Annexure 3

Environmental Management Plan

ENVIRONMENTAL MANAGEMENT PLAN

Darwin Cattle Processing Facility

Prepared for

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1.0 INTRODUCTION

This Environmental Management Plan has been prepared as part of the environmental assessment of a cattle processing facility proposed to be established by the Australian Agricultural Company Limited on land approximately eight (8) kilometers south of Noonamah adjacent to the Stuart Highway.

The EMP is intended to guide the environmental management at the processing facility and focuses on the key environmental aspects over which the owners will have some control and influence. These environmental aspects are the basis for development of the operational environmental management plan. Refer to Section 3.0

One aspect over which management has no influence is the build up and onset of the annual wet season. This can have significant environmental effects and has to be carefully considered with the proposed development.

Overall, the environmental objectives of the project are to:

- prevent pollution
- minimize any adverse impacts on the environment, both on and off site
- treat the solid by-products (cattle manure & paunch contents) on an environmentally sustainable basis by composting
- safely dispose of effluent by beneficially irrigating crops & pasture for haymaking operations
- recycling of salt from hide curing processes.

Importantly, the EMP outlines best practicable environmental management options including regular on-site environmental monitoring, and annual review and reporting of environmental performance.

The design of the facility and the proposed operations satisfy three fundamental pollution reduction and environmental management principles, namely:

- minimization of effluent volumes through implementation of State Of The Art processing designs and water use efficiencies

- beneficial utilization of effluent using effective treatment, storage & irrigation

- recycling composted organic matter on an environmentally sustainable basis.

This document should be read in conjunction with the detailed plans and supporting information that accompanies the application for an exceptional development permit.

2.0 THE FOOD PROCESSING FACILITY

Following is a brief description of key features of the proposed facility:-

- The intention is to establish a beef processing facility with a capacity to humanely slaughter and process approximately 1000 cattle per day or over 210,000 head per annum
- The intention is that slaughtering capacity will begin at 240 cattle per day and increase in stages to the maximum intended capacity of 1000 head per day using two shifts
- Facilities to include a fully contained lairage area with about 2 days holding capacity, a State Of The Art slaughter floor with boning and slicing areas, chilling and freezing rooms, rendering plant and bio-filter, a bunded manure/paunch content composting area, effluent treatment ponds, and effluent irrigation system
- Best management practices will be employed to minimize odour generation
- The property has an area of ~ 600 hectares of mainly gently undulating cropping and pasture land with a centrally located wet area draining to the west
- The typical soil type is a relatively deep mottled yellow duplex soil often with a lateritic &/or ironstone layer at about 80 – 100 cm and deep yellow/grey clayey soils lower in the terrain and associated with seasonally waterlogged areas
- Historically land use has focused on intensive rotational cattle grazing during the wetter seasons and then stock removal and growing out improved pastures for haymaking operations later in the dry season
- The majority of arable land across the property has had improved pastures (mainly Humidicola and Jarra grass) established to enhance livestock carrying capacity and fodder and hay production
- Future land use will focus on the beneficial reuse of treated effluent by irrigating crops such as lucerne and improved pastures with the objective of maximizing the uptake of applied nutrients and optimal hay production
- Composted cattle manure and paunch contents will mostly be reused offsite
- Construction of the effluent ponds will include 3 x anaerobic ponds, 3 x aerobic ponds and a 2 cell storage dam designed to treat the effluent from the facility
- Operation of the storage dam, water balance and irrigation system is to be carefully scrutinized to determine the need for additional water by collection and storage of stormwater runoff to ensure sustainability of the irrigation system and the maximization of fodder production
- Effluent ponds will be carefully monitored to help ensure optimal treatment of the effluent being generated
- An environmental monitoring program is to be undertaken including regular monitoring of treatment ponds, groundwater and the soils of the irrigation area
- An annual Environmental Monitoring Report outlining the overall environmental performance of the facility will be routinely completed

3.0 ENVIRONMENTAL ASPECTS

Key environmental aspects comprise those elements of the processing operation that may have potential effects on the environment, either harmful or positive effects, and over which management has some control and influence.

The identification of these key environmental aspects is important to help prevent pollution and minimize adverse impacts on the local environment. The following aspects are the basis for development of this environmental management plan.

