)	10.9	16.3	21.8
Potassium (t/yr)	24.3	36.5	48.6

Ideally, the moisture content of the composting material will be maintained at ~55% during the active stage. It is expected that the materials will start at about this moisture content. Twice weekly additions of effluent will replace water lost during heating of the pile and turning. Figure 3, Figure 4 and Figure 5 show the output of a spreadsheet prepared to calculate the amount of effluent needed to keep the compost moisture content optimal throughout the composting process for each stage. In each case, it is assumed that there will be:

- loss of 1.5% of total solids and 5% of moisture at each turn in the first week until the composting process is established, effluent added to bring moisture content up to 55%
- loss of 3% of total solids and 10% of moisture at each turn in weeks 2-5 when the composting process is most active, effluent added to bring moisture content up to 55%
- loss of 1.5% of total solids and 10% of moisture in weeks 6-8 as the composting process slows. Effluent will be added to bring the moisture content up to 55% after the first turn but no effluent will be added at the last turn. The moisture content of the finished compost is assumed to be 50%.

Combined Solids	Stage 1		Wet Weight	Total Solids	Effluent Applied	Moisture loss
		(%)	2,166	953	kL	kL
		56.00%				
Week 1 - pass 1	Moisture loss (%)	5.0%	1,916			
	Total Solids loss (%)	1.5%		939		250
	Wet to moisture content (%)	55%	2,086		170	
Week 1 - pass 2	Moisture loss (%)	5.0%	1,849			
	Total Solids loss (%)	1.5%		925		237
	Wet to moisture content (%)	55%	2,055		205	
Week 2 - pass 1	Moisture loss (%)	10%	1,631			
	Total Solids loss (%)	3.0%		897		424
	Wet to moisture content (%)	55%	1,993		362	
Week 2 - pass 2	Moisture loss (%)	10%	1,582			
	Total Solids loss (%)	3.0%		870		411
	Wet to moisture content (%)	55%	1,933		352	
Week 3 - pass 1	Moisture loss (%)	10%	1,534			
	Total Solids loss (%)	3.0%		844		399
	Wet to moisture content (%)	55%	1,875		341	
Week 3 - pass 2	Moisture loss (%)	10%	1,488			
	Total Solids loss (%)	3.0%		819		387
	Wet to moisture content (%)	55%	1,819		331	
Week 4 - pass 1	Moisture loss (%)	10%	1,444			
	Total Solids loss (%)	3.0%		794		375
	Wet to moisture content (%)	55%	1,764		321	
Week 4 - pass 2	Moisture loss (%)	10%	1,400			
	Total Solids loss (%)	3.0%		770		364
	Wet to moisture content (%)	55%	1,712		311	
Week 5 - pass 1	Moisture loss (%)	10%	1,358			
	Total Solids loss (%)	3.0%		747		353
	Wet to moisture content (%)	55%	1,660		302	
Week 5 - pass 2	Moisture loss (%)	10%	1,318			
	Total Solids loss (%)	3.0%		725		343
	Wet to moisture content (%)	55%	1,610		293	
Week 6 - pass 1	Moisture loss (%)	10.0%	1,298			
	Total Solids loss (%)	1.5%		714		313
	Wet to moisture content (%)	55%	1,586		288	
Week 6 - pass 2	Moisture loss (%)	10.0%	1,278			
	Total Solids loss (%)	1.5%		703		308
	Wet to moisture content (%)	55%	1,562		284	
Week 7 - pass 1	Moisture loss (%)	10.0%	1,259			
	Total Solids loss (%)	1.5%		693		303
	Wet to moisture content (%)	55%	1,539		280	
Week 7 - pass 2	Moisture loss (%)	10.0%	1,240			
	Total Solids loss (%)	1.5%		682		299
	Wet to moisture content (%)	55%	1,516		276	
Week 8 - pass 1	Moisture loss (%)	5.0%	1,344			
	Total Solids loss (%)	1.5%		672		172
	Wet to moisture content (%)	55%	1,493		149	
Week 8 - pass 2	Moisture loss (%)	5.0%	1,324			
	Total Solids loss (%)	1.5%		662		169
	Wet to moisture content (%)	50%	1,324		0	
Total	**Completed Compost**	t/yr	1,324	662		
	Total moisture required	kL/yr			4,265	
	Total moisture loss	kL/yr				5,107
	Mass reduction	t/yr	842			
		%	39%			
	Net Total Solids reduction	t/yr		291		
		%		30.6%		
	Effluent Use	L/kg TS	4.5			
	Effluent Use	L/day	11685		4.3	ML/yr
	Final m/c	(%)	50%			

Figure 3 – Moisture Requirement for Composting – Stage 1

Combined Solids	Stage 2		Wet Weight	Total Solids	Effluent Applied	Moisture loss
		(%)	3,244	1,428	kL	kL
		55.98%				
Week 1 - pass 1	Moisture loss (%)	5.0%	2,869			
	Total Solids loss (%)	1.5%		1,407		375
	Wet to moisture content (%)	55%	3,126		256	
Week 1 - pass 2	Moisture loss (%)	5.0%	2,771			
	Total Solids loss (%)	1.5%		1,385		355
	Wet to moisture content (%)	55%	3,079		308	
Week 2 - pass 1	Moisture loss (%)	10%	2,443			
	Total Solids loss (%)	3.0%		1,344		635
	Wet to moisture content (%)	55%	2,986		543	
Week 2 - pass 2	Moisture loss (%)	10%	2,370			
	Total Solids loss (%)	3.0%		1,304		616
	Wet to moisture content (%)	55%	2,897		527	
Week 3 - pass 1	Moisture loss (%)	10%	2,299			
	Total Solids loss (%)	3.0%		1,264		598
	Wet to moisture content (%)	55%	2,810		511	
Week 3 - pass 2	Moisture loss (%)	10%	2,230			
	Total Solids loss (%)	3.0%		1,227		580
	Wet to moisture content (%)	55%	2,726		496	
Week 4 - pass 1	Moisture loss (%)	10%	2,163			
	Total Solids loss (%)	3.0%		1,190		562
	Wet to moisture content (%)	55%	2,644		481	
Week 4 - pass 2	Moisture loss (%)	10%	2,098			
	Total Solids loss (%)	3.0%		1,154		546
	Wet to moisture content (%)	55%	2,565		466	
Week 5 - pass 1	Moisture loss (%)	10%	2,035			
	Total Solids loss (%)	3.0%		1,119		529
	Wet to moisture content (%)	55%	2,488		452	
Week 5 - pass 2	Moisture loss (%)	10%	1,974			
	Total Solids loss (%)	3.0%		1,086		513
	Wet to moisture content (%)	55%	2,413		439	
Week 6 - pass 1	Moisture loss (%)	10.0%	1,945			
	Total Solids loss (%)	1.5%		1,070		468
	Wet to moisture content (%)	55%	2,377		432	
Week 6 - pass 2	Moisture loss (%)	10.0%	1,916			
	Total Solids loss (%)	1.5%		1,054		461
	Wet to moisture content (%)	55%	2,341		426	
Week 7 - pass 1	Moisture loss (%)	10.0%	1,887			
	Total Solids loss (%)	1.5%		1,038		454
	Wet to moisture content (%)	55%	2,306		419	
Week 7 - pass 2	Moisture loss (%)	10.0%	1,858			
	Total Solids loss (%)	1.5%		1,022		448
	Wet to moisture content (%)	55%	2,271		413	
Week 8 - pass 1	Moisture loss (%)	5.0%	2,014			
	Total Solids loss (%)	1.5%		1,007		258
	Wet to moisture content (%)	55%	2,237		224	
Week 8 - pass 2	Moisture loss (%)	5.0%	1,983			
	Total Solids loss (%)	1.5%		992		254
	Wet to moisture content (%)	50%	1,983		0	
Total	Completed Compost	t/yr	1,983	992		
	Total moisture required	kL/yr			6,392	
	Total moisture loss	kL/yr				7,653
	Mass reduction	t/yr	1,261			
		%	39%			
	Net Total Solids reduction	t/yr		436		
		%		30.6%		
	Effluent Use	L/kg TS	4.5			
	Effluent Use	L/day	17513		6.4	ML/yr
	Final m/c	(%)	50%			

Figure 4 – Moisture Requirement for Composting – Stage 2

Combined Solids	Stage 3		Wet Weight	Total Solids	Effluent Applied	Moisture loss
		(%)	4,326	1,904	kL	kL
		55.99%				
Week 1 - pass 1	Moisture loss (%)	5.0%	3,826			
	Total Solids loss (%)	1.5%		1,875		500
	Wet to moisture content (%)	55%	4,168		341	
Week 1 - pass 2	Moisture loss (%)	5.0%	3,695			
	Total Solids loss (%)	1.5%		1,847		473
	Wet to moisture content (%)	55%	4,105		411	
Week 2 - pass 1	Moisture loss (%)	10%	3,258			
	Total Solids loss (%)	3.0%		1,792		847
	Wet to moisture content (%)	55%	3,982		724	
Week 2 - pass 2	Moisture loss (%)	10%	3,160			
	Total Solids loss (%)	3.0%		1,738		822
	Wet to moisture content (%)	55%	3,863		702	
Week 3 - pass 1	Moisture loss (%)	10%	3,065			
	Total Solids loss (%)	3.0%		1,686		797
	Wet to moisture content (%)	55%	3,747		681	
Week 3 - pass 2	Moisture loss (%)	10%	2,973			
	Total Solids loss (%)	3.0%		1,635		773
	Wet to moisture content (%)	55%	3,634		661	
Week 4 - pass 1	Moisture loss (%)	10%	2,884			
	Total Solids loss (%)	3.0%		1,586		750
	Wet to moisture content (%)	55%	3,525		641	
Week 4 - pass 2	Moisture loss (%)	10%	2,798			
	Total Solids loss (%)	3.0%		1,539		727
	Wet to moisture content (%)	55%	3,419		622	
Week 5 - pass 1	Moisture loss (%)	10%	2,714			
	Total Solids loss (%)	3.0%		1,493		706
	Wet to moisture content (%)	55%	3,317		603	
Week 5 - pass 2	Moisture loss (%)	10%	2,632			
	Total Solids loss (%)	3.0%		1,448		684
	Wet to moisture content (%)	55%	3,217		585	
Week 6 - pass 1	Moisture loss (%)	10.0%	2,593			
	Total Solids loss (%)	1.5%		1,426		624
	Wet to moisture content (%)	55%	3,169		576	
Week 6 - pass 2	Moisture loss (%)	10.0%	2,554			
	Total Solids loss (%)	1.5%		1,405		615
	Wet to moisture content (%)	55%	3,122		568	
Week 7 - pass 1	Moisture loss (%)	10.0%	2,516			
	Total Solids loss (%)	1.5%		1,384		606
	Wet to moisture content (%)	55%	3,075		559	
Week 7 - pass 2	Moisture loss (%)	10.0%	2,478			
	Total Solids loss (%)	1.5%		1,363		597
	Wet to moisture content (%)	55%	3,029		551	
Week 8 - pass 1	Moisture loss (%)	5.0%	2,685			
	Total Solids loss (%)	1.5%		1,342		344
	Wet to moisture content (%)	55%	2,983		298	
Week 8 - pass 2	Moisture loss (%)	5.0%	2,645			
	Total Solids loss (%)	1.5%		1,322		339
	Wet to moisture content (%)	50%	2,645		0	
Total	Completed Compost	t/yr	2,645	1,322		
	Total moisture required	kL/yr			8,522	
	Total moisture loss	kL/yr				10,204
	Mass reduction	t/yr	1,681			
		%	39%			
	Net Total Solids reduction	t/yr		582		
		%		30.6%		
	Effluent Use	L/kg TS	4.5			
	Effluent Use	L/kg comp	3.2			
	Effluent Use	L/day	23349		8.5	ML/yr
	Final m/c	(%)	50%			

Figure 5 – Moisture Requirement for Composting – Stage 3

This gives a total solids loss of ~30% over the whole process, which is consistent with the Piggery Manure and Effluent Management and Reuse Guidelines (Tucker, 2015). Effluent usage is 4.5 L/kg of initial total solids, or 3.2 L/kg of compost. This is consistent with research into the co-composting of liquid effluent with pig manure and woodchips which used 1.7–4.7 L of effluent for every kilogram of total solids being composted (Vazquez, MA dela Varga, D Plana R and Soto M, 2015).

The total volume of effluent that can be used in the co-composting process at each stage is estimated to be:

- stage 1: 4.3 ML/yr, av. 11,685 L/day
- stage 2: 6.4 ML/yr, av. 17,500 L/day
- stage 3: 8.5 ML/yr, av. 23,350 L/day

Space will be needed to manage the composting process and to store the finished product. Table 16 summarises the space requirements. If the composting process takes 12 weeks, and allowance is made for a 1 week turn-around to move the compost to the stockpile, quarter of the years' material will be in the actively composting windrows at any time. Each windrow will be 4 m wide at the base, and 4 m of manoeuvring space will be provided alongside and around the ends of each windrow.

Compost will generally be spread around the same time each year, but storage for 12 months finished compost will allow for contingency storage. Table 16 shows the mass and volume of compost (assuming a bulk density of 650 kg/m^3) as well as the dimensions of a trapezoidal stockpile 2 m high with 3:1 side batters. It is assumed that the stockpile extends to the bank of the composting pad on three sides with a 4 m clearance to the windrows (already provided for above).

In addition, Table 16 shows the space required for mortalities composting. The total space includes 4 m along one side of the mortalities composting pad as 4 m has been allowed at the ends of the active composting rows. Further detail on this is provided later in this section.

Table 16 – Compost Space Requirements

Item	Stage 1	Stage 2	Stage 3
Raw materials (m^3/yr)	3321	4497	6636
Material actively composting (m^3)	830	1424	1659
Windrow length needed (m)	208	281	415
Windrows needed	4 X 52 m	6 X 52 m	8 x 52 m
Space needed (L & W) (m)	60 m X 36 m	60 m X 52 m	60 m x 68 m
Completed compost (t/yr, wet weight)	1324	1983	2645
Completed compost (m^3/yr)	2037	3051	4069
Stockpile dimensions (m)	60 m X 25 m	60 m X 34 m	60 m X 44 m
Space needed (L & W) (m)	60 m X 25 m	60 m X 34 m	60 m X 44 m
Annual mortalities (t/yr)	46.4	69.6	92.8
Volume for 12 months mortalities (m^3)	186	278	371
Minimum number of 155 m^3 bays	2	2	3
Space needed (L & W) (three bays)	22 m X 8.6 m	22 m X 8.6 m	22 m X 8.6 m
Space needed (m)	22 m X 13 m	22 m X 13 m	22 m X 13 m
Total space needed (L & W) (m)	60 m X 74 m	60 m X 99 m	125 m X 60 m
Total space needed (area) (m^2)	4440 m^2	5940 m^2	7500 m^2

It is proposed that the pad will initially be constructed to meet the stage 1 requirements. It will be extended at stage 2 to provide the full stage 3 pad.

Figure 6 shows the general layout of the composting pad. The finished compost will be located upslope of the composting material and mortalities to minimise the risk of cross-contamination of finished compost. As the highest-risk material, the mortalities will go at the bottom of the pad. Runoff from the composting pad will be collected in a drain that will it to the main piggery holding pond. Sizing and construction details are provided in section 2.3.6.

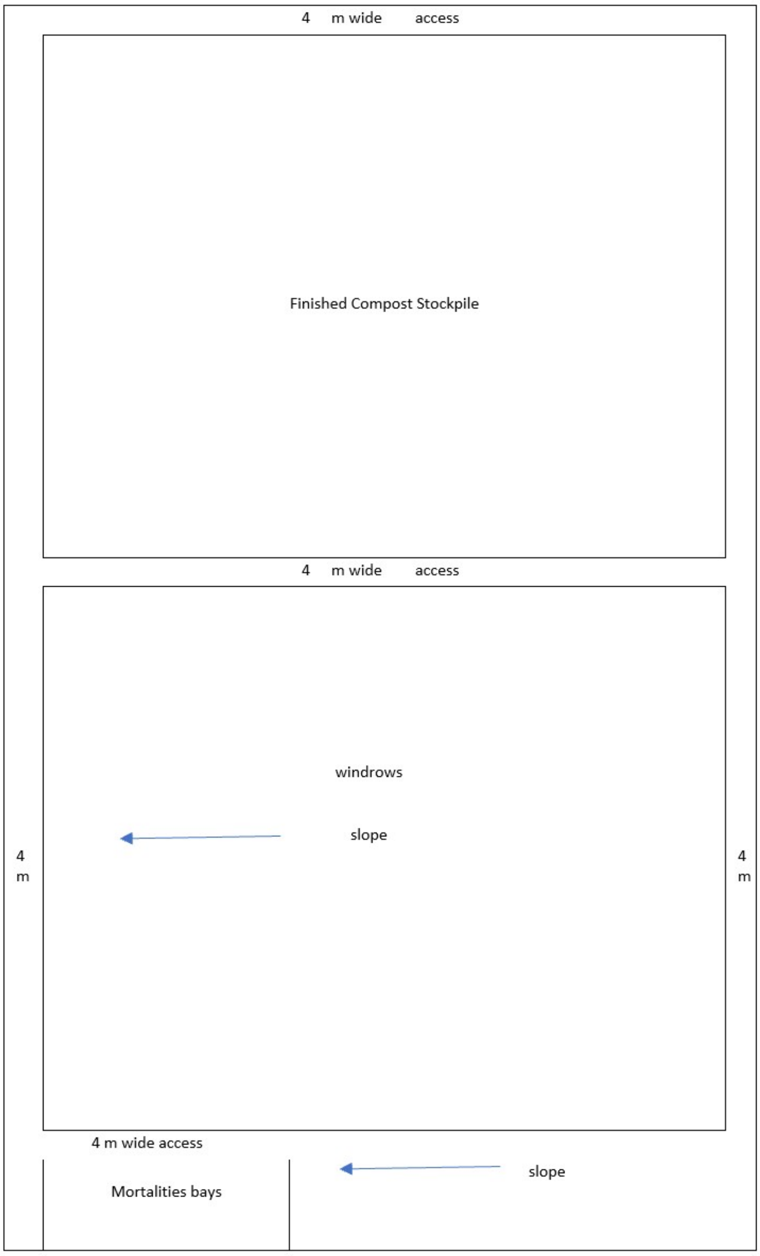


Figure 6 – Schematic Layout of Composting Pad

Mortalities Management

Composting Facility

Mortalities will be composted in bays formed from large square hay bales. This will be undertaken in the area used to compost the spent bedding and manure solids, which is a bunded, hardstand area (see section 2.2.3). Composting in a controlled drainage area is the most environmentally-friendly method for mortalities disposal. It poses a very low risk of groundwater or surface water contamination. Composting uses micro-organisms to break-down organic matter to form a humus-like substance. Spent bedding will provide the carbon and cover material for the process. Providing sufficient cover material is used, composting is a low odour, aerobic process and it yields a valuable soil amendment.

Table 5 sets out the expected animal mortalities by stage. For the fully developed piggery, there will be approximately 93 t/yr of mortalities to manage. As a guide, 4 m^3 of storage space is needed per tonne of mortalities annually, or about 373 m^3. Square bales are typically 4' X 3' X 8' (1.2 m X 0.9 m X 2.4 m) or 4'X 4''X 8' (1.2 m X 1.2 m X 2.4 m) in dimensions. A bay with sides three bales long and ends three bales wide will provide about 43 m^2 (i.e. ((3 X 2.4 m) - 1.2 m) = 6 m long) X ((3 X 2.4 m = 7.2 m)) of floor area. If the bays are three bales high, then the bin height is 3.6 m making a total volume of 155 m^3. Assuming a usable volume of 85%, the storage volume is about 132 m^3. Hence, three bays would be sufficient for all the mortalities. These would have a total footprint of 8.6 m (3 bales X 2.4 m + 1.2 m) X 22.8 m (9 bales X 2.4 m + 1 bale (vertical) X 1.2 m) or 190 m^2. Figure 7 shows a schematic plan view of the possible mortalities composting bays.

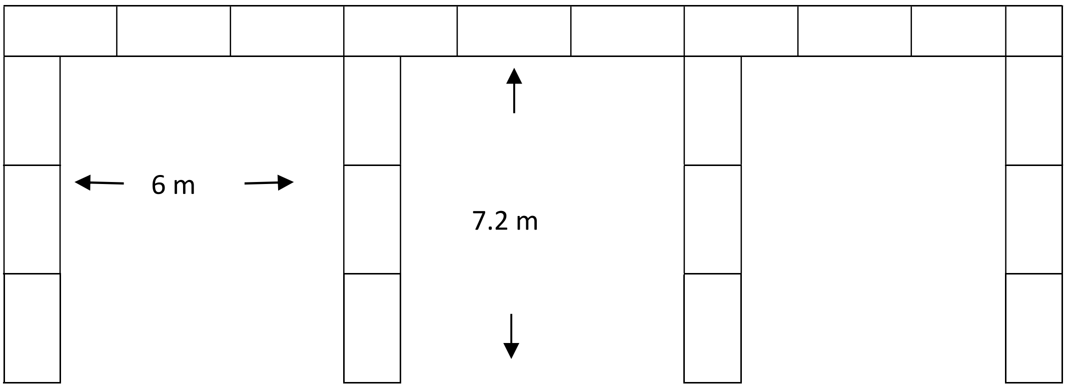


Figure 7 – Plan View Configuration of Bays for Mortality Composting

The closed end of the mortalities composting bays will go hard up against the bunding of the composting area. Additional length will be added to the manure composting area to provide for the mortalities composting area.

Composting Method

The following procedure will be used for composting mortalities as it has been proven to produce low odour levels while effectively breaking-down the carcasses:

- place at least 0.3 m of spent bedding over the base of the active composting bay before placing the carcasses.

- cover each carcass with at least 0.5 m of spent bedding before placing the next carcass. (Stack up to two carcasses high with good coverage between and around each carcass)
- ensure the carcasses are always well covered. Good coverage promotes composting by adding a carbon source, and is essential for controlling odours and in vermin control
- active composting will typically occur over a three to four-month period. Aging for at least two months will follow.
- the mortalities will be screened as necessary to remove any remaining bones. These will be added to the active composting bay.

It is proposed that three composting bays will be used. Together, these will provide sufficient space to store 12 months mortalities. To ensure appropriate maturation times, and to avoid the possibility of cross-contamination between new and old mortalities, one compost bay will be filled before the next and then the next. Hence, by the time the third bay is being filled, all material in the first bay will have undergone several months of composting and maturation. Emptying of the first bay will occur only after filling of the third bay has commenced, and so on.

Compost produced from mortalities will be spread on land managed by the owners of KBM Farms where it will provide an excellent soil amendment. From the Piggery Manure and Effluent Management and Reuse Guidelines (Tucker, 2015), mortalities compost typically contains 1.5% nitrogen, 0.5% phosphorus and 0.3% potassium. Assuming 6 m^3 (or ~4.2 t) of spent bedding is used to compost each tonne of mortalities, there will initially be ~484 t/yr of material composting for the stage 3 facility. If the combined mortalities plus spent bedding have an initial moisture content of 60%, the dry matter content is 193.6 t. If there is a 50% loss of material during the composting process (remaining total solids of 95.8 t) and the product has a moisture content of 30%, the finished mass will be about 138 t/yr. This could contain about 2070 kg of nitrogen, 690 kg of phosphorus and 415 kg of potassium.

Mass Mortalities

In the event of mass mortalities, KBM Farms will act under the direction of the Chief Veterinary Officer and EPA with regard to disposal method. However, they could be windrow-composted at the manure composting area. A contingency site for mass burials has also been identified (see Figure 1 for location). The site is located in the north-west corner of the property. This site is suitable as it is readily accessible but well separated from waterways, houses, public roads and the piggery.

Reuse

The products for reuse are:

- effluent
- sludge extracted from the anaerobic pond
- compost produced from spent bedding, separated manure solids and effluent
- mortalities compost.

Designated Reuse Areas

Most of the effluent will be used in the composting process, with the balance irrigated onto 69 ha of land to the south of the piggery complex and onto adjacent cropping land on the Munyabla farm. It is intended that mortalities compost will also be spread onto cropping land on the Munyabla Farm. Some of the sludge and manure compost produced from the spent bedding, manure solids and effluent will also be spread onto these farms and also the Urana Farm and the Yerong Creek Farm, but these products may also be offered to nearby farmers for spreading onto cropping land. Sustainable reuse of manure products involves applying them evenly to suitable land areas, using appropriate spreading rates and using sound reuse practices.

Figure 8 shows the land on-site and on the adjacent land on the Munyabla Farm that could be used for reuse. The property boundary for the piggery site and the Munyabla Farm is shown in black, with the boundary of each reuse area in white. Blue lines represent waterways surrounded by a 50 m buffer, the red shading represents an old waterway and a wildlife area near the proposed effluent reuse area (identified as part of the Aboriginal cultural heritage investigations), and dams (excluded from the area) have black boundaries. All of the reuse areas have been used to grow cereal and oilseed crops. None of them have been spread with effluent or manure products in the past. After removing buffers to sensitive areas (discussed below), there is some 910 ha available at this farm. Of this, 195 ha has been allocated for effluent and mortalities compost reuse, leaving 715 ha available for reuse of mortalities compost, sludge and compost. Most of the land allocated for effluent reuse is over Dick Knobels Road, so the effluent would need to be pumped under the road via a pipeline. The Lockhart Shire Council has previously granted permission to put a pipe under the road to transfer water. A similar under-road pipe could be used for this purpose (see Figure 1). Mr David Webb, Director of Engineering & Environmental Services at Lockhart Shire Council was consulted about this proposal and indicated that he did not expect it would create any issues (pers. comm. 23rd July 2019). An application will be lodged with council for this new pipe.

The "Effluent Management Guidelines for Intensive Piggeries" (ARMCANZ and ANZECC, 1991) identify that land for effluent reuse should have the following properties:

- structure allows for air and water movement;
- sufficient depth for root penetration;
- adequate drainage;
- sufficient capacity to hold water
- nutrients are available in sufficient quantities to provide for optimal plant growth;
- moderate pH; and
- ease of cultivation.

A preliminary survey of the soils to the west of Dick Knobels Road close to the proposed effluent reuse area is included as Appendix B. It shows that the land and soils of the Munyabla are generally suitable for the purpose.

Figure 8 – Munyabla Farm: Land Available for Reuse

Areas of the Urana farm designated as compost reuse areas are shown on Figure 9. The property boundary is shown in black, with the boundary of each reuse area in white. Blue lines represent waterways with a 50 m buffer, the red shading represents a wetlands area and dams (excluded from the area) have black boundaries. After removing buffers to waterways and other sensitive areas, some 2210 ha of land is available. Section 3.3.3 and Figure 51 identify that the soils of this area are vertosols and well suited to cropping. Figure 9 shows that the farm is used for this purpose. While Figure 37 shows that most of the farm is subject to flooding, this is not expected to affect its suitability for compost reuse due to the average flooding frequency (see sections 3.2.4 and 5.4.1 for more details).

Figure 9 – Urana Farm: Potential Reuse Areas

Areas of the Yerong Creek farm that are suitable as reuse areas are shown on Figure 10. The property boundary is shown in black, with the boundary of each reuse area in white. Blue lines represent waterways with a 50 m buffer, the red shading represents a native vegetation area and dams (excluded from the area) have black boundaries. In total, 1128 ha of land is available. Section 3.3.3 and Figure 52 identify that the soils of this area are likely to include kurosols, sodosols, chromosols and kandosols. These areas have been cropped for many years. The Hanericka Farmstay, located adjacent to the Yerong Creek Farm is owned and operated by Amanda Aygun who is the sister of James Male and Greg Male. The Farmstay is surrounded by ~40 ha of farming land that is leased by James Male. This land is not included in the reuse areas.

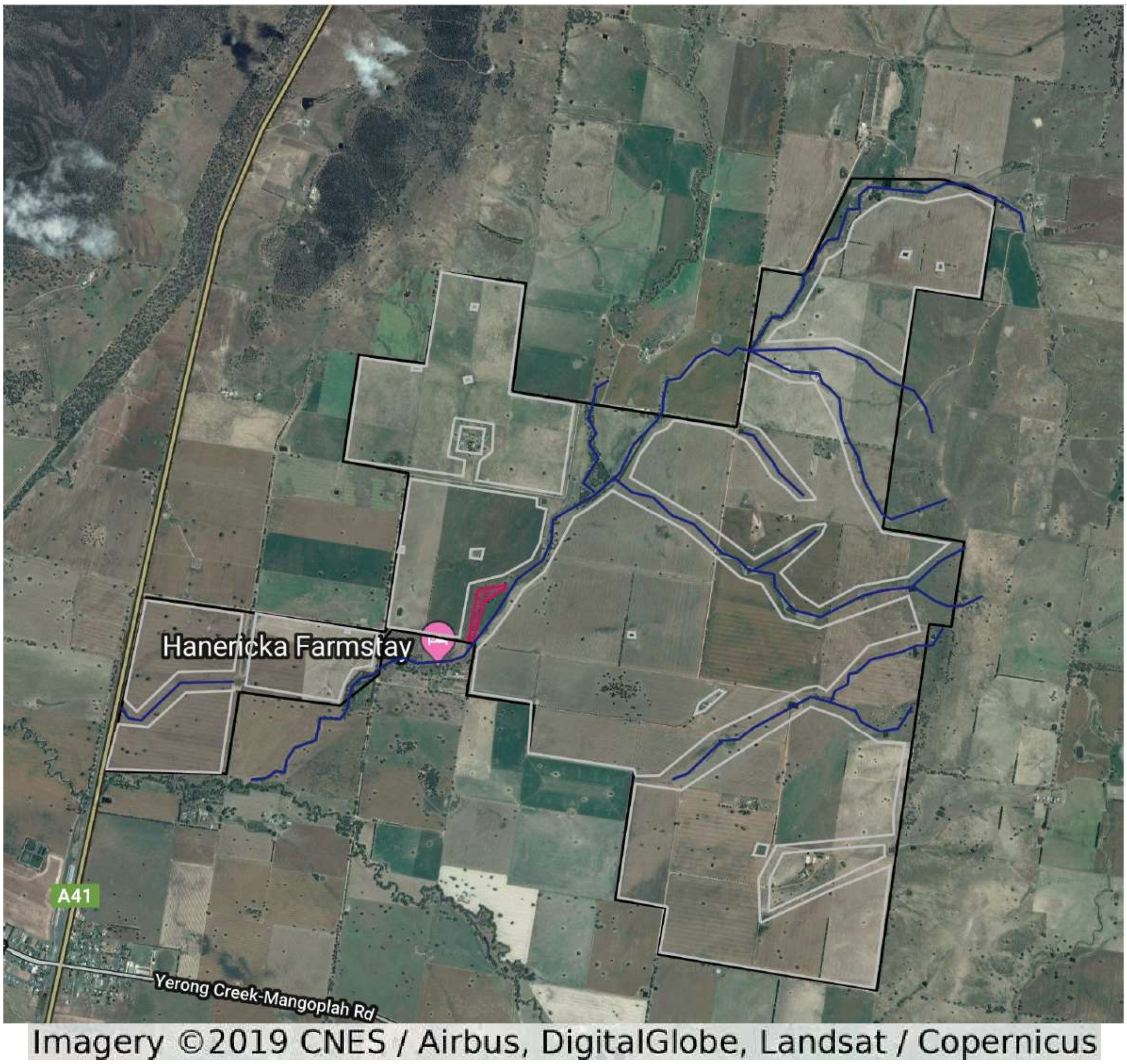


Figure 10 – Yerong Creek Farm: Potential Reuse Areas

Environmental Buffers
The land allocated for reuse on Figure 8, Figure 9 and Figure 10 excludes buffers to sensitive land uses and features. The National Environmental Guidelines for Indoor Piggeries (Tucker, 2018) recommend minimum buffers that should be provided between manure reuse areas and sensitive features as a secondary layer of protection. Buffers for reuse of effluent (but not manure) are provided in the environmental guidelines: Use of Effluent by Irrigation (Department of Environment and Conservation (NSW), 2004). The buffers from both these guidelines are summarised in Table 17.

Table 17 – Buffers for Reuse Areas in Relevant Guidelines

Sensitive Use	National Environmental Guidelines for Indoor Piggeries		Use of Effluent by Irrigation	
	Manure products (e.g. separated solids, sludge or spent bedding) that will remain on the soil surface for more than 48 hrs without being ploughed in	Spent bedding and manure products that are incorporated into the soil within 48 hours of spreading	Low strength effluent*	High strength effluent*
Major water supply storage	800 m	800 m	800 m	
Waterway	50 m	25	-	-
Natural waterbody e.g. river or lake	-	-	50 m	80 m
Other waters e.g. artificial waters with beneficial uses, small streams, intermittent streams, water distribution and drainage channels and farm dams	-	-	Site-specific	Site-specific
Domestic well used for household water supply	-	-	Site-specific	250 m
Town water supply bores	-	-	Site-specific	1000 m
Where spray irrigation gives rise to aerosols near houses, schools, playing fields, roads, public open space and waterbodies	-	-	50 m	50 m
Other sensitive areas (e.g. waters in drinking water catchments, aquatic ecosystems with high conservation value, wetlands, native stands of vegetation)	-	-	Site-specific	250 m

* applies to effluent irrigation, not manure or compost

There are no major water supply storages (within 800 m), town water supply bores or rivers within 1000 m of the reuse areas.