The key environmental aspects are identified as follows:

- Effluent Treatment System
- Cattle Holding Yards
- Composting Area
- Runoff Holding Dam
- Composting Site & Operations
- Effluent Irrigation System
- Irrigation Management
- Sewerage Treatment System
- Salt Evaporation System
- Environmental Monitoring Program

Note that in addition to the above listed aspects separate design information and details have been prepared to support the proposal, covering -

- Stormwater Runoff Management
- Soil Erosion & Sediment Control
- Odour Control – Rendering

4.0 EFFLUENT TREATMENT SYSTEM

As indicated above the intention is that approximately 1000 head of cattle will be slaughtered and processed daily in the facility. Water usage at the plant has been calculated as a maximum of two (2) kilolitres per head or two (2) megalitres per day with 75 % of this water ie. 1.5 megalitres, presenting to the effluent treatment system.

The effluent treatment system is to comprise a series of treatment ponds and dams as follows:-.

- 3 x Anaerobic ponds (Total ~15 ML and 14 days retention time)
- 3 x Aerobic serpentine ponds (Total of ~20 ML and 20 days retention time)
- A Storage Dam comprising 2 x separated sections with a common dividing earthen wall

It is generally acknowledged that processing effluent contains a variety of valuable nutrients including nitrogen (N), phosphorus (P) and potassium (K). When sustainably applied to land these nutrients support significant increases in agricultural productivity and the greater yields of fodder harvested from the plant-soil system.

Table 1. Rainfall and Evaporation – Batchelor, NT

Month	Mean Monthly Rainfall (mm)	Average Rain Days	Pan Evap. (mm)	Pond Evap.[1] (mm)
Jan	307.5	20	186	171
Feb	380.3	21	160	155
Mar	237.5	17	180	178
Apr	108.2	7	189	185
May	16.1	2	211	205
Jun	0.5	0	204	200
Jul	0.2	0	211	207
Aug	3.1	1	223	212
Sep	6.7	2	231	224
Oct	66.6	7	248	236
Nov	129.6	12	222	220
Dec	281.0	19	205	201
	1537.3	**108**	**2470**	**2394**

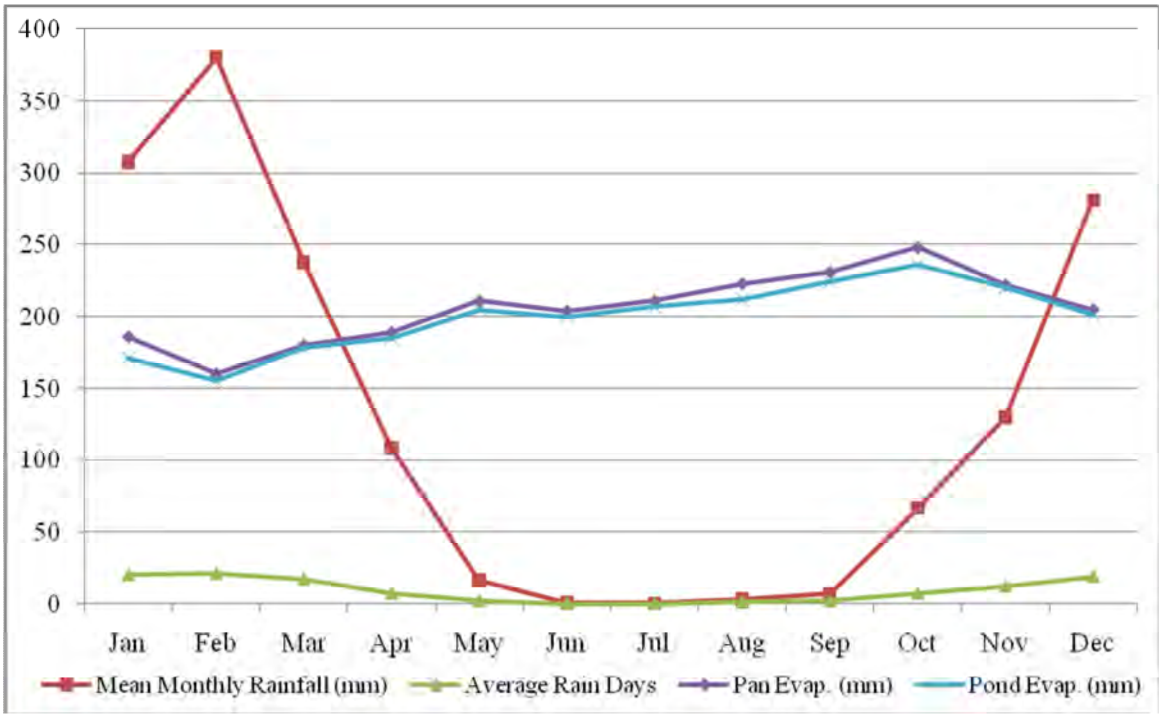
Note 1.