For each reuse product, the buffers that will be used are shown in Table 18. Preliminary proposed buffers were discussed with Jessica Creed of EPA on 27th May 2019. She advised that any proposed buffers needed to be justified by providing any references and describing site or management factors that reduce risk. Minor adjustments were made to the suggested buffers following this discussion.

Table 18 – Proposed Reuse Area Buffers

	Effluent	Sludge	Manure Compost	Mortalities Compost
Major water supply storage	800 m	800 m	800 m	800 m
Natural waterbody e.g. river or lake	80 m	50 m	50 m	50 m
Other waters e.g. intermittent streams, water distribution and drainage channels and farm dams	50 m	50 m	50 m	50 m
Domestic well used for household water supply	250 m	25 m	25 m	25 m
Town water supply bores	1000 m	100 m	100 m	100 m
Property boundary	25 m	25 m	25 m	25 m
Where spray irrigation gives rise to aerosols near houses, schools, playing fields, roads, public open space and waterbodies	50 m	25 m	25 m	25 m
Other sensitive areas (e.g. waters in drinking water catchments, aquatic ecosystems with high conservation value, wetlands, native stands of vegetation)	250 m	25 m	25 m	25 m

The buffers for effluent reuse are consistent with those for high strength effluent in Table 17. The effluent will be spray irrigated using a low-pressure travelling irrigator which will minimise aerosol production and spread. Hence, buffers of 50 m to waterways and 250 m to sensitive native vegetation are appropriate. The risk will be minimised by using a low-pressure irrigation system and avoiding irrigation on windy days or under conditions when drift is likely (e.g. early in the morning, late afternoon/evening, overcast or rainy weather).

Figure 34 and Figure 35 shows the location of the intermittent Mittagong tributaries through the Munyabla farm. A 50 m wide buffer either side of these will be excluded from reuse to protect both water quality and aquatic ecosystems.

Figure 60 shows native vegetation regulatory mapping around the Munyabla Farm. A 250 m buffer will be provided between effluent reuse areas and the vegetation marked on this map. The buffers to sensitive native vegetation will ensure these are not impacted by elevated soil nutrient levels resulting from reuse of sludge and manure compost.

Section 3.1.5 details an investigation into heritage items for environmental protection. This highlights the need to protect any recorded Aboriginal items in close proximity to the Munyabla Farm. Figure 28 shows the location of these. There are some scar trees and canoe trees to the south-east and north-east of the piggery. The only ones close to the reuse areas are some scar trees near the south-eastern corner of the eastern margin of the Munyabla farm. It was agreed that these would be protected from inadvertent drift from reuse activities. A 25 m buffer will be provided from this corner of the property.

Sludge and compost may be spread on the Munyabla, Urana and Yerong Creek farms, and could also be made available to other nearby farmers. Because of their physical properties, and the way they will be spread, it will be easier to ensure sludge and compost are applied to target areas with minimal drift. The sludge will be a thick liquid and will be tanker-spread at low pressure and dropped close to the ground. There will not be any significant aerosol production and the material will go where it is intended to be applied.

The manure and mortalities compost will be consistent, stable, solid products. These will be applied with a manure spreader that drops material low to the ground, ensuring it is spread evenly over the target area. To minimise dust release risk, very dry material will not be spread. Fresh compost will be damp and more mature product can be moistened with water and mixed before application. To minimise the risk of sludge and manure moving off the reuse area, these will not be spread under windy conditions or if significant rain is forecast within the following 24 hours.

As sludge and compost are less likely to move from the application site than spray-irrigated effluent, some reductions in buffers are justified for these products. The 50 m buffer to a river or lake matches the distance to a waterbody for low strength effluent and the distance to a watercourse in the National Environmental Guidelines for Indoor Piggeries (Tucker, 2018). It exceeds the 25 m buffer for incorporated spent bedding and manure solids in the National Environmental Guidelines for Indoor Piggeries (Tucker, 2018).

On the Munyabla, Urana and Yerong Creek farms, a 50 m buffer has been provided to waterways identified as blue lines on the topographic maps shown as Figure 34, Figure 36 and Figure 40. The 25 m buffer to a bore is appropriate as this material is most unlikely to enter bore casing which would usually have a pump or cap attached. Although minimum tillage farming is practiced to maintain soil structure, if there are any concerns with the adequacy of the buffers, the sludge and compost can be incorporated to a depth of 30 cm.

A 25 m buffer to property boundaries will be provided to protect against off-farm movement of material.

Any sludge or compost recipients will be made aware of the need to respect the buffers proposed in Table 18.

Effluent, Sludge and Compost Reuse Rates

Effluent, sludge and compost reuse rates can be considered sustainable if the nutrients added are removed by harvesting crops grown on the land with adjustments to account for gaseous losses of nitrogen, soil nutrient deficiencies or surpluses and soil storage (of phosphorus). Appendix B provides soil test results for the Munyabla property. The soils generally have very low Colwell phosphorus levels. The Phosphorus Buffering Index (PBI) ranged from 44 to 130, which is very, very low to low. This suggests very limited capacity for the soil to hold phosphorus. Hence, the only phosphorus proposed is short term storage between the three years of a crop rotation described below.

As a starting point for determining the nutrient application rates, data on crop yields and nutrient removal rates were collected. Lisa Castleman at Riverina Local Land Services, Wagga Wagga (pers. comm. 21st May 2018) was consulted regarding dry matter crop yields. She suggested using 3.5 t/ha as a conservative long-term average for oats and wheat crops, with straw yields of 4-6 t/ha where this is harvested. For canola, she suggested using 1.7 t/ha as a long-term average. In a further communication with Lisa (pers. comm. 11th April 2019), she suggested that lucerne might yield 7-10 t/ha. A good liming program would be needed to maximise yields.

Crop yield data was also collected from James Male, who is part of KBM Farms and has cropped in the district for many years. He suggested a typical rotation and yields of:

- canola 2.5 t/ha
- wheat 4 t/ha
- wheat 3.5 t/ha
- lupins 3 t/ha
- wheat 4 t/ha
- barley 4 t/ha
- lucerne 8 t/ha over 4-5 years

Table 19 shows expected crop nutrient removal rates using conservative long-term yields. The crop nutrient concentrations have been taken from the National Environmental Guidelines for Indoor Piggeries (Tucker, 2018) except where marked.

Table 19 – Adopted Crop Nutrient Removal Rates

Crop	DM Yield (t/ha)	Nitrogen (kg/t)	Phosphorus (kg/t)	Potassium (kg/t)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
Canola	1.7	33	0.3	12	56.0	0.5	20.5
Wheat grain	3.5	19	4	5	66.5	14	17.5
Wheat straw	5	6	0.5	14	30	2.5	70
Grain + straw					96.5	16.5	87.5
Lupins	2.5	45	3	8	112.5	7.5	20
Barley grain	3.5	19	3	4	66.5	10.5	14
Barley straw	5	7	0.7	24	35	4.9	129
Grain + straw					101.5	15.4	143
Lucerne	8	31	3	25	248	24	200

* source: (National Research Council, 1984)

The nutrient removal rate by a typical rotation is shown in Table 20. Lucerne has the highest nutrient removal rates. Excluding lucerne from the average nutrient removal rate calculations, the long-term nutrient removal rate is 83 kg/ha for nitrogen, 11 kg/ha for phosphorus and 51 kg/ha for potassium. A rolling three-year average has also been used to examine nutrient removal rates over that time period. The three years with the lowest nutrient removal rates strip 73 kg/ha for nitrogen, 10 kg/ha for phosphorus and 42 kg/ha for potassium. The lower removal rate is about 12% lower than the overall average for nitrogen, 9% lower for phosphorus and 18% lower for potassium. The average nutrient removal rate, excluding lucerne, has been used as the primary way to size the reuse areas. However, extra land will be provided to account for the variation in the three-year rolling average depending on what crops are being grown. Additionally, crop rotations can be varied to allow for increased nutrient removal if necessary.

Table 20 – Nutrient Removal by a Typical Crop Rotation on Reuse Areas

Crop	Nutrient Removal Rate (kg/ha/yr)			Rolling three-year average (2 years before & current)		
	N	P	K	N	P	K
Canola	56	0.5	20.5	75	10	60
Wheat	66.5	14	17.5	75	10	60
Wheat + straw	96.5	16.5	87.5	73	10	42
Lupins	112.5	7.5	20	92	13	42
Wheat	66.5	14	17.5	92	13	42
Barley + Straw	101.5	15.4	143	94	12	60
Lucerne	248	24	20	-	-	-
Lucerne	248	24	20	-	-	-
Lucerne	248	24	20	-	-	-
Lucerne	248	24	20	-	-	-
Lucerne	248	24	20	-	-	-
Average	158	17	37	-	-	-
Av. excluding lucerne	83	11	51	-	-	-

Since effluent, sludge, manure compost and mortalities compost contain nutrients in different ratios, it is necessary to prepare a nutrient balance for each product type. Hence, it is necessary to estimate the nutrients partitioned to each.

The liquid effluent is partitioned between compost and irrigation. The amount of effluent required for compost production at each stage is shown in Figure 3, Figure 4 and Figure 5. The amount of effluent that needs to be drawn from the pond system for reuse is shown in Table 33. It is assumed that effluent not used in compost production is irrigated. Table 21 summarises the distribution of effluent for reuse between compost and irrigation for each stage. There is a relatively small difference between the volume of effluent for reuse at stage 3 compared with stage 2, partly because the increase in inflow at stage 3 is relatively small (due to the exclusion of rainfall from the CAP which avoids transfer of this water from a full CAP to the holding pond) and partly because there are more solids for composting so a greater amount of effluent can be used in compost production. The modelling in that table is based on 130 ha irrigation area. However, a 65 ha area (which would be large enough to handle the nitrogen and phosphorus – see Table 25) was also tested and this only made a very slight difference to the volume irrigated.

Table 21 – Effluent for Reuse and Distribution Between Compost and Irrigation

Item	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Effluent for reuse (m^3)	5750	9413	10,654
Effluent needed for compost (m^3)	4265	6392	8522
Percent to compost (%)	74%	68%	80%
Effluent for irrigation (m^3)	1485	3021	2132
Percent to irrigation (%)	26%	32%	20%

Table 22 shows the split of nutrients in effluent going to irrigation and to compost production. The initial quantities come from Table 11, Table 12 and Table 13. This table also shows the amount of nitrogen that would effectively be added to the soil during irrigation; some 20% of nitrogen is likely to be lost through ammonia volatilisation.

Table 22 – Effluent Nutrient Partitioning between Irrigation and Compost

Effluent	Nitrogen	Phosphorus	Potassium
Stage 1:			
Nutrient in liquid effluent (kg/yr)	11,200	600	8600
Effluent for irrigation (%)	26%		
Effluent for irrigation (kg/yr)	2893	154	2221
Effluent added to land (less 20% N losses) (kg/yr)*	2314	154	2221
Effluent to compost production (kg/yr)	8307	445	6379
Stage 2:			
Nutrient in liquid effluent (kg/yr)	16,700	900	12,900
Effluent for irrigation (%)	32%		
Effluent for irrigation (kg/yr)	5360	289	4140
Effluent added to land (less 20% N losses) (kg/yr)*	4288	289	4140
Effluent to compost production (kg/yr)	11,340	611	8760
Stage 3			
Nutrient in liquid effluent (kg/yr)	22,300	1250	17,200
Effluent for irrigation (%)	20%		
Effluent for irrigation (kg/yr)	4463	250	3442
Effluent added to land (less 20% N losses) (kg/yr)*	3570	250	3442
Effluent to compost production (kg/yr)	17,837	1000	13,758

* it is expected that 20% of nitrogen could volatilise through spray irrigation of effluent

Table 23 shows the split of nutrients in sludge at each stage, with the initial nutrient masses coming from Table 11, Table 12 and Table 13. It also shows the amount of nitrogen that would effectively be added to the soil during spreading; some 10% of nitrogen is likely to be lost through ammonia volatilisation.

Table 23 – Nutrients in Sludge

Nutrient	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Nitrogen ex-ponds (kg/yr)	3400	5100	6800
Nitrogen added to land (less 10% losses) (kg/yr)	3060	4590	6120
Phosphorus (kg/yr)	5600	8400	11,250
Potassium (kg/yr)	500	700	900

Table 24 shows the composition of the materials that will be used to make compost, along with the estimated composition of the compost. It uses data from Table 22 and Table 15. This table also shows the quantity of nitrogen effectively added to the soil after losses (assumed to be 20%) during composting and reuse.

Table 24 – Nutrients in Separated Solids, Spent Bedding and Effluent for Compost Production

Nutrients Added	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Separated solids + spent bedding			
Nitrogen (kg/yr)	43,200	64,700	86,200
Phosphorus (kg/yr)	10,900	16,300	21,800
Potassium (kg/yr)	24,300	36,500	48,600
Effluent			
Nitrogen (kg/yr)	8307	11,340	17,837
Phosphorus (kg/yr)	445	611	1000
Potassium (kg/yr)	6379	8760	13,758
Total			
Nitrogen (kg/yr)	51,507	76,040	104,037
Nitrogen ex-losses (kg/yr)*	41,206	60,832	83,230
Phosphorus (kg/yr)	11,345	16,911	22,800
Potassium (kg/yr)	30,679	45,260	62,358

* assuming 20% losses during composting and reuse

The minimum area of land (ha) needed to reuse the nitrogen, phosphorus and potassium in the effluent, sludge and compost can be calculated by dividing each nutrient mass (kg) by the nutrient harvest rate (kg/ha) for the crops grown. This has been done for the average of the typical crop rotation, the lowest three-year average in the rotation and for lucerne. Three years is considered a reasonable period for storage of nutrients in the soil. Hence, the lowest three-year average has been used to identify the minimum area that is likely to protect against possible nutrient leaching under a mixed crop rotation. The results for effluent, sludge, manure compost and mortalities compost are shown in Table 25, Table 27, Table 28 and Table 29, respectively.

Table 25 shows that potassium is the limiting nutrient for effluent reuse; the largest land area is needed to manage potassium. Under the lowest three-year average for the crop rotation, at stage 2 some 99 ha of land is needed to ensure potassium uptake and guard against unacceptable leaching losses. It is worth noting that the effluent will not provide enough nitrogen or phosphorus to produce optimal crop yields if the area is sized based on potassium load. Other nutrients may also be lacking. The usual agronomist will be consulted regarding crop nutrition and fertiliser recommendations.

Table 25 – Minimum Area Needed for Sustainable Effluent Reuse at Each Stage Under Different Cropping Options

Nutrients	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Nitrogen (ha)			
• average without lucerne	28	52	43
• lowest three-year average	32	59	49
• lucerne	9	17	14
Phosphorus (ha)			
• average without lucerne	14	26	22
• lowest three-year average	15	28	24
• lucerne	6	12	10
Potassium (ha)			
• average without lucerne	44	81	67
• lowest three-year average	53	99	82
• lucerne	11	21	17

Because the EC of effluent can be quite high, the risk of salinisation of the effluent reuse areas needs to be considered. Data in the National Environmental Guidelines for indoor Piggeries (Tucker, National Environmental Guidelines for Indoor Piggeries, 2018) show that the EC of effluent for irrigation can range from 2.5 dS/m to 11.7 dS/m with a mean of 6.4 dS/m. It is worth noting that EC measures not just potentially harmful dissolved salts, but inorganic compounds like carbonate and bicarbonate salts, magnesium and calcium sulphates and potassium (Natural Resources South Australia, 2015). Nevertheless, the mass and rate of salt added to the soils of the reuse areas can be estimated from the likely EC of the effluent, the effluent volume (Figure 3, Figure 4 and Figure 5) and the area of land available for effluent reuse. Estimates based on an EC of 6.4 dS/m and 11.7 dS/m are shown in Table 26. Using the average EC, the salt addition rate will be to 94 kg/ha/yr at stage 1, reducing to 45 kg/ha/yr at stage 3. To put this in perspective, less than two teaspoons of salt would be added to each square metre of soil annually at stage 1 dropping to less than one teaspoon at stage 3. Even when an EC of 11.7 dS/m is used, less than four teaspoons of salt will be added to each square metre of soil annually at stage 1, dropping to less than two teaspoons at stage 3. This small amount of salt should be readily leached through the loam topsoil. Leaching through the heavier subsoil will be slower, but given the very small salt addition rate, this is not expected to result in significant adverse impacts to soils. It is worth noting that salinity is rarely induced on piggery effluent reuse areas when nutrients are applied at sustainable rates.

The other potential impact of salt on reuse areas Is reduced crop yields, which in turn affects nutrient removal rates. Crops differ in their salt tolerance. Barley and canola are salt-tolerant and wheat has moderately high tolerance. Lucerne and some varieties of lupin are less tolerant. It is proposed that the effluent will be shandied with rainwater collected into the tanks near the sheds as necessary to reduce the salt concentration and avoid leaf burn, particularly for the less tolerant crops. Effluent could also be applied to land planted to less tolerant crops just before planting to provide nutrients without risking leaf burn. Other areas could be planted with more tolerant crops and these could then have effluent applied during the growing season.

The quantity of sodium added to the soil can be estimated using the same process as for salt (see Table 26). From the National Environmental Guidelines for Indoor Piggeries (Tucker, 2018), piggery effluent can contain 41-1132 mg/L of sodium with an average of 399 mg/L. Using the average sodium concentration, the effluent will add 26 kg Na/ha/yr (2.6 g/m^2/yr at stage 1, reducing to 12 kg/ha or (1.2 g/m^2/yr) by stage 3. This sodium is likely to leach through the topsoil and soil structure is unlikely to be adversely affected. It may move more slowly through the heavier clayey subsoil. This is unlikely to pose an erosion risk while minimal tillage is practiced.

Table 26 – Estimated Mass and Rate of Salt Added to Soils of Effluent Reuse Areas

Item	Stage 1		Stage 2		Stage 3	
Effluent volume (L)	1,485,000		3,021,000		2,132,000	
Area for reuse (ha)	65		195		195	
Av. effluent rate (L/ha)	22,846		15,492		10,933	
Salt	Av.	Max	Av.	Max	Av.	Max.
EC (dS/m)	6.4	11.7	6.4	11.7	6.4	11.7
TDS (mg/L)	4096	7488	4096	7488	4096	7488
Total salt added (kg)	6083	11,120	12,374	22,621	8733	15,964
Salt addition rate (kg/ha/yr)	94	171	63	116	45	82
Salt addition rate (g/m^2/yr)	9.4	17	6.4	12	4.5	8
Sodium (Na)						
Na (mg/L)	399	1132	399	1132	399	1132
Total sodium added (kg)	593	1681	1205	3420	851	2413
Salt addition rate (kg/ha/yr)	9	26	6	18	4	12
Salt addition rate (g/m^2/yr)	0.9	2.6	0.6	1.8	0.4	1.2

Soil salinity and sodicity will both be monitored. If salinity or sodicity become an issue, KBM Farms will take corrective and mitigation action. This could include the use of a reverse osmosis plant to improve the quality of the bore water used in the piggery, which will also reduce the salinity of the effluent. Plants with low salt tolerance could be eliminated from the rotation. Gypsum could also be used to displace sodium to address sodicity.

The addition of sludge to land will add valuable phosphorus and a range of other nutrients. It will add some salt but this is not expected to be at levels that will create an issue.

Compost additions will enhance soil quality by adding significant organic matter and nutrients that will be used by crops. Because very little water is used in deep litter housing, the salt load will be relatively low. No negative effects are expected.

Table 27 shows that phosphorus is the limiting nutrient for sludge reuse. Under the lowest three-year average for the crop rotation, some 1089 ha of land is needed to ensure phosphorus uptake at stage 3. It is expected that significant nitrogen, potassium and possibly other nutrients will need to be added to the soil to optimise crop yields on the sludge reuse areas. Applying three years phosphorus once every three years (i.e. putting all the sludge onto 363 ha of land at a time) will help with managing practical sludge application. Although the soil has relatively poor phosphorus sorption capacity, this is a very modest storage rate (~30 kg P/ha applied) and would not significantly increase the leaching and runoff risks under the minimum tillage farming system. Expert agronomic advice will be sought on fertiliser application rates.

Table 27 – Minimum Area Needed for Sustainable Sludge Reuse at Each Stage Under Different Cropping Options

Nutrients	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Nitrogen (ha)			
• average without lucerne	37	55	74
• lowest three-year average	42	63	84
• lucerne	12	19	25
Phosphorus (ha)			
• average without lucerne	495	742	994
• lowest three-year average	542	813	1089
• lucerne	233	350	469
Potassium (ha)			
• average without lucerne	10	14	18
• lowest three-year average	12	17	22
• lucerne	3	4	5

Table 28 shows that phosphorus is the limiting nutrient for manure compost reuse. Under the lowest three-year average for the crop rotation, some 2206 ha of land is needed at stage 3 to ensure phosphorus uptake. The land area required for nitrogen is about half that needed for phosphorus. Applying two years phosphorus to the land every second year will provide for more practical spreading rates, will roughly meet the crop nitrogen requirements in the year of application and will satisfy potassium requirements. There will be some surplus potassium at the end of the first year, but this is unlikely to result in any environmental consequences and can be used by the crop grown the following year.

Table 28 – Minimum Area Needed for Sustainable Manure Compost Reuse at Each Stage Under Different Cropping Options

Nutrients	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Nitrogen (ha)			
• average without lucerne	495	731	1000
• lowest three-year average	564	833	1140
• lucerne	166	245	336
Phosphorus (ha)			
• average without lucerne	1003	1494	2015
• lowest three-year average	1098	1637	2206
• lucerne	473	705	950
Potassium (ha)			
• average without lucerne	602	887	1223
• lowest three-year average	733	1082	1491
• lucerne	153	226	312

Table 29 shows that phosphorus is also the limiting nutrient for mortalities compost reuse. Under the lowest three-year average for the crop rotation, some 67 ha of land is needed at stage 3 to ensure phosphorus uptake.

Table 29 – Minimum Area Needed for Sustainable Mortalities Compost Reuse at Each Stage Under Different Cropping Options

Nutrients	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Nitrogen (ha)			
• average without lucerne	10	15	20
• lowest three-year average	11	17	23
• lucerne	3	5	7
Phosphorus (ha)			
• average without lucerne	30	46	61
• lowest three-year average	33	50	67
• lucerne	14	22	29
Potassium (ha)			
• average without lucerne	4	6	8
• lowest three-year average	5	7	10
• lucerne	1	2	2

Table 30 shows the total land areas needed to manage effluent, sludge, manure compost and mortalities compost at each stage, assuming all reuse areas are under the same crop rotation at any time. Based on the lowest three-year average, this is 1688 ha for stage 1, 2528 ha for stage 2 and 3386 ha for stage 3.

Table 30 - Total Land Areas (ha) Needed to Manage All Effluent, Sludge, Manure Compost and Mortalities Compost at Each Stage

Stage	Nitrogen	Phosphorus	Potassium
Stage 1 – 600 sows			
• average without lucerne	569	1542	659
• lowest three-year average	649	1688	803
• lucerne	191	727	168
Stage 2 – 900 sows			
• average without lucerne	852	2308	988
• lowest three-year average	972	2528	1205
• lucerne	286	1088	252
Stage 3 – 1200 sows			
• average without lucerne	1136	3092	1316
• lowest three-year average	1296	3386	1604
• lucerne	381	1458	336

In total, some 4454 ha of land has been allocated for reuse on the Munyabla (992 ha), Urana (1251 ha) and Yerong Creek (2210 ha) farms. Hence, there is ample land for the reuse of the nutrients in the effluent, sludge, manure compost and mortalities compost. However, it is expected that nearby farmers are likely to be interested in using the sludge and manure compost in their farming systems, so some of this may go off farm.

Good management practices are vital in protecting the environment and amenity. Use of Effluent for Irrigation (Department of Environment and Conservation (NSW), 2004) includes environmental performance objectives applicable to the use of effluent by irrigation. The principles are relevant for both effluent and manure reuse. They are:

- protection of surface water – effluent irrigation systems should be located, designed, constructed and operated so that surface waters do not become contaminated by any flow from irrigation areas, including effluent, rainfall runoff, contaminated sub-surface flows or contaminated groundwater.
- protection of groundwater - effluent irrigation areas and systems should be located, designed, constructed and operated so that the current or future beneficial uses of groundwater do not diminish as a result of contamination by the effluent or runoff from the irrigation scheme or changing water tables.
- protection of lands – an effluent irrigation system should be ecologically sustainable. In particular, it should maintain or improve the capacity of the land to grow plants, and should result in no deterioration of land quality through soil structure degradation, salinisation, waterlogging, chemical contamination or soil erosion.
- protection of plant and animal health – design and management of effluent irrigation systems should not compromise the health and productivity of plants, domestic animals,

wildlife and the aquatic ecosystems. Risk management procedures should avoid and or manage the impacts of pathogenic micro-organisms, biologically active chemicals, nutrients and oxygen depleting substances.

- prevention of public health risks – the effluent irrigation scheme should be sited, designed, constructed and operated so as to not to compromise public health. In this regard, special consideration should be given to the provision of barriers that prevent human exposure to pathogens and contaminants.
- resource use – potential resources in effluent, such as water, plant nutrients and organic matter, should be identified, and agronomic systems developed and implemented for their effective use.
- community amenity – the effluent irrigation system should be located, designed, constructed and operated to avoid unreasonable interference with any commercial activity or the comfortable enjoyment of life and property off-site. In this regard, special consideration should be given to odour, dust, insects and noise.

The National Environmental Guidelines for Indoor Piggeries (Tucker, 2018) identify a range of recommended reuse practices that will help in meeting these objectives and will be adopted here. These include:

- analysing effluent and manure compost annually before the main reuse period to confirm its nutrient content then determining sustainable reuse rates that balance nutrient applications with nutrient removals (and acceptable gaseous losses). Sludge will also be analysed annually (or every year that it is extracted), although for practical reasons the analysis from the previous year can be used to determine reuse rates.
- applying effluent, compost and sludge evenly and at controlled rates
- spreading effluent, compost and sludge just before sowing and / or when the crop is actively growing
- delaying reuse if the soil is saturated, or if it is raining or forecast to rain within 24 hours
- incorporating sludge into the soil where practical
- providing suitable vegetated buffers between reuse areas and water bodies
- providing suitable buffers to sensitive land uses (as discussed above)
- avoiding reuse close to neighbouring houses when the wind is carrying towards them
- avoiding effluent, compost and sludge spreading early in the morning or in the evening when odour is less likely to disperse.

Off-farm recipients of manure or sludge will be provided with a handout including these principles, an analysis for the product they are receiving and a copy of the duty of care statement from the Australian Pork Ltd "Piggery Manure and Effluent Management and Reuse Guidelines" (Tucker, 2015) guidelines which is included in this EIS as Appendix C.

2.1.5. B.1.g Crop Management and Nutrient Removal

Lisa Castleman at Riverina Local Land Services, Wagga Wagga (pers. comm. 21st May 2018) was consulted regarding crop management. The timing of the Autumn break, liming and fertiliser management are all important determinants of yield. As they do now, the farmers making up KBM Farms will consult with their agronomists for liming and fertiliser recommendations (including nutrients added by piggery effluent and manure). Long term average yield data provided by Lisa was included in section 2.1.4. This data was used in the estimation of nutrient removal rates which are provided in the same section (see Table 19 and Table 20).

2.1.6. B.1.h Volume and Nature of Truck Movements

Trucks will need to transport grain and prepared feed and straw for bedding to the site. Some grain will be grown on the Munyabla farm with the remainder sourced from the Urana and Yerong Creek farms and other local farmers. The Munyabla farm is currently producing grain and straw and local roads are being used to transport this produce. Hence, only the grain and straw coming from other farms has been included in the traffic calculations. It could be expected that grain coming from other farms will be transported to the site throughout the year as the proponents have off-farm storage they can utilise. Straw would mostly be taken to the site after each years' harvest.

Finished pigs, compost and some sludge will represent exports from the farm and will generate new traffic. The pigs will be sold weekly or fortnightly throughout the year. Most compost is likely to be transported from the site for spreading from February to April as farmers prepare their land for planting.

From section 2.1.1:

- the annual feed usage is expected to be: ~4074 t/yr at stage 1, 6112 t/yr at stage 2 and 8149 t/yr at stage 3. This includes feed commodities as well as pre-mixed feed (Table 3). Some grain will be grown on the Munyabla farm. Assuming 50% of the 992 ha reuse area land is used to grow wheat or barley crops in any year, some 1736 t/yr of grain would be grown on-farm and not require any transport in addition to that currently occurring. This means some 2338 t/yr at stage 1, 4376 t at stage 2 and 6413 t at stage 3 would need to be transported to the farm.
- bedding use will be ~770 t/yr at stage 1, 1,150 t/yr at stage 2 and 1540 t/yr at stage 3. If straw is harvested from 25% of the 992 ha of land at Munyabla farm each year, some 1240 t/yr will be harvested. This means that the piggery would not generate any additional straw transport at stages 1 and 2, with some 300 t needing to be transported to the farm at stage 3.
- Weekly pigs for sale will average ~258 pigs weighing 28.2 pigs at stage 1, 388 pigs weighing 42.3 t at stage 2 and 517 pigs weighing 56.5 t at stage 3 (Table 4).

From section 2.1.4:

- sludge for reuse annually will be 377 m^3 at stage 1, 566 m^3 at stage 2 and 755 m^3 at stage 3. Of the 992 ha of land at the Munyabla farm, 195 ha has been allocated for effluent reuse and 83 ha for mortalities compost leaving 714 ha potentially available for sludge reuse. The total area needed for sludge reuse is 542 ha at stage 1, 813 ha at stage 2 and 1089 ha at stage 3. This means that all the sludge can be used on the Munyabla farm at stage 1, 88% at stage 2 and 66% at stage 3. Hence, the quantity that will need to go off-farm at each stage is: 69 m^3 at stage 2 and 260 m^3 at stage 3.
- compost production will be ~1324 t/yr at stage 1, 1983 t/yr at stage 2 and 2645 t/yr at stage 3.

Table 31 shows estimated truck movements.

On average, there will be about:

- 4 truck movements in and 4 truck movements out each week at stage 1,
- 7 truck movements in and 7 truck movements out each week at stage 2, and
- 10-11 truck movements in and 10-11 truck movements out each week at stage 3.

Peak traffic volumes are likely to occur in the first few months of each year when compost will be transported from the site for spreading. If this occurs evenly in February, March and April peak truck movements in these months will average:

- Stage 1: ~8 trucks per week (~5 compost trucks, ~3 other trucks)
- Stage 2: ~13 trucks per week (~7-8 compost trucks, ~5-6 other trucks)
- Stage 3: ~18 trucks per week (~10 compost trucks, ~8 other trucks)

Staff will access the site using cars or utility vehicles. It is likely that there will be limited car-pooling. The four staff (FTE) at stage 1 would need about three car trips in and out of the site each weekday (3 cars X 5 days = 15) and say one each weekend day (1 car X 2 days = 2). The six staff (FTE) at stage 2 would need about four car trips in and out of the site each weekday (4 cars X 5 days = 20) and say two each weekend day (2 cars X 2 days = 4). With eight staff (FTE) at stage 3, there will be about six car trips in and out of the site each weekday (6 cars X 5 days = 30) and say two each weekend day (2 cars X 2 days = 4).

Section 2.4.5 provides details of road condition and transport requirements.

Table 31 – Weekly and Annual Vehicle Movements

Type	Vehicle type	Quantity for transport	Av. no. trips/wk (both ways)	Av. no. trips/yr (both ways)	Destination
	Stage 1				
Staff	Car/utility	-	17	884	Local
Feed Trucks	Semi-trailer 26 t	2338 t	1.7	90	Local
Bedding In	Semi-trailer 20 t	100 t	0.1	5	Local
Stock Out	Semi-trailer ~250 pigs/load	258 pigs	1.0	54	Benalla or Laverton
Compost out	Semi-trailer 20 t	1324 t	1.3	66	Local, Urana, Yerong Creek
Total trucks			4.1	215	
	Stage 2				
Staff	Car/utility	-	24	1248	Local
Feed Trucks	Semi-trailer 26 t	5172 t	3.2	168	Local
Bedding In	Semi-trailer 20 t	480 t	0.5	24	Local
Stock Out	Semi-trailer ~250 pigs/load	388	1.5	81	Benalla or Laverton
Sludge out	Slurry tanker 20 m^3	58 m^3	0.1	4	Local
Compost out	Semi-trailer 20 t	1983 t	1.9	99	Local, Urana, Yerong Creek
Total trucks	Semi-trailer 26		7.2	376	Local
	Stage 3				
Staff	Car/utility	-	34	1768	Local
Feed Trucks	Semi-trailer 26 t	7209 t	4.8	247	Local
Bedding In	Semi-trailer 20 t	870 t	0.8	44	Local
Stock Out	Semi-trailer ~250 pigs/load	517	2.0	108	Benalla or Laverton
Sludge out	Slurry tanker 20 m^3	250 m^3	0.3	13	Local
Compost out	Semi-trailer 20 t	2645 t	2.5	132	Local, Urana, Yerong Creek
Total trucks			10.5	544	

2.1.7. B.1.i Heating and Cooling

The piggery will be designed to be energy efficient to minimise the need for artificial heating and cooling. Design and management elements to manage heating and cooling:

- sheds will run east west (to limit sun exposure)
- sheds roofs will be insulated
- conventional sheds will have automatically controlled natural ventilation (side curtains). The curtains that run the full length of the shed will open and close under the control of a thermostat set to optimise the shed temperatures. Generally, the curtains will be open most of the time in summer and during the warmer hours of the day in winter.
- drip and spray coolers will be used for cooling
- heat pads in the farrowing house will keep the piglets warm

2.1.8. B.1.j The Frequency of Effluent Pond Clean Out

It is intended that the anaerobic pond will be desludged annually, although there is provision to store sludge for two years if necessary. Sludge will be extracted by inserting a pipe from a vacuum tanker into the pond directly for stage 1 or via built-in desludging portals for stages 2 and 3. These portals will consist of pipelines inserted at an angle through the wall of the pond that extend down to the bottom of the pond. Several pipelines will be installed along the long bank of the pond. Photograph 4 shows an example of a desludging port at a piggery (top of bank), with a vacuum tanker being used to extract sludge.