A coefficient is applied to Pan Evaporation allowing for differential evaporation from an open water body which is deeper, cooler and subject to wind action

(Ref. Bureau of Meteorology)

Effluent passes through the series of treatment ponds to the effluent storage dam and it is from the storage structures that effluent is pumped and beneficially reused by irrigating crops and pasture for haymaking.

Figure 1. Rainfall and Evaporation – Batchelor, NT



It follows that the sizing of the irrigation area is a key component in achieving environmental sustainability.

The critical design parameter is determined by comparing the area calculated for each parameters' sustainable loading rate as follows:-

- hydraulic loading, or
- effluent constituent/nutrient loading

and then selecting the largest area.

The critical design parameter is that which corresponds to the largest field area requirement.

Details of the effluent volume generated, the water balance, effluent storage dam and irrigation reuse are outlined in the following sections.

Table 2. Water Balance for Effluent Irrigation

Month	Mean Monthly Rainfall (mm)	Mean Monthly Evap (mm)	Crop Factor[1]	Evapo-Transpir. (mm)	Potential Effluent Applied (mm)
Jan	307.5	186	0.4	74	0
Feb	380.3	160	0.4	64	0
Mar	237.5	180	0.4	72	0
Apr	108.2	189	0.9	170	62
May	16.1	211	0.9	190	174
Jun	0.5	204	0.9	184	183
Jul	0.2	211	0.9	190	190
Aug	3.1	223	0.9	201	198
Sep	6.7	231	0.9	208	201
Oct	66.6	248	0.9	223	156
Nov	129.6	222	0.9	200	70
Dec	281.0	205	0.4	82	0
	1537.3	**2470**		**1858**	**1234**

Note 1. Monthly Crop Factor for Lucerne

4.1 Water Balance

In designing a beneficial effluent irrigation system the local water balance needs to be established to determine the maximum volume of effluent which can be sustainably utilised each year, on average, by the intended agronomic system.

The water balance is generally expressed as follows:-

Design Rainfall + Effluent Applied = Evapo-transpiration

Table 1. outlines information needed to calculate the water balance including average monthly rainfall, average rain days and evaporation for the local Batchelor district. This data set was chosen as it has 17 years of recorded data (Bureau of Meteorology, 2011) and is considered to be more representative than the data set for Darwin which is more subject to maritime influences.

Note that this rainfall data provides an indication of rainfall distribution across the year. It also indicates rainfall in the buildup to the tropical monsoon and during the wet and dry seasons generally.

Evaporation is usually measured in a Standard Evaporation Pan and is expressed as depth of water (mm) per day. Pan evaporation is adjusted for the particular crop being grown by applying a crop factor. For example the evapo-transpiration of lucerne is determined by multiplying the monthly pan evaporation by the monthly crop factor.

There are differences in evaporation between pan evaporation and an exposed water body such as large effluent storage ponds so a multiplication factor is also applied to determine pond evaporation. Refer to Table 1.

Table 2. indicates the application of rainfall data, evaporation and the crop factor for lucerne in determining the maximum potential effluent that can be applied monthly to the effluent irrigation area.

Note that the maximum effluent application amount occurs in September and ostensibly nil irrigation can be applied from December – March. (Depending on the actual rain days in the month there may be opportunities to undertake some effluent irrigation during this period).

The annual potential effluent irrigation amount is 1234 millimetres or 12.34 ML/ha.

Table 3. Processing Effluent

Month	Effluent Generated [1.] (ML)	Effluent Available[2.] (mm)
Jan	8	29.3
Feb	8	29.3
Mar	33	121.0
Apr	32	117.0
May	33	121.0
Jun	32	117.0
Jul	33	121.0
Aug	33	121.0
Sep	32	117.0
Oct	33	121.0
Nov	32	117.0
Dec	28	103.0
	337	**1234.6**

Note -

1. Calculated based on monthly plant operations with shutdown from mid January – mid February & only operating a single shift in the remainder of these two months eg. January has 10 working days @ 1 shift generating 0.75 ML/day = 7.5 say 8.0 ML/month.
2. Effluent available is calculated as follows eg. January : 8000Kl x 0.1 mm/Kl / 27.3 hectares = 29.3 mm where land area required is 36.5 x 923 Kl/day effluent / 1234 mm of potential effluent applied

4.2 Effluent Irrigation Area

As indicated earlier, the sizing of the irrigation area is a key component in achieving environmental sustainability of the effluent reuse system.