Photograph 4 – Pond Desludging Infrastructure

2.1.9. B.1.k Chemical Usage & Storage

Chemical usage will be minimised and relatively small quantities of chemicals will be kept on-farm at any time. This will include veterinary chemicals, disinfectants for cleaning the conventional sheds, rodenticides and insect baits, and small amounts of pump fuel.

Veterinary chemicals requiring refrigeration will be kept in a refrigerator in a lockable area of the office. Disinfectants and other chemicals will be kept in locked areas within the piggery. Spill containment equipment will be kept with the chemicals in or near these storage areas.

Chemicals will be stored, used and disposed strictly in accordance with package directions or veterinary advice. It is intended that the piggery will seek certification under the APIQ Quality Assurance Program which necessitates proper handling and record keeping for chemicals.

2.1.10. B.1.j The Projected Life of the Operation

The projected life of the operation is 20 years.

2.1.11. B.1.m Staging

It is intended that the piggery will be built in three stages: 600 sows farrow-to-finish, 900 sows farrow-to-finish and 1200 sows farrow-to-finish. The timing of the construction of each stage will depend on economic conditions (particularly pork and grain prices) and other factors e.g. access to sufficient suitable staff and markets.

For each stage, construction will be continuous unless unforeseen circumstances arise. Earthworks will be undertaken first, followed by construction of the bases of the deep litter shelters and the drainage and effluent system of the conventional sheds and finally the sheds themselves.

Stage 1 will involve the construction of the roads, buildings needed to house the 600 sow herd and associated infrastructure (silos, water tanks); the feed mill; the office and staff amenities; parking; the maintenance shed; the loading shed; the effluent sump and screw press; an anaerobic pond sized to handle the stage 1 and stage 2 effluent; the effluent holding pond; the composting pad sized to handle the stage 1 manure and mortalities and the associated runoff collection pond.

Stage 2 will involve the construction of buildings to accommodate the next 300 sows and progeny and associated infrastructure (silos, water tanks); and the expansion of the composting pad to full size.

Stage 3 will involve the construction of buildings to accommodate the final 300 sows and progeny and associated infrastructure (silos, water tanks); the conversion of the anaerobic pond to a covered anaerobic pond (CAP) and the installation of a biogas shed. The anaerobic pond will need to be expanded, in-situ sludge extraction pipes installed and a cover will be placed over the anaerobic pond. The biogas shed will house the generators that will convert the collected biogas into power and heat.

Figure 1 shows the layout of the sheds, effluent ponds and composting pad for the fully developed piggery, but also the details of construction at each stage.

2.2. B.2 DESCRIPTION OF OPERATIONS

2.2.1. B.2.a Location, Elevation and Materials of Buildings

The location of the piggery on the farm is shown on Figure 33. The layout of the sheds, effluent ponds and composting pad for the fully developed piggery is shown on Figure 1.

As detailed in section 2.1.1, the pigs will be raised using a combination of conventional farrowing sheds, and deep litter sheds. The classes of pig that will utilise each type of shed are shown in Table 1. The conventional housing will accommodate the pigs within steel-framed sheds with walls that are half solid and half nylon curtain, iron roofing and slatted flooring over concreted under-floor pits fitted with pull plugs. The exterior materials for the sheds will be light, non-reflective colours so excess heat is not absorbed.

Figure 11, Figure 12 and Figure 13 show elevation details of the farrowing, dry sows and grower sheds respectively from preliminary plans prepared by Stockyard Industries. Complete floor and elevation plans have been prepared and these will be provided with the building application. Photograph 1 also shows an example of conventional housing, similar to that proposed for the farrowing sheds and grower sheds. The shed dimensions are:

- farrowing sheds 36.6 m X 15.15 m with a height of 4.625 m
- dry sow sheds 113 m X 11.9 m with a height of 4.609 m
- grower sheds 82.35 m X 21.35 m with a height of 5.101 m.

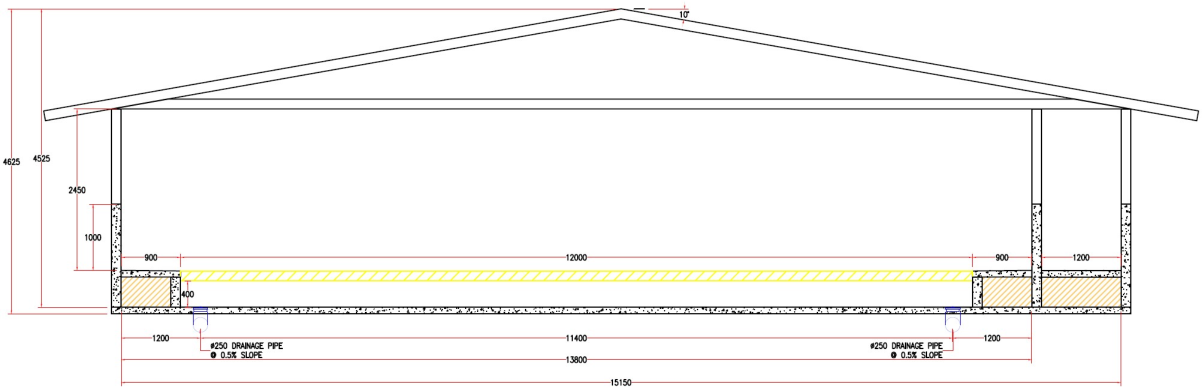


Figure 11 – Farrowing Shed – Elevation View of Front including Drainage Details

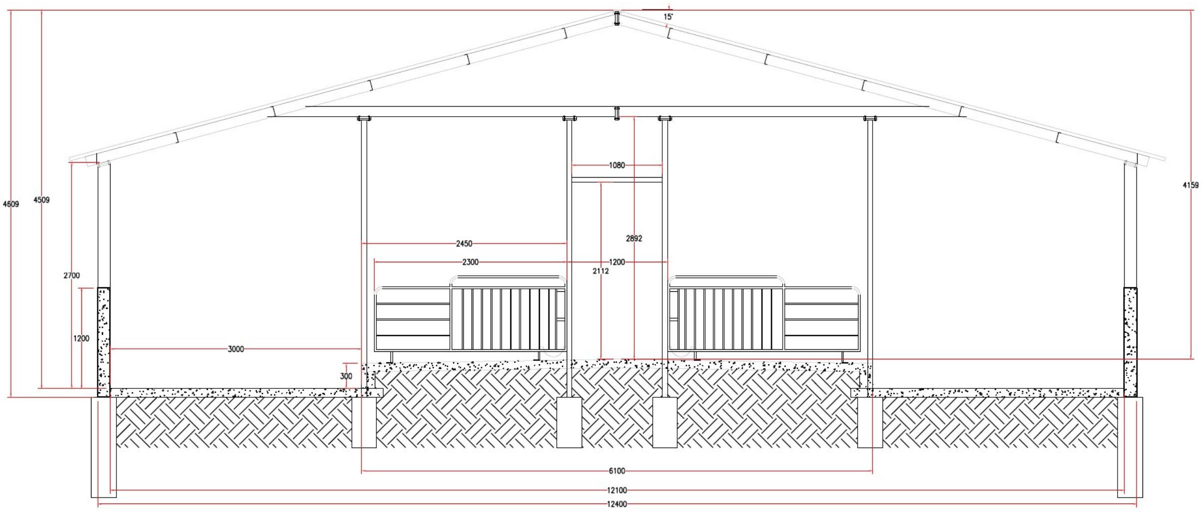


Figure 12 – Dry Sow Shed – Elevation View of Front including Drainage Details

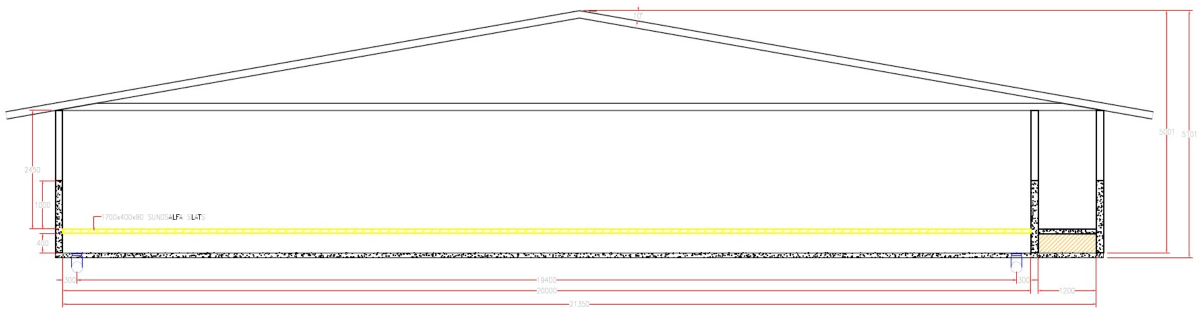


Figure 13 – Grower Shed – Elevation View of Front including Drainage Details

The weaner deep litter housing will consist of hooped structures covered in a waterproof canvas fabric with concrete floors, partial concrete walls and roll-up canvas blinds. The canvas material will be white to reflect heat. Figure 14 shows a schematic of the proposed shelters. Photograph 2 also shows an example of deep litter housing, similar to what is proposed. Complete floor and elevation plans have been prepared and these will be provided with the building application. The shelters will have floor dimensions of 15.175 m X 10.25 m with an elevation of 5.4 m.

Steel silos will also be constructed near the pig sheds. It is expected that two 117 t silos with an elevation of up to 10.5 m would be installed at stage 1, with 5 such silos in total at stage 3.

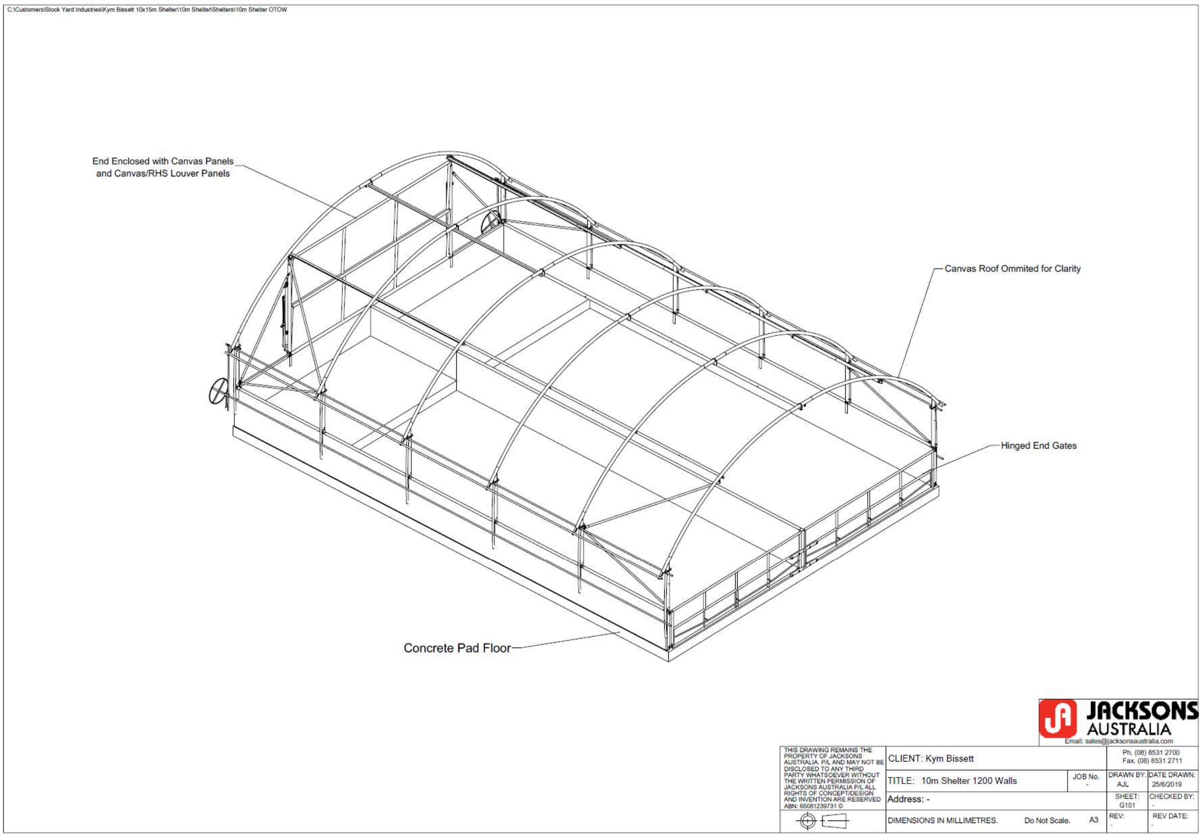


Figure 14 – Schematic of Weaner Deep Litter Shelter

2.2.2. B.2.b Earthworks, Fencing, Dams and Ponds

Earthworks will be needed to construct:

- piggery roads
- bunding around the piggery complex
- building pads
- effluent settling tank
- anaerobic pond and holding pond
- manure composting pad

The most significant earthworks will be for the construction of the effluent ponds which will be excavated into the ground. Section 2.3.6 provides construction details and dimensions. The conventional sheds will have below-floor effluent pits that will need to be excavated. While the finished surface of the manure composting area will sit at or near natural surface level, it will include a 600 mm thick compacted base that will require significant earthworks.

The piggery site will be fenced with a wire mesh and barbed wire fence. Vehicles will need to go through entrance gates. Signage at the entry to the site will alert people of the biosecurity requirements and provide a phone number for them to call should they wish to enter the farm. The effluent ponds will not be separately fenced but will carry appropriate signs warning of deep water.

2.2.3. B.2.c Waste Management Facilities and Effluent Holding and Utilisation Areas

Figure 2 summarises the effluent treatment train for all stages of the piggery development. The layout and siting of the effluent treatment facilities and the manure composting area are shown on Figure 1. Figure 8, Figure 9 and Figure 10 show the proposed reuse areas on the Munyabla, Urana and Yerong Creek Farms.

A 100,000 L in-ground sump will collect effluent released from the pull-plug pits. The sump will be constructed from concrete and will be impervious. The lip of the sump will sit 20-30 cm above ground level to exclude stormwater runoff from surrounding areas.

Section 2.3.6 provides details of the dimensions and construction of the anaerobic pond and holding pond at each stage. The dimensions of the effluent treatment and holding ponds are shown on Figure 15, Figure 16 and Figure 17.

Spent bedding and separated solids will be composted in a dedicated area shown on Figure 1. It is proposed that a pad able to handle the manure, separated solids and mortalities from stage 1 will be built initially and that this would be expanded to full size at stage 2. The base of the composting pad will consist of two 300 mm deep layers constructed to produce a maximum pad permeability of 1 X 10^{-7} m/s. From the soil testing described above, it is expected that the permeability of the compacted in situ subsoil will be able to meet this criterion. If the in-situ soil cannot be compacted to achieve this permeability, suitable material will be imported. The area will be graded to provide a slope of 2%. The base of the pad will be at least 2 m above the highest seasonal groundwater table at all times. It will be bunded with a 0.3 m high bank to contain contaminated leachate and runoff and prevent the entry of extraneous stormwater runoff. Runoff from this area will collected in a drain which will empty into the piggery holding pond which has been sized to manage this runoff (see section 2.3.6 for pond sizing and construction details).

The piggery will generate very little waste. The principles of the waste hierarchy described in the "NSW Waste Avoidance and Resource Recovery Strategy 2014-21" (NSW EPA, 2014) will be adopted, with waste avoided and reduced where possible. The commodities for the pig feed will be mostly delivered in bulk, without packaging. There will be some pharmaceutical and cleaning product packaging and some office wastes. Wastes (e.g. office paper, plastic containers) will be collected in bins or skips and, where practical, will be recycled. The small amount of rubbish for disposal will be collected in skips and the contents will go to off-farm waste facilities. Sharps will be collected in suitable containers and the contents will be disposed of through the Lockhart Shire Council facility at the hospital.

2.2.4. B.2.d Type of Machinery to be Used

Feed for the piggery will be processed using a disc mill and mixer. This will be distributed to the pigs using an automatic system powered by electricity.

A diesel pressure washer will be used for cleaning the conventional shed pens.

An electric pump will be used to transfer water around the piggery. An electric pump will also be used to transfer effluent from the sump to the screw press.

A screw press will be used to pre-treat the effluent stream. This will be powered by mains electricity. For further details, see section 2.1.4 and Photograph 3.