Table 3. outlines the monthly volume of effluent generated from the plant and this data is used in calculating the required irrigation area.

The irrigation area required, based on hydraulic loading using mean monthly rainfall, is calculated as follows:

Area = C x Q / H

Where C is a constant (36.5) covering annual time period and to adjust for units in the calculation
Q is kilolitres effluent generated per day (337 ML / 365 days)
H is the potential annual effluent loading per year (1234 mm)

Area = 36.5 x 923 / 1234

= 27.3 Ha

4.3 Storage Dam

Calculations relating to storage volume requirements are indicated in Table 4. The accumulated storage column comprises the sum of the monthly change in storage.

Calculations indicate that the maximum storage requirement occurs in April and totals 122.4 megalitres. The surface area of the storage dam is nominally 4 hectares where the required design depth is approximately 3 metres.

Importantly, approximately 1.5 metres of additional depth in the storage is necessary to comply with requirements eg. capacity for the Q100 storm, plus 0.5 metres of freeboard and 0.5 metres of water to be held in the pond late in the irrigation season to help prevent cracking & maintain the integrity of the clay lining.

Thus the storage pond volumetric capacity is ~160 ML.

Table 4. also indicates a shortfall of approximately 50 megalitres of irrigation water late in the irrigation season (September and October).

Naturally, the above calculations are based on the theoretical modelling using mean rainfall. In practice annual seasonal variations occur and each year is different eg. the length of the dry season, the annual build up and the onset of the Wet, as well as the number of rain days and rainfall distribution across each month.

The local daily rainfall and evaporation ie. the water balance, needs to be monitored. To operate an environmentally sustainable and productive effluent reuse system it is essential that the daily/weekly management of the effluent treatment and irrigation system is responsive to these seasonal variations.

Table 4. Effluent Storage Dam - Batchelor, NT

Month	Effluent Available (ML)	Mean Rainfall (mm)	Mean Rainfall (ML)	Total Inflow (ML)	Potential Effluent Applied (mm)	Effluent Applied (ML)	Pond Evap. (mm)	Pond Evap. (ML)	Total Losses (ML)	Storage (ML)	Accumulative Storage (ML)
Jan	8	307.5	12.3	20.3	0	0	171	6.8	6.8	13.5	54
Feb	8	380.3	15.2	23.2	0	0	155	6.2	6.2	17	71
Mar	33	237.5	13.5	46.5	0	0	178	7.1	7.1	39.4	110.4
Apr	32	108.2	4.3	36.3	62	16.9	185	7.4	24.3	12	122.4
May	33	16.1	0.6	33.6	174	47.5	205	8.2	55.7	-22.1	100.3
Jun	32	0.5	0	32	183	50	200	8.0	58	-26	74.3
Jul	33	0.2	0	33	190	51.9	207	8.3	60.2	-27.2	47.1
Aug	33	3.1	0.1	33.1	198	54.1	212	8.5	62.6	-29.5	17.6
Sep	32	6.7	0.3	32.3	201	54.9	224	9.0	63.9	-31.6	-14
Oct	33	66.6	2.7	35.7	156	42.6	236	9.4	52	-16.3	-30.3
Nov	32	129.6	5.2	37.2	70	19.1	220	8.8	27.9	9.3	9.3
Dec	28	281	11.2	39.2	0	0	201	8.0	8	31.2	40.5
	337	**1537**			**1234**		**2392**				

Note:- Storage Dam Nominally 200 m x 200 m x 3.06 m
plus 0.5 m (Q100 storm) plus 0.5 m freeboard plus 0.5 to prevent cracking of clay liner

4.4 Land Area Requirement (Based on Nutrient Loadings)

As indicated above the critical design parameter is determined by comparing the area necessary for hydraulic and nutrient loading rate and then selecting the largest area.

The total volume of the nutrient rich effluent to be generated from the proposed processing facility has been calculated as 337 ML per year.

The nutrients in processing effluent are generally regarded as a valuable resource for the growth of crops and fodder. When properly applied the nutrient rich effluent will have beneficial effects on soil fertility generally eg. soil organic matter, soil organisms and physical characteristics such as soil structure.

Note that the Environmental Monitoring Program in Section 13. proposes that treated effluent will be analysed prior to irrigation to enable fine tuning of irrigation practices and the effluent management operations overall.

Table 5. Estimated Mass of Nutrients in Processing Effluent

Effluent Constituent	Concentration (mg/Litre)	Effluent Content (Kg/day)	Nutrients Generated (T/annum)
Total Nitrogen	120	110.76	40.4
Total Phosphorus	40	36.9	13.5

Ref: Meat Research Corporation (1995)

Table 5. estimates the mass of the key nutrients in the effluent generated annually and are based on typical concentrations of these constituents in processing effluent.

The key nutrient uptake rates for a number of crops are outlined in Table 6. below.

Note that Blue Pea is a tropical legume that responds to dry season irrigation and is considered a suitable companion to a tropical grass such as Rhodes Grass, a highly productive perennial grass. A paddock with Rhodes Grass and Blue Pea as a companion crop is high yielding and a gross user of the key plant nutrients in Processing effluent.

Lucerne, another perennial fodder crop, can be grown in the NT and with good management will produce an average yield of approximately 12 tonnes/hectare. It will be a useful option in a rotational cropping program but lucerne is not likely to persist longer than about three seasons due to disease problems arising from the extended seasonal hot and humid weather experienced in the tropical north.

There are a number of other effluent irrigated cropping options outlined in Table 6.

Table 6. Nutrient Content of Harvestable Irrigated Crops & Nutrient Uptake

Crop	Estimated Yield (t/ha)	Nitrogen %	Phosphorus %
Forage Sorghum	15	1.8 (270)	0.3 (45)
Forage Oats	5	1.5 (75)	0.3 (15)
Guinea Grass	22	1.25 (275)	0.44 (97)
Rhodes Grass /Blue Pea	15 10	1.6 (240) 3 (300)	0.16 (24) 0.44 (44)
Lucerne	12	3.5 (420)	0.4 (48)

Note 1. Figures in brackets are kg/ha
2. Refer NSW Agriculture, 1997
3. Ref: Meat Research Corporation (1995)

Table 7. indicates the minimum area required for applications of effluent where applied nutrients are in balance with the nutrients taken up by the various crops and including an allowance of 112 kg/hectare for Phosphorus sorption in the soil profile.

Soil storage is an important sink for Phosphorus and it is well known that many light textured soils in Australia "fix" Phosphorus making it largely unavailable for plant growth. The capacity of a soil to absorb P varies widely but the typical soil to be irrigated with effluent is expected to have a P sorption capacity of in excess 1200 Kg/hectare.

Table 7. Minimum Area (Ha) Required for Application of N & P in Effluent

Crop	Nitrogen[1]	Phosphorus	P + Psorp.[2]
Forage Sorghum	112	300	86
Forage Oats	404	900	106
Guinea Grass	110	139	65
Rhodes Grass /Blue Pea	56	199	75
Lucerne	72	281	84

Note :-
1. A loss of 25 % of applied Nitrogen due to volatilisation is included
2. Includes an allowance of 112 Kg/Ha P sorption in the soil annually – assuming P sorption capacity of 1200 Kg /Ha and a 10 year life of the area for effluent irrigation

Note that a 72 hectare crop of lucerne will take up the mass of nitrogen contained in the effluent from the proposed facility, allowing for a 25 % loss of applied N through volatilisation, and an area of 281 hectares is required to utilise the Phosphorus applied in the effluent. When P sorption of 112 Kg/Ha is added to the equation the area of lucerne required for applied Phosphorus is 84 hectares.

Remembering that the critical design parameter is determined by selecting the largest area calculated, assuming the nominated rate of P sorption, with a Lucerne crop the critical area is determined by the Phosphorus loading rate.

The area of Rhodes Grass/Blue Pea necessary to take up the phosphorus in the effluent (allowing for 112 Kg/Ha of P sorption) is 75 hectares.