A front-end loader will be used to clean spent bedding from the deep litter shelters. It will also be used to remove solids from underneath the screw press. Both the spent bedding and the manure solids will be loaded into a tip-truck for transportation to the manure composting area. Initially a telehandler will be used to turn the material but it is expected that a BearCat will be purchased and used for stages 2 and 3.

Compost will be spread using a tractor-pulled or truck-mounted manure spreader. Initially a contractor will be engaged to undertake this task. However, KBM Farms may purchase their own spreader in the future.

Sludge will be extracted and spread using a vacuum tanker. For stage 1, it is intended that a contractor will be engaged to undertake sludge removal and spreading. However, for stages 2 and 3 it is expected that KBM Farms will purchase its own tanker.

A small tractor will be used to pick-up dead pigs and transport these to the mortalities composting area.

2.2.5. B.2.e Silt Traps, Drainage & Stormwater Facilities

Stormwater protection has been carefully considered in the piggery design. A 0.3 m high surface water diversion bank will surround the piggery complex to divert clean stormwater runoff around it. This will be installed before building of the pig sheds, effluent ponds and composting pad commences to minimise erosion and sediment risks during construction. Runoff caught within this area will drain to the north and will be absorbed by the landscaping buffer which will be planted with species that are tolerant of seasonal waterlogging. Further details of controls to be used during construction are provided in section 2.3.4.

For the operating piggery, various measures will also be used to ensure clean stormwater will be kept separated from water that may have been in contact with manure.

All sheds will have impervious floors and solid lower-walls that will prevent manure and effluent from inadvertently leaving the sheds. The conventional sheds will have impervious underfloor pits; all manure, waste feed, wastewater and wash water will be captured in these. Effluent will only be released from a pull plug pit after checking the available capacity in the settling tank. The impervious drains to the sump and the sump itself will have a lip that sits 0.2-0.3 m above ground level to prevent entry of stormwater runoff. The sump will be fitted with a pump to the screw press that is triggered at a certain water level. After pre-treatment by the screw press, a pipe will transfer the effluent directly to the anaerobic pond under gravity flow. The crest of the anaerobic pond and the effluent holding pond will sit ~0.6 m above ground level to prevent the entry of any stormwater runoff. The pond system has been sized so as not to spill even in a 90th percentile wet year. In the unlikely event of a spill, the water would be captured within the bunding surrounding the piggery complex.

Solids removed by the screw press will be deposited onto a bunded concreted bay. After draining, these will be transferred to the manure composting pad using a front-end loader and tip truck. The drained liquid will return to the sump via a drain with a lip to exclude stormwater runoff. Spent bedding from the deep litter shelters will be directly transferred from the sheds to the composting area. The composting area will be surrounded by a 0.3 m high bund to prevent ingress of clean stormwater and egress or contaminated water.

Guttering on the roofs of the conventional sheds and the dry sow sheds will catch rainwater from rooves. This will be directed to tanks near the ends of the sheds. Based on shed floor area (which will under-estimate roof area slightly), the total volume of water that can be captured from shed roofs is shown in Table 32. The roof runoff is based on an average annual rainfall of 540 mm, and a roof runoff coefficient of 0.95. Hence, about 3.7 M/yr could potentially be collected at stage 1, 5.6 ML/yr at stage 2 and 7.5 ML/yr at stage 3, although the actual volume collected will vary with rainfall received in any given year and it may not be possible to collect all runoff as the tanks may occasionally over-fill.

Table 32 – Potential Rainfall Capture from Pig Shed Roofs

Item	Stage 1 – 600 sows	Stage 2 – 900 sows	Stage 3 – 1200 sows
Approx. roof area sheds (m^2)	7315	10,972	14,629
Runoff collected (m^3)	3752	5629	7505

2.2.6. B.2 f Storage Areas and Sheds

In addition to the piggery sheds, the piggery will need a feed shed for storing commodities and milling and mixing feed, a machinery and maintenance shed and (at stage 3) a biogas shed for the generators and a stock loading shed. A small office with staff facilities (lunch room, showers and toilets connected to septic) and a lockable area for storing veterinary chemicals will also be installed.

The feed shed will have floor dimensions of approximately 20 m X 15 m with an elevation no higher than 5 m. It will be a steel-framed shed with corrugated iron or colourbond walls and roof in muted colours. It will have a concrete floor. Feed storage silos will also be installed near the farrowing sheds and the dry sow sheds.

The machinery and maintenance shed will have floor dimensions of approximately 30 m X 20 m with an elevation no higher than 5 m. It will be a steel-framed shed with corrugated iron or colourbond walls and roof in muted colours. It will have a concrete floor.

The biogas shed will be a small steel-framed shed with corrugated iron or colourbond walls and roof in muted colours. It will have a concrete floor.

The loading shed will be a small, concrete-floored, hooped-structure, similar to the plastic greenhouses used in horticulture.

The office will be a small pre-fabricated or demountable building.

Water will be stored in tanks. Two large water tanks (~100,000 L in total) have been installed next to the bore on the property which is situated close to the house on the property, which is shown on Figure 18. Water tanks for storing water pumped from the bore will be situated adjacent to the office. Roof runoff from the iron-roofed sheds will also be collected into tanks near the sheds.

Bales of straw for use as bedding will be stored adjacent to the manure composting pad. This is sufficiently close to the deep litter shelters for practical purposes, but separate enough to protect the shelters in the event of a fire.

Effluent and compost storage is detailed in section 2.1.4.

2.2.7. B.2.g Processing, Storage and Loading Facilities for Transport

Some feed will be delivered ready-made and some will be milled and mixed on-farm (see Table 3). An auger will deliver purchased pellets directly from the truck into silos situated adjacent to the pig sheds. Feed commodities will be delivered straight to either silos (via an auger) or the feed shed for storage ahead of processing. Feed prepared on-farm will be processed using a disc mill and mixer before being augured into silos adjacent to the sheds. It will be distributed to the pigs using an automatic system. The road between the pig sheds will be used by feed delivery vehicles.

Pigs will move between sheds via a concreted, fenced walkway. This will be used to transfer sows from deep litter shelters to conventional sheds for farrowing and back again afterwards, weaners to deep litter shelters and growers to conventional sheds. It will also be used to move sale pigs to the loading shed which will include a loading ramp designed to load pigs onto a three-deck semi-trailer.

2.3. B.3. SITE LAYOUT

2.3.1. B.3.a Vegetation to be Cleared or Disturbed

The piggery will be sited within a paddock that has been cleared and cropped for decades. Although there are isolated paddocks within the area, the piggery layout has been designed to retain these. Hence, no native vegetation at all will be cleared or disturbed. Similarly, the reuse areas have all been cleared and farmed for decades and no native vegetation will be removed for the development. Buffers between reuse areas and sensitive native vegetation will be used to ensure they are protected from aerosols and inadvertent nutrient movement in runoff.

2.3.2. B.3.b Internal Access Roads, Truck Parking, Loading & Turning Areas

All piggery vehicles will enter the property at a single, existing property entry point from Dick Knobels Road (see Figure 1 for location). The land to be used for the piggery is currently cropped and roads within the piggery complex will need to be built. In accordance with the Lockhart Shire DCP engineering standards for commercial and industrial development, the property entry point and the roads to the office, feedmill and pig loading shed will be constructed to 6 m width to provide for two-way traffic. The road running north-south down the centre of the piggery complex will also be 6 m wide to provide for two-way traffic. All internal roads will be constructed to provide all-weather access and suitable drainage.

Trucks will need to be able to park for loading pigs and for off-loading feed, feed commodities and bedding. Trucks loading pigs may pose a biosecurity risk if they access other farms to collect pigs. To avoid this risk, the farm will use only Matt Klemke's trucks for stock transportation. These will be clean on arrival and won't enter the fenced piggery compound. KBM Farms will consult with their vet to finalise their biosecurity protocol. This could possibly include a truck wash near Matt Klemke's and / or a small tyre disinfection wash on the entry road.

To minimise this risk, the loading ramp will be situated to the south of the finisher sheds. Livestock trucks will only use the eastern part of the road so as to avoid going past all the sheds. A turning circle will be provided so that stock trucks can go up and back along the eastern section of road only. Trucks delivering to silos near the farrowing and dry sow sheds will use the north-south road. They will park on the road alongside the silos for the short time needed to auger the feed from the truck, so no designated parking is required. A space for trucks to park while delivering commodities is provided in front of the feed shed.

Car parking space for 10 staff and visitor cars will be provided alongside the office.

2.3.3. B.3.c Effluent Storage, Land Application Areas, Controlled Drainage Areas and Waste Disposal Areas

At each stage, effluent will be stored in an anaerobic treatment pond and a holding pond. Details of these are provided in sections 2.3.6 and on Figure 15, Figure 16 and Figure 17.

Effluent and mortalities compost produced at the farm will be beneficially reused on the Munyabla farm. It is expected that most of the sludge will also be used on this farm but some manure compost could be also. It is likely that most of the manure compost will be beneficially reused on the Urana or Yerong Creek farms, but sludge and manure compost will also be offered to nearby land owners for use in their farming systems. See section 2.1.4 for details.

The piggery complex will be situated within a controlled drainage area, with a 0.3 m high bund surrounding the site. All of the sheds and other facilities will be constructed to prevent the entry of stormwater runoff or uncontrolled exit of contaminated water. The composting area will sit within a bund. The anaerobic pond and the pond will have above-ground banks that prevent the entry of stormwater runoff.

Sewage from the staff toilets and showers will be treated using a septic system.

No on-farm waste disposal areas are planned. For details of rubbish management, see section 2.2.3.

2.3.4. B.3.d Site Drainage, Erosion and Sediment Control During Construction

Best management practices will be used to minimise the risk of soil erosion and for sediment control during construction. Appendix B provided some recommendations for mitigating erosion, particularly during the construction phase. These included:

- integrate project design with site constraints
- preserve and stabilise drainage ways
- minimise the extent and duration of disturbance
- control stormwater flows onto, through and from the site in stable drainage structures

- install perimeter controls
- stabilise disturbed areas promptly
- use sediment control measures to prevent on-site and off-site damage
- protect inlets, storm drain outlets and culverts
- provide access and general construction controls
- inspect and maintain sediment and erosion control measures regularly.

There is a moderate risk of site erosion during construction. The site has very low relief and generally low salinity, although dispersion testing suggests some subsoil sodicity. This means care needs to be taken when subsoils are exposed. A 0.3 m high bund will be installed around the piggery complex before other construction commences to minimise stormwater movement through the area and to protect external areas from sediment transfer. Next, the access roads will be installed. The area stripped of vegetation at any time will be limited to areas where construction is actually occurring. Stripped areas will be stabilised as quickly as practical, with building footings, ponds and the composting pad being built in a short-time frame. Groundcover around these areas will be maintained where possible to prevent topsoil losses through wind erosion. Excavation of subsoils will be limited, with removed material stockpiled and contained within the bunded area to minimise potential dispersion and sediment removal.

Guidance in Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) will be used in developing an Erosion and Sediment Control Plan (ESCP) for this project.

2.3.5. B.3.e Landscaping

Tree lines will be planted to screen the piggery complex. They will be planted on all sides of the complex. These will be at least three trees wide. Additionally, shrubs of varying heights will be planted amongst the trees to provide an effective visual screen. Indigenous trees and shrubs will be selected for the landscaping. Trees and shrubs will be ordered from Jayfields Nursery. Tracey Geppert, Environmental Officer at Lockhart Shire Council was consulted (23rd July 2019) re landscaping. She was happy to support the nurseries plant suggestions. In developing a landscaping plan for the site, KBM will consult with the Lockhart Shire Council regarding appropriate plant species, planting density and other management. An irrigation system will be installed to ensure the plants establish. Any dead or diseased plants will be promptly removed and replaced.

2.3.6. B.3.f Dimensions and Construction Details of Storage Ponds Used for Liquid Effluent

Figure 15 and Figure 16 show the proposed anaerobic pond sizing for stages 1 and 2, and stage 3, respectively. In both cases, the pond has been designed to have a storage depth of 5 m, with 0.6 m freeboard above top water level and internal batters of 2.5 horizontal to 1 vertical.

It is proposed that the anaerobic pond built for stage 1 will be large enough for stage 2 as well. This pond will need to be extended for stage 3. To allow for covering of the pond at stage 3, the bank crest will be built 5 m wide to allow for trenching of the cover and to provide safe access. The extension to the pond will be undertaken during the summer when rainfall is slightly lower. The effluent will be pumped into the holding pond from which it can be irrigated which will allow for the anaerobic pond extension. When the extension is undertaken, angled pipes will be inserted through the wall and down to the pond base. Several pipes will be installed along the length of the wall to provide access across the pond floor. A vacuum tanker pipe can be inserted into these pipes and used to extract sludge as required. Approximately a dozen similar covered anaerobic ponds (CAP) with in situ sludge removal pipes have been installed at Australian piggeries.

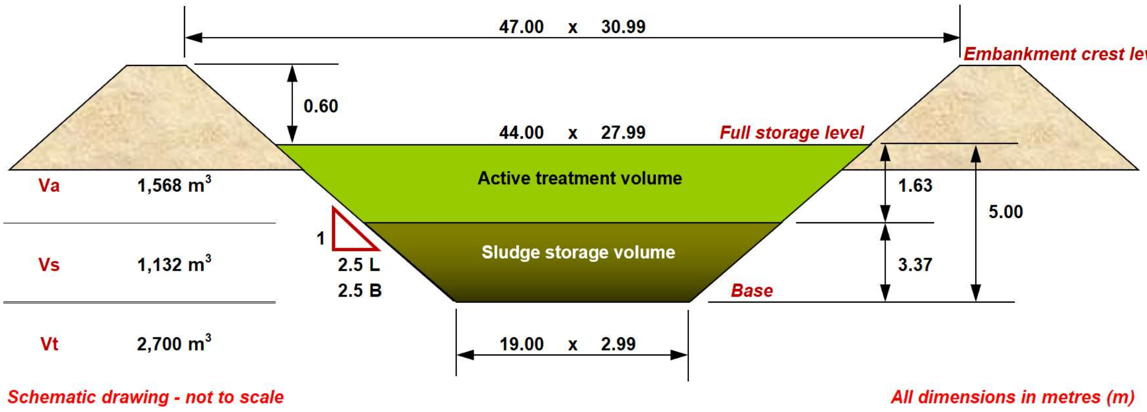


Figure 15 – Dimensions of Anaerobic Pond – Stages 1 & 2

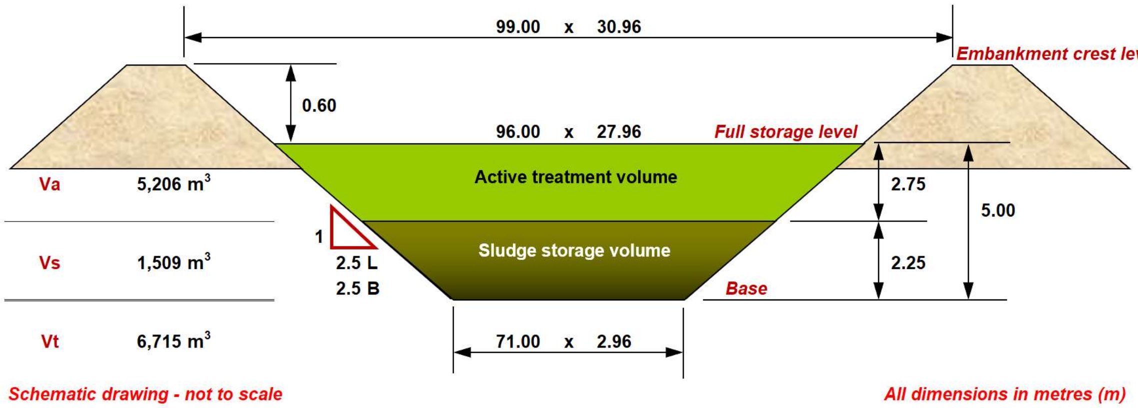


Figure 16 – Dimensions of Anaerobic Pond – Stage 3

The pond cover will likely be constructed from either high-density polyethylene (HDPE) or 2 mm low density polyethylene. It will be embedded into a trench in the pond crest to crated a gas-tight seal. The cover will be held down with water-filled weight pipes. These will guide stormwater collecting on the cover into a sump built into the cover, from where it can be pumped off the cover to either the rainwater tanks or the dam near the bore. Slotted pipes under the cover will collect the biogas released as a consequence of anaerobic digestion. The collected biogas will be scrubbed to remove hydrogen sulphide, pumped using a biogas blower and dried before it is transferred to the generators. A flare will be installed to provide for safe venting and burning of excess biogas when needed. (Pork CRC, 2016). The CAP will be constructed and operated in accordance with the Code of Practice for On-Farm Biogas Production and Use at Piggeries (Australian Pork Limited, 2015). A biogas safety management plan will also be developed using the Australian Pork Limited template (Gas Advisory Services Pty Ltd, 2014).