In conclusion :-

- Relatively large cropping areas are required to utilise the nutrients applied in the effluent
- Controlling and managing the effluent nutrients is the critical design issue rather than the hydraulic loading
- Additional irrigation water is essential to help maximise the harvestable yield of the crop ie. calculations for hydraulic loading indicate an area of 27.3 hectares is required but to utilise the nutrients in effluent growing lucerne an area of 84 hectares is required (Refer to Section 4.5 and Section 10.3)

As discussed above, the proposed Environmental Monitoring Program, including analysis of effluent prior to irrigating and soils analysis, will verify the quality of the final effluent and help determine the effect of effluent applications.

Application rates and land and soil management practices can then be subject to fine-tuning and be modified to ensure implementation of a sustainable effluent reuse system.

Importantly, the processing facility and waste management infrastructure will only take up approximately 2.5% of the proposed area of land AACo are considering to purchase if the project is to proceed.

4.5 Additional Irrigation Water

The basic objective with any irrigation system is to supply sufficient water to meet the needs of the crop and thereby help to maximise plant productivity and overall crop yield. This cannot be achieved if the plant is under water stress.

Earlier discussions indicate that in planning effluent irrigation schemes the critical design parameter ie. either hydraulic loading or nutrient loading, is that which corresponds to the largest field area requirement.

Calculations show that the real issue is managing and controlling the nutrients in the effluent because these require the largest area.

Table 7. for example, indicates that 84 hectares of lucerne is needed to balance applied P with that taken up in by the crop or sorbed in the soil profile.

The quoted nutrient use and uptake for lucerne assumes that there is enough water ie. rainfall and irrigation to meet the water needs of the crop. As stated above, Table 4. indicates a shortfall of effluent irrigation water late in the irrigation season and this relates to an area of only 27.3 hectares.

These calculations indicate that there is insufficient effluent irrigation water to permit maximum crop yield and therefore without additional irrigation water supply nutrient uptake would be significantly reduced.

The local water balance (See Table 2.) indicates that ~12.3 megalitres of water per hectare is required during the irrigation season from April to November in the average rainfall year. Therefore the additional irrigation water required to grow lucerne is calculated as follows :-

$$\mathbf{W = (A - B) \times I \times D}$$
$$\mathbf{= 56.7 \times 12.34 \times 0.85}$$
$$\mathbf{= \sim 600\ ML}$$

Where	W	Irrigation water
	A	Nutrient application area (84 ha)
	B	Area for hydraulic loading (27.3 ha)
	I	Potential irrigation volume (12.34 ML/ha)
	D	Coefficient allowing for a “deficit irrigation” strategy

Section 10.3 discusses the “deficit irrigation” strategy often employed at cattle processing facilities where irrigation water supply is limiting. Essentially it involves irrigating the available water at the crop growth stage when it is of most benefit to help maximise production and thereby the uptake of applied nutrients.

In terms of sourcing this additional water supply, it is proposed to construct three (3) stormwater runoff dams, to be site immediately below each of the irrigation areas, to harvest wet season runoff from within the property. It is proposed that these dams will each have a volumetric capacity of ~200 ML.

Typical design specifications of these stormwater runoff storage dams is outlined as follows :-

Batter grades	-	1V:3H
Crest width	-	4 m
Width	-	120 m
Length	-	280 m
Depth	-	6 m

Bureau of Meteorology records for Batchelor indicate that there is ~ 1205 mm of rainfall from December to March in the average rainfall year and ~ 731 mm of evaporation in this period giving a difference of ~474 mm.

Assuming a Coefficient of Runoff of 0.85 then a catchment area of ~150 hectares would yield ~ 600 ML.

Additional water would be pumped from the holding dam collecting runoff from the cattle holding yards and composting area ie. a combined catchment of ~2.4 hectares. This additional water is estimated at ~10 ML ie. average rainfall less evaporation in November to March using a Coefficient of Runoff of 0.85.

5.0 CATTLE HOLDING YARDS

Cattle will generally be transported to the plant by road trains with a carrying capacity of about 160 head. The cattle holding yards are to have 1.5 days processing capacity plus 0.5 days capacity for load in ie. a total capacity of approximately 2000 head.

The plan is to have 12 cattle yards of 20 m x 40 m and providing ~5 $metres^2$ per head.

Allowing for access roading above, a cattle laneway and a catch drain below and the unloading pen the overall dimensions of the complex is 280 m x 50 m or 1.4 hectares.

Even though the manure from the cattle holding yards at the proposed facility is to be regularly scraped and cleaned out, the runoff can be heavily contaminated with organic wastes. The regularity of cleaning and manure removal intervals influence sediment accumulation volumes in sedimentation structures.