The holding pond has been sized using the Australian Pork Limited WatBal model (Department of Agriculture and Fisheries, Queensland, 2019). The aim of this modelling was to size the holding pond for an average spill frequency not exceeding 1 in 10 years. WatBal performs a daily water balance on piggery effluent treatment and storage systems. It includes provisions for modelling additions to the effluent stream from piggery manure, waste feed, fresh and recycled flushing and water used for shed pressure-washing, runoff e.g. from outdoor production areas, drinking water wastage, and rainfall falling onto pond surfaces. Effluent system extractions incorporated in the model include evaporation from pond surfaces, and use of recycled effluent for shed cleaning and application (irrigation) onto land growing crop and/or pasture. However, WatBal is very conservative, not accounting for any evaporation from the anaerobic pond as a crust that hinders evaporation may sometimes form over these ponds. A daily water balance for the soil in the effluent application area is used to trigger effluent application to land when the soil water deficit reaches a selected value. This soil water balance allows selection of a range of typical crop/pasture species growing on a selection of different textured soil types in the application area. The model uses historical daily climatic data which is downloaded from the SILO climate data website (https://www.longpaddock.qld.gov.au/silo/). The model accommodates analysis periods commencing from 1900 up until the day prior to the analysis.

In this case, modelling was undertaken for:

- Stage 1 heavily loaded 2.7 ML anaerobic pond, holding pond, 4400 m^2 composting pad
- Stage 2 heavily loaded 2.7 ML anaerobic pond, holding pond, 7500 m^2 composting pad
- Stage 3 6.715 ML covered anaerobic pond, holding pond, 7500 m^2 composting pad

In all cases, the modelling used weather data for the Yerong Creek Fertiliser depot from 1900 to April 2019. However, climate data for The Rock (which has a slightly higher rainfall) was also tested with no significant change in results. Runoff from the hard catchment composting area and the concreted area under the screw press were accounted for. These were both classed as hard catchment. This is likely to significantly over-estimate the runoff from the composting pad as most of the time a significant portion will be covered with composting or composted material that will absorb some moisture. Hence, this is a very conservative approach. The reuse area was set at 130 ha, although an area of 65 ha was also tested with only a very small difference in the volume drawn. Irrigation was allowed when there was a water deficit of 20 mm from April to October and not following 20 mm of rainfall. No separate allowance was made for reuse of effluent in the composting process, which makes the modelling conservative particularly over the summer period when effluent would still be drawn for composting. However, it also means that the pond will be large enough should this method of reuse cease for some reason in the future.

Once the model was set-up, an iterative process was used to find the size of the holding pond that corresponded with an average spill frequency of 1 in 10 years. This was 6.9 ML for the stage 1 system, 7.7 ML for the stage 2 system and 9.5 ML for the stage 3 system. Note that if effluent irrigation was permitted in every month when the soil water deficit was 20 mm, the pond size could be reduced to 7.9 ML at stage 3. However, to provide some additional buffer at stage 3 for management flexibility, it was decided to make the pond capacity 10 M ensuring additional environmental protection.

Table 33 shows the modelled holding pond water balance for stages 1, 2 and 3. The modelled average long-term spill frequency is ~1 in 30 years for stage 1, 1 in 17 years for stage 2 and 1 in 12 years for stage 3. In reality, the average long-term spill frequency is likely to be considerably less due to the reuse of effluent in the composting process and the conservative assumptions used or built into the model.

Table 33 – 10 ML Holding Pond Water Balance Modelled Using WatBal

Item	Stage 1	Stage 2	Stage 3
Inflow from anaerobic pond (m^3/yr)	7,407	11,048	12,855
Inflow from pond rainfall (m^3/yr)	2,484	2,485	2,484
Outflow from irrigation / compost (m^3/yr)	5,750	9,413	10,654
Outflow from pond evaporation (m^3/yr)	4,149	4,029	4431
Outflow from overtopping (m^3/yr)	17	127	274
Average spill recurrence interval	29.9 years	17.1 years	12 years
No. of significant spill events in 118 years	4	7	10

The holding pond must also be large enough to store the 1 in 20 year, 24 hour storm. From Table 40, this event would produce 87.8 mm of rain. As Table 34 shows, even if the holding pond was 80% full, it would be more than able to contain a rainfall event of this size.

Table 34 – 1 in 20 Year, 24 Hour Storm Inflows to Pond System

Item	Stage 1	Stage 2	Stage 3
Crest surface area of anaerobic pond (m^2)	~1,457	~1457	0*
Rainfall inflow (m^3)	128	128	0*
Crest area of holding pond (m^2)	~4620	~4620	~4634
Inflow (m^3)	406	406	407
Area of composting pad (m^2)+	4,490	7550	7550
Pad runoff coefficient#	0.95	0.95	0.95
Inflow (m^3)	375	630	630
Total inflow (m^3)	909	1,164	1,037

* as this pond is covered, it has no surface area upon which rain can land

+ includes 50 m^2 of concrete pad under screw press

From the Engineers Australia publication "Project 13 Stage 3: Urban Rational Method Review" Goyen et al. (2014), an impervious clay is likely to yield a runoff coefficient of 0.9-0.95. For the purpose of this assessment, a value of 0.95 will be used for the pad area. However, it is noted that this is a very conservative approach since most of the time there would be signficant composting and composted material that would absorb signficant moisture.

Figure 17 shows the dimensions of the proposed 10 ML holding pond. Assuming 80% volatile solids removal by the anaerobic pond, the load to the holding pond is 223 kg VS/d entering the pond at stage 3. When the pond is half full, the loading rate is ~45 g VS/m^3/d which is about 60% the recommended loading rate for a rational design standard anaerobic pond in this location. However, it is expected that most of the time there will be very little effluent at all in this pond as it will be continually extracted for use in the composting process and for irrigation as required.

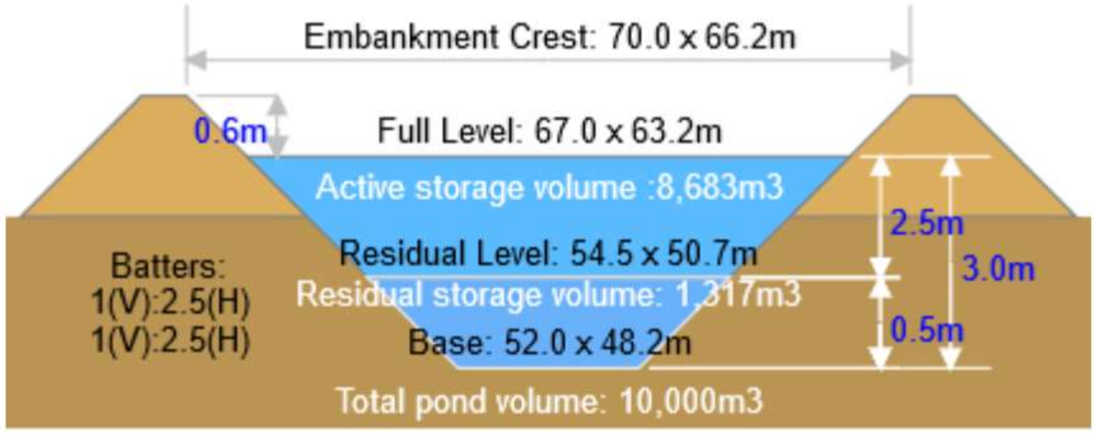


Figure 17 – Dimensions of Holding Pond

It is intended that the anaerobic effluent treatment pond and holding pond will be constructed from in-situ earth. The bases of these ponds will be at least 2 m above the highest seasonal groundwater table at all times. The pond walls and base will be lined with clay compacted to have a maximum permeability of 1 X 10^{-9} m/s for a depth of 450 mm consisting of three 150 mm layers. DM McMahon was engaged to undertake a geotechnical investigation at the site of the ponds and the composting pad (see Appendix D). This involved drilling four test holes; assessing the soils for particle size analysis, Atterberg limits and falling head permeability; comparing the results with the standard; and forming recommendations for earthworks and compaction control. Subsurface conditions were generally consistent with a thin topsoil to ~0.2 m (OL) over brown to yellowish silty-clays of low to medium plasticity (CL, Cl) to approximately 0.8 m overlying yellowish-brown to brownish-yellow silty clays of low to medium plasticity. The results were compared with the in "Earth Pad Preparation for Deep Litter Piggeries, Solid Waste Stockpiles and Composting Areas" (DAF Queensland, 2013) and "Constructing Effluent Ponds" (DAF Queensland, 2013). The soil texture (CL, Cl) was suitable and other parameters were within the desired ranges (liquid limit 30-60%, plasticity index >10%). The permeability of the subsoil at test holes 1 (effluent pond) and 2 (holding pond) were measured at 1.83 X 10^{-9} m/s. This is slightly below the 1 X 10^{-9} m/s target. From the McMahon Earth Sciences report, it is expected that the materials are suitable for the construction and use of the proposed clay liner if field conditions closely replicate that of the test method. As per AS 1289.6.7.2, samples are to be compacted to a laboratory density ratio of 100 +/- 1% of maximum dry density. However, if the in-situ soil cannot be compacted to achieve this permeability, suitable material will be imported. Alternatively, a synthetic liner made from 1.5-2 mm thick high-density polyethylene (HDPE) or 1 mm thick polypropylene (PP) will be used.

2.3.7. B.3.g Assumptions Regarding Seasonal Variations, Meteorological Conditions and Storm Events used to Estimate the Required Capacity

For the anaerobic pond sizing, SILO temperature data for Yerong Creek was used to determine the appropriate pond activity rate for the anaerobic ponds. Yerong Creek is about 15 km from the piggery site. It is worth noting that the closest site built into PigBal 4, Wagga Wagga, which is about 50 km away, recommends a higher (less conservative) pond activity ratio of 0.76.

SILO data for Yerong Creek was used with the WatBal model to size the holding pond. The suitability of this data set was tested by also using data for The Rock, which produced very similar results despite the slightly higher rainfall. The WatBal model determines the average spill frequency of effluent ponds using water balance modelling. A 1 in 10 year spill frequency from the ponds was used as the design criteria. This is consistent with the recommendations of the National Environmental Guidelines for Indoor Piggeries (Tucker, 2018). The holding pond sizing also used the 1 in 20 year, 24 hour storm event as a sizing criterion. From www.bom.gov.au, for the farm's location, the 1 in 20 year, 24 hour storm produces 87.8 mm of rainfall (see Table 40).

2.4. B.4 INFRASTRUCTURE AND SERVICES REQUIREMENTS

2.4.1. B.4 A Energy Supply

The primary power supply for the site will be mains electricity. This will need to be connected at the site. Preliminary consultation with the power supplier has occurred and a quote for the connection has been obtained. Details of equipment using electricity are provided in section 2.2.4. Electricity will also be needed for lighting and for office purposes.

However, the bore pump is operated by solar power. The water will move from tanks near the bore to the piggery under gravity flow.

Diesel will also be used for the pressure washer and some pumps. A diesel tank with approved bunding will be installed near the feed mill.

Diesel generators will provide power supply back-up. These will be located at the bore and near the feed mill.

At stage 3, biogas captured under the cover of the anaerobic pond will be used in conjunction with generators to producer power and heat that can be used by the piggery.

2.4.2. B.4.b Total Water Requirements

Water is needed for pig consumption, cleaning the conventional sheds, topping up the underfloor pits and cooling the pigs. The estimated usage is presented in Table 35. Default drinking water consumption data in PigBal 4 was used. Cleaning water was based on 5 hours per day of high-pressure cleaning of the conventional sheds at stage 3. If additional pit recharge water is needed, treated effluent from the holding pond will be used. Water won't be needed to clean the deep litter shelters; manure, waste feed and spilt water will be absorbed by the bedding which will be regularly removed and replaced. The cooling water usage was based on 540 hr/yr of spray or drip cooling.

Table 35 – Breakdown of Water Requirements

Water Requirement	Daily Water Use (L/day)		
	Stage 1	Stage 2	Stage 3
Drinking	32,820	49,240	65,650
Drinker waste	7,500	11,250	15,000
Cleaning	2,400	3,600	4,800
Cooling	2,390	3,580	4,770
Total	**45,110**	**67,670**	**90,220**
Water Requirement	Annual Water Use (ML/yr)		
	Stage 1	Stage 2	Stage 3
Drinking	11.98	17.97	23.96
Drinker waste	2.74	4.11	5.48
Cleaning	0.88	1.31	1.75
Cooling	0.87	1.31	1.74
	16.47	**24.70**	**32.93**

A minimum of two days total water requirement will be stored in tanks close to the piggery sheds.

2.4.3. B.4.c Sources of Water Supply

It is expected that groundwater will provide the primary water supply for the piggery. However, roof runoff will also be collected and used for shed cleaning. Approximately 33 ML/year of water will be needed for the fully developed piggery.

A bore was recently drilled near the southern boundary of the piggery block (Works Licence no. 40WA417210). Appendix E is a hydrogeological study providing details of the expected water supply from the bore. The TDS concentration of the water was tested at 2300 mg/L. While the water appears to be suitable for pig consumption, KBM Farms would consider installing a reverse osmosis plant to improve water quality if necessary. The bore has a cumulative yield of 2 L/s. At 80% efficiency, the bore would need to pump for ~16 hours per day to provide the total required daily volume.

However, roof runoff will also be collected from the conventional and dry sow sheds to provide part of the cleaning water requirements. From Table 32, roof runoff could potentially contribute up to 3.7 ML at stage 1, 5.6 ML at stage 2 and 7.5 ML/yr at stage 3, although the actual volume collected will vary with rainfall received in any given year and it may not be possible to collect all runoff as the tanks may occasionally over-fill.

It appears that the bore alone could provide a suitable water supply to meet all the needs of the piggery, although the collection of roof runoff for shed cleaning will reduce pumping pressure, although this water may also be used to dilute effluent for reuse. The development of the piggery in stages will allow the pumping capacity of the bore to be tested over time. If necessary, additional bores can be installed as suggested in the hydrogeological review. Each stage of the piggery development will only progress if the proponents are confident that the groundwater supply will meet the needs.

2.4.4. B.4.d Off-site Waste Disposal Requirements

The principles of the waste hierarchy described in the "NSW Waste Avoidance and Resource Recovery Strategy 2014-21" (NSW EPA, 2014) will be adopted, with waste avoided and reduced where possible. Effluent and sludge will be reused as a fertiliser source for crops. Manure and mortalities will be converted into compost, also for reuse in farming systems. Biogas will be collected from the anaerobic pond at stage 3, for energy and heat recovery.

The piggery will generate few other wastes. The main feedstuffs will be purchased in bulk, avoiding packaging. The only off-site waste disposal will be for a small amount of feed and chemical packaging, non-recyclable office wastes and other non-recyclables which will go to a local waste facility. Sharps will be collected in suitable containers and the contents will be disposed of through the Lockhart Shire Council facility at the hospital. Recyclable containers and packaging will be transferred to appropriate recycling facilities.

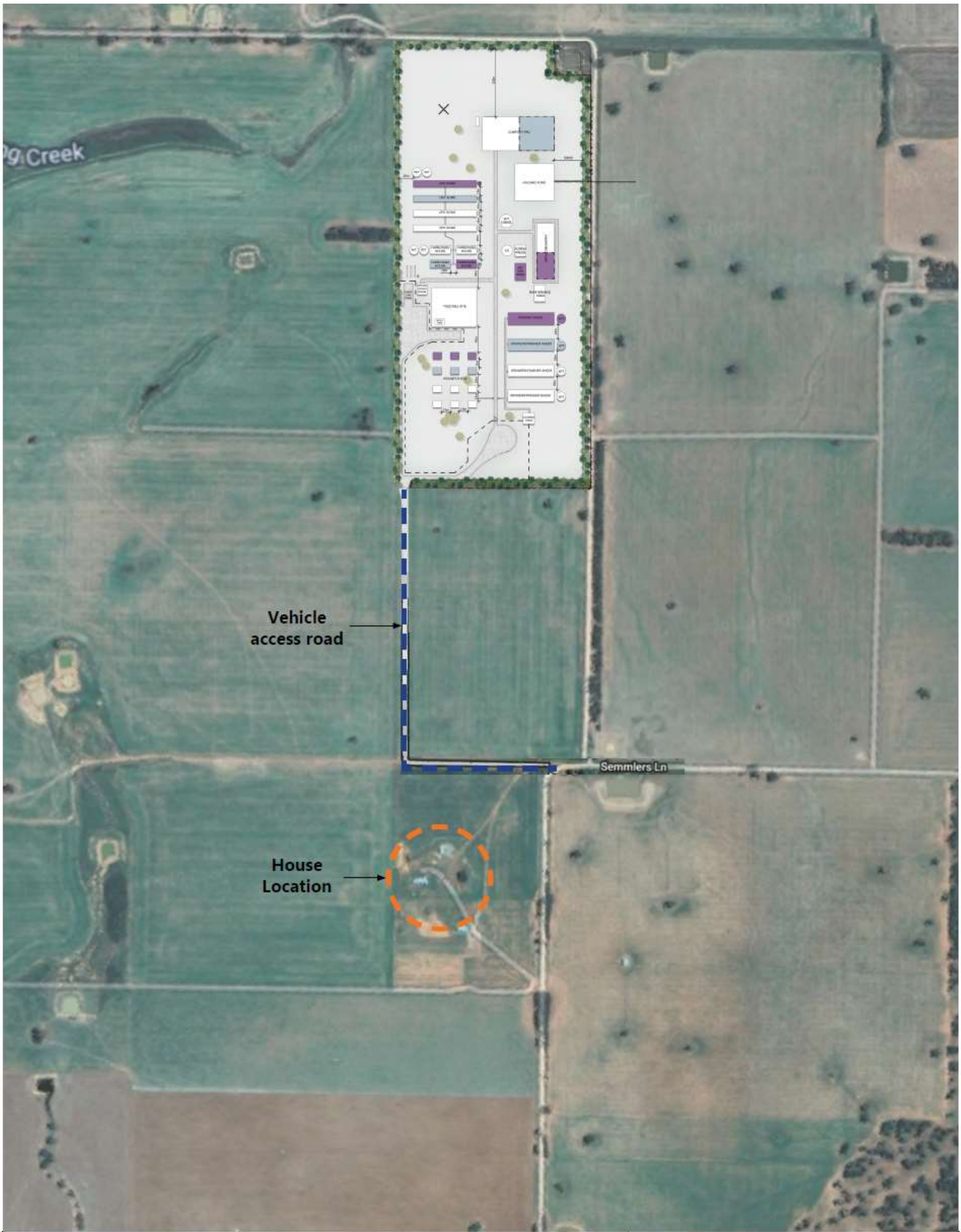
2.4.5. B.4.e Road Condition and Transport Requirements

The property entry point will be off Dick Knobels Road, with local access via Dick Knobels Road and Semlers Lane (see Figure 18). Dick Knobels Road is an unsealed, near-flat white gravel road in good condition. There are trees alongside parts of the road (see Photograph 5 which shows Dick Knobels Road and the current property entry point). Semlers Lane is a gravel road in reasonable condition. Dick Knobels Road joins the Henty-Pleasant Hills Road and Semlers Lane the Woodend-Five Ways Road; both these roads are sealed. Robertsons Lane, including the closed crown road to the north of the site, will not be used for any purpose associated with the proposed piggery.

Consultation with David Webb, Director of Engineering & Environmental Services (pers. comm. 23rd July 2019) identified that both Semlers Lane and Dick Knobels Road are rural roads classification 2. They are rated to take B-triple trucks. He suggested that it is possible that these roads could require some upgrading to allow for the proposed use. However, both roads are of a reasonable standard and withstanding current traffic numbers satisfactorily. Currently, KBM Farms proposes to direct about half the vehicles down each road to minimise impacts to them both. Average additional truck numbers in and out per road are around two per week at stage 1, three to four per week at stage 2 and five to six at stage 3. KBM Farms understands that some road upgrading and maintenance is a possibility and any requirements will be negotiated with council. If road upgrading is needed, KBM Farms will direct all heavy vehicles down Semlers Lane and avoid Dick Knobels Road as this is the shortest route and therefore the cheapest to upgrade.

Semi-trailers (general access heavy vehicles) will be used to cart feed, bedding and sale pigs. Grain and straw will be transported in single semi-trailers with load weights of up to 42.5 t. These will enter the site from either Dick Knobels Road or Semlers Lane. Pigs will also be transported in semi-trailers that will access the site via Dick Knobels Road or Semlers Lane. Sale pigs are likely to go to either CA Sinclair Abattoirs in Benalla or Diamond Valley Pork in Laverton North.

Figure 19 shows the traffic route from the farm to CA Sinclair Abattoirs, Benalla. This is via either Dick Knobels Road or Semlers Lane and Woodend Five Ways Road, Henty-Pleasant Hills Road, Alma Park Road, Walbundrie-Alma Park Road, Kywong-Howlong Road to Riverina Highway in Howlong then C381 and National Highway M31 to Baddaginnie-Benalla Road and onto Firth Road.



KBM Farms Pty Ltd Po Box 14, Henty NSW 2658 Mobile - 0403 343 254	SITE CONTEXT PLAN	Scale NTS Date 24.07.19 Job Number 20190213 North Proposed Works at Robertsons Lane, Henty NSW

Figure 18 – Site Context Plan

Photograph 5 – Dick Knobels Road Near Munyabla Farm Entrance

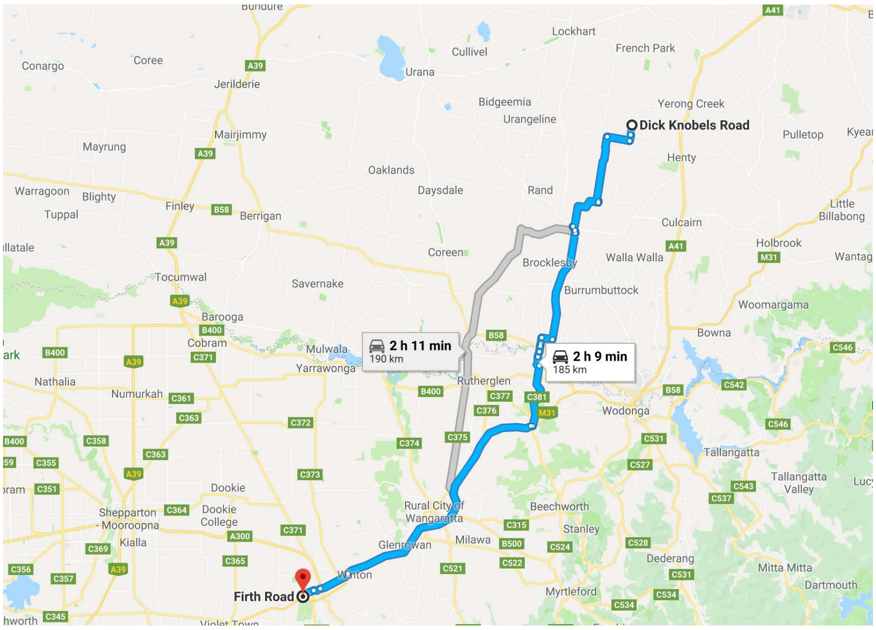


Figure 19 – Traffic Route from Farm to Benalla

Figure 20 shows the traffic route to Diamond Valley Pork, Laverton North. This is via either Dick Knobels Road or Semlers Lane and Woodend Five Ways Road, Henty-Pleasant Hills Road, Alma Park Road, Walbundrie-Alma Park Road, Kywong-Howlong Road to Riverina Highway then National Highway M31 to Boundary Road/State Route 32 in Sunshine West, Boundary Road exit (from M80) to Raymond Road and then Thomas Road in Laverton North.

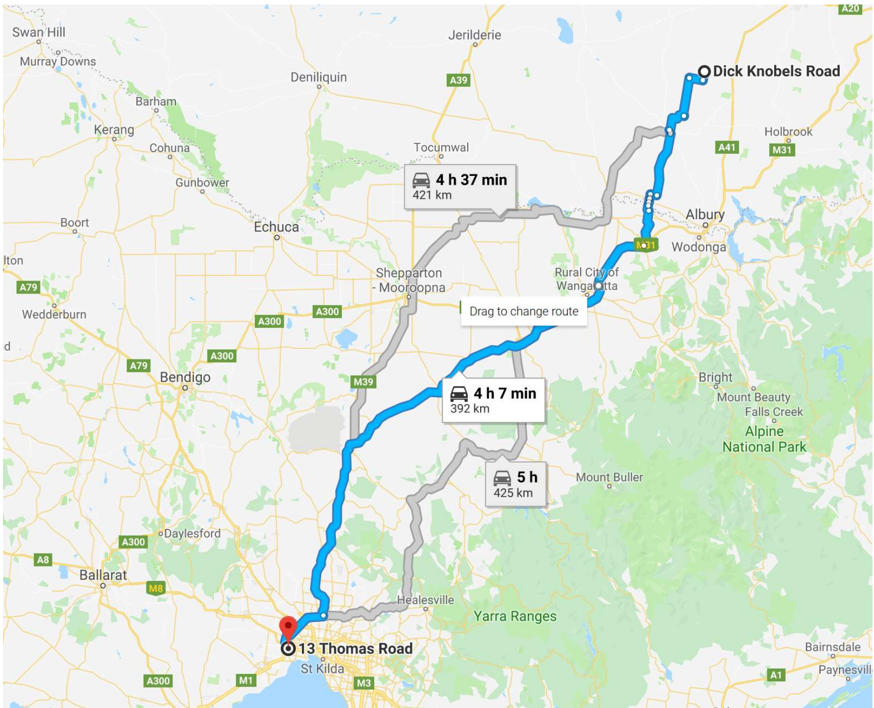


Figure 20 – Traffic Route to Diamond Valley Pork

Some manure products will be spread on the Munyabla farm and other land close to the piggery site, and some will go to the Urana and Yerong Creek farms. Figure 21 shows the route to the Urana farm which is via either Dick Knobels Road or Semlers Lane and Woodend Five Ways Road, Henty Pleasant Hills Road, Albury Road, Bidgeemia Road, Mahonga Road, Federation Way, Butterwah Road, Cockegedong Road and Doctors Road.

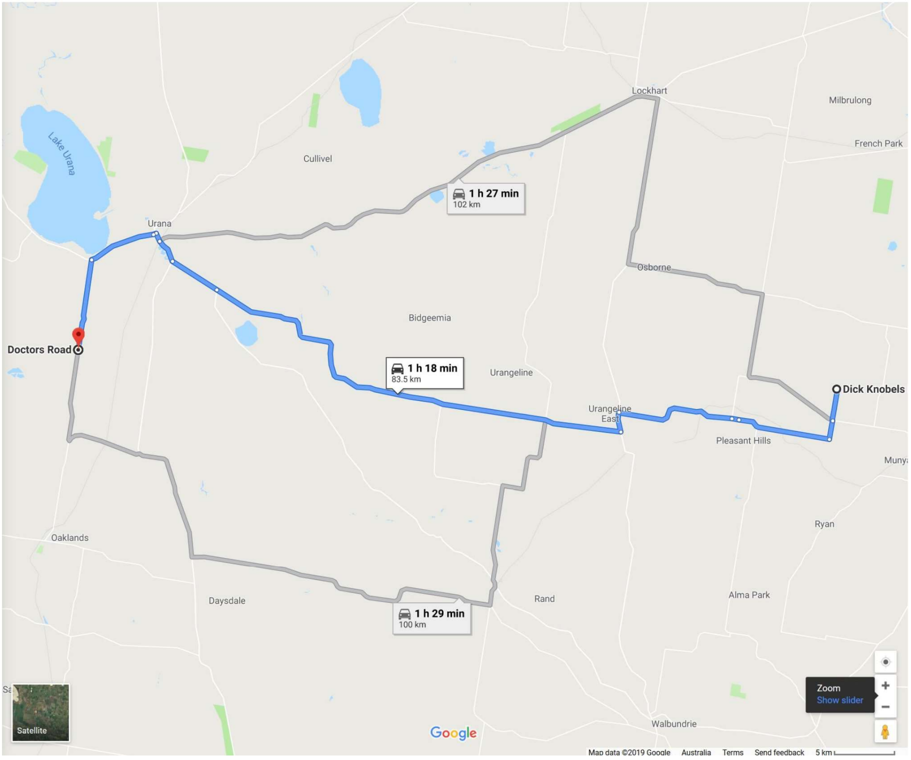


Figure 21 – Traffic Route Piggery Site to Urana Farm

Figure 22 show the routes to the Yerong Creek farm which is via either Dick Knobels Road or Semlers Lane and Woodend Five Ways Road, Osborne Yerong Creek Road, Yerong Creek Mangoplah Road and Adams Lane.

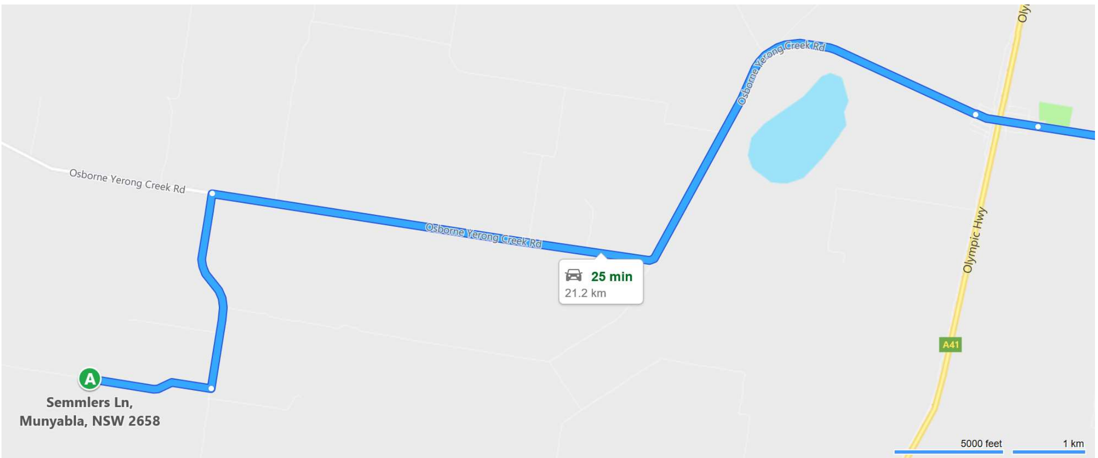


Figure 22 – Traffic Route Piggery Site to Yerong Creek Farm

Internal roads will provide suitable all-weather access for trucks carrying feed, straw, pigs, sludge and compost. The roads will provide suitable access for emergency vehicles if required.

2.5. B.5 PREVIOUS AND EXISTING OPERATIONS ON THE SITE

The site for the piggery complex has been cropped for many years. It has also been grazed in the past. The reuse areas have been used for similar purposes. The Munyabla, Urana and Yerong Creek farms have similar histories.

2.6. B.6 CONSIDERATION OF ALTERNATIVES

The applicants propose to operate a piggery as this will diversify the use of the farm and provide an alternative source of income.

The reasons for choosing the particular site are:

- the site is well isolated from houses, there are no neighbours within the recommended separation distances.
- road access and other infrastructure distance to the site is reasonable.
- the site is reasonably flat, which suits construction.
- the site is well separated from waterways.
- the site has previously been cleared for development.

The applicants have considered different sized options and have elected to apply for a 1200 sow unit since this is big enough to enter what is an increasingly competitive market. However, the development will be constructed in three stages: 600 sows, 900 sows and 1200 sows. This will allow the applicants to demonstrate that they can suitably manage a smaller unit at this stage before maximum capacity is achieved. The applicants originally considered starting with a 300 sow unit but now consider the 600 sow unit a more viable commencement size.

The applicants considered constructing a conventional piggery, a deep litter piggery or a combination. A conventional piggery provides for very good production control, but is expensive to construct. A deep litter piggery is relatively lower cost but offers less control (e.g. over feed intake) and is less suitable for some stock classes. Constructing a combination conventional-deep litter unit provides a good compromise for capital cost.

When designing the effluent treatment system, a range of options were considered. Some solids separation before the anaerobic pond was desirable to reduce the size of the pond and therefore the odour emitting surface. The applicants considered using either a settling tank or a screen for the 600 sow unit. However, both these options require more management and will produce wetter solids than a screw press. Initially, the most cost-effective effluent treatment option is a heavily-loaded anaerobic pond. Although these ponds have a higher volatile solids loading rate than rational design standard pond, they achieve similar treatment rates and generally release less odour due to their considerably smaller surface areas (Tucker, National Environmental Guidelines for Indoor Piggeries, 2018). At stage 3, it will become economically feasible for the anaerobic pond to be covered with an impermeable cover. This will significantly reduce odour and greenhouse gas emissions and will allow KBM Farms to generate power and heat for use within the piggery, thereby providing a very eco-friendly option.

The effluent holding pond will store effluent before it is used in the manure composting process and irrigated to land. The applicants' preference is to use most of the effluent as a moisture source for composting, with surplus effluent irrigated onto land. These uses provide for beneficial reuse of the water, organic matter and nutrients in the effluent.

The possibility of constructing a holding pond large enough to manage the entire effluent stream through evaporation alone was explored. The National Environmental Guidelines for Indoor Piggeries (Tucker, 2018) recommend a 1 in 20-year spill frequency for evaporation ponds for effluent. While this is possible, an evaporation pond would occupy a large footprint and fails to beneficially reuse the organic matter and nutrients in the effluent.

Similarly, it would be possible to manage the effluent through a combination of composting and evaporation. If for any reason effluent irrigation was no longer found to be viable, KBM Farms would prefer to manage the effluent through a combination of composting and evaporation. It is understood that council and EPA approval would need to be sought before an evaporation pond could be constructed and operated.