To help prevent polluted runoff from entering natural waterways a specially designed sedimentation and effluent holding system is to be constructed.

A fundamental requirement with such a system is that the catchment of the holding yards be the minimum necessary and that the area be fully contained as a “controlled drainage area”. Extraneous runon water is to be diverted and safely conveyed away from the cattle complex.

A key component of the system is a sediment removal structure where solids entrained in the runoff are separated from the liquid portion, mainly by settling, prior to the runoff entering the holding dam.

At this site it is intended that there be a common runoff holding dam to retain the runoff from both the cattle holding yards and the proposed composting area (See Section 6.). Stored runoff will be regularly pumped to the large treated effluent holding dam for subsequent disposal by irrigation.

5.1 Sedimentation System

It is proposed that the sedimentation structure comprise a shallow elongated trafficable sedimentation terrace. A trafficable terrace is one that has a concrete entry/exit ramp and compacted gravel bed. The design includes a multi-celled structure to optimise settling of solids and to facilitate removal and clean out.

Cells will be separated by throttle weir structures as will the discharge points to the holding dam. The throttle weir performs as a discharge regulator and helps to reduce flow velocity and thereby promote the settling out of solids/manure.

Note that the important variables in terrace design are the basin volume, bed width and length dimensions, bed slope and discharge regulator flow characteristics. With the intended single vertical slot discharge regulator the most important design parameters are the height and aperture width.

Solids cleaned from the sedimentation system will be incorporated into manure stockpiles and be composted into a stable moist and crumbly dark soil-like product.

The formula for design of sedimentation terraces comprises a calculation of the volume required to achieve significant settling of solids as follows :-

$$\mathbf{V = Qp \times (l/w) \times z / v}$$

where:

	V	=	volumetric capacity of sedimentation terrace
	Qp	=	peak inflow rate (m^3/s) ARI 1 –20 Year (Tc is 12 min.)
	l/w	=	length to width ratio (l is length of direction of flow)
	z	=	a scaling factor (1.0 for this site)
	v	=	maximum flow velocity 0.005 m/s.

Therefore

$$\mathbf{V = Qp \times (l/w) \times z / v}$$

$$\mathbf{= 0.7 \times 8 \times 1 / 0.005}$$

$$\mathbf{= 1120\ metres^3}$$

The proposed 2 cell sedimentation terrace has a design capacity of 1120 $metres^3$. It is proposed that the design of the terrace conform with the following specifications:-

Bank height	-	1.0 m (outside bank)
Batter grades	-	1V:2.5H
Crest width	-	1 m
Terrace width	-	12.5 m
Depth of cell	-	0.9 m
Terrace length	-	100 m

Note :- The designs comply with the *National Guidelines for Beef Cattle Feedlots in Aus.* (Standing Comm. Agriculture and Resource Management, 1997).

5.2 Holding Dam

The purpose of the retention or holding dam is to hold treated runoff for regularly pumping to the large effluent storage dam and thereby prevent its discharge to natural drainage. It is intended as a temporary, short-term holding dam not as an anaerobic treatment pond or evaporation pond.

The approach adopted in designing the holding dam is the major storm design method ie. based on the 1 – 20 year, 24 hr storm event over the area of the yards and composting. Note that it is considered inappropriate to attempt to capture all of the runoff arising from the wet season rainfall. In the event of "catastrophic rainfall" diluted runoff would discharge to natural drainage under high flow conditions.

As there is to be a common runoff holding dam to retain the runoff from both the cattle holding yards and the proposed composting area the design details are outlined in a subsequent part of this document after consideration of the composting area drainage system. Refer to Section 7.0.

6.0 COMPOSTING AREA

As discussed above it is proposed that ~1000 head of cattle will be processed daily and that about 1000 cattle will be held in the cattle unloading and holding yards when the facility is operating at capacity.

It is therefore estimated that approximately 1000 tonnes of manure will be cleaned from the cattle holding yards per year and this by-product, along with the fibrous paunch content, is to be composted into a stable moist and crumbly dark soil-like product.

The composting area will include numerous active stockpiles to be regularly turned and aerated as well as a minimal amount of stockpiled product that has been through the composting process and is ready for transport, mainly for reuse off site.

Similar to the cattle holding yards composting will be carried out on a fully contained and compacted area that forms a "controlled drainage area".

Extraneous runon water is to be diverted and safely conveyed away and stormwater runoff from the composting area will be directed to the runoff holding dam via a specially designed sedimentation structure.

As per the cattle holding yards, a key component of the controlled drainage system is a sedimentation terrace where solids entrained in the runoff are separated from the liquid portion prior to the runoff entering the holding dam.

The runoff is to be piped to the large treated effluent storage dam where it will ultimately be disposed of by irrigation of crops grown for haymaking.

The composting facility will be approximately 150 m x 50 m or 0.75 hectare.

6.1 Sedimentation System

It is proposed that the sedimentation structure comprise a shallow elongated trafficable multi-celled sedimentation terrace.

Cells will be separated by throttle weir structures as will the discharge point to the holding dam.

The formula for design of sedimentation terraces comprises a calculation of the volume required to achieve significant settling of solids as follows :-

$$\mathbf{V = Qp \times (l/w) \times z / v}$$

where:

where:	V	=	volumetric capacity of sedimentation terrace
	Qp	=	peak inflow rate (m^3/s) ARI 1 –20 Year (Tc is 9 min.)
	l/w	=	length to width ratio (l is length of direction of flow)
	z	=	a scaling factor (1.0 for this site)
	v	=	maximum flow velocity 0.005 m/s.

Therefore

$$\mathbf{V = Qp \times (l/w) \times z / v}$$
$$\mathbf{= 0.4 \times 8 \times 1 / 0.005}$$

$$\mathbf{= 640\ metres^3}$$

Therefore the 2 cell sedimentation terrace has a design capacity of 640 $metres^3$.

It is proposed that the design of the terrace conform with the following specifications:-

Bank height	-	1.0 m (outside bank)
Batter grades	-	1V:2.5H
Crest width	-	1 m
Terrace width	-	10 m
Terrace length	-	80 m
Terrace depth	-	0.8 m

7.0 RUNOFF HOLDING DAM

As stated in Section 5.2 the purpose of the holding dam is to temporarily hold the runoff from both the cattle holding yards and composting area before it is pumped to the effluent storage dam and subsequently irrigated onto cropping paddocks.

The stated approach in designing the holding dam is the major storm design method ie. based on the 1 – 20 year, 24 hr storm event.

The design volume of holding dams is calculated as follows :-

V = C x (I x 24) x A

where:	V	=	volumetric capacity
	C	=	Coefficient of Runoff (0.8)
	I	=	Rainfall intensity (mm/hr) of 1 – 20 Yr 24 hour storm (9.21 mm/hour)
	A	=	Area factor inclusive of the sedimentation structures (23.55)

Therefore

V = C x (I x 24) x A
= 0.8 x 221 x 23.55

= 4164 metres³

It is proposed that the design of the structure conform with the following specifications including two identical storage cells (~2100 m³) divided by a common internal wall:-

Batter grades	-	1V:3H
Crest width	-	3 m
Width	-	25 m
Length	-	55 m
Depth	-	3.2 m

Note :- The designs comply with the *National Guidelines for Beef Cattle Feedlots in Aus.* (Standing Comm. Agriculture and Resource Management, 1997).

8.0 COMPOSTING SITE AND OPERATIONS

8.1 Composting Site

It is considered important to summarise a few key features of the proposed composting area to help demonstrate that adverse environmental impacts to surface and groundwaters have been minimised as follows :-

- the site has been selected in part because it is above the land that experiences periodic and seasonal inundation by stormwater and is not flood prone
- extraneous runon stormwater has been diverted away and safely conveyed to natural drainage
- the composting area forms a fully contained “controlled drainage area”
- construction will ensure that a properly compacted clayey base with a gravel surface lining be established to ensure all weather access and to minimise the downwards movement of salts
- a specialised sedimentation system has been incorporated into the design ie. a trafficable sedimentation terrace to separate and settle solids entrained in runoff
- runoff is to be directed to a runoff holding dam before it is regularly pumped to

the effluent storage dam for subsequent irrigation

Note that great care will be taken to not disturb the manure/surface interface during operations on the composting pad because the compacted organic lining that develops is a relatively impermeable barrier to any downwards movement of leachate and salts.

8.2 The Composting Operation

It is considered relevant that a brief description of the proposed composting operation be outlined.

Essentially, the manure and organic matter collected from various sources associated with the proposed facility including the cattle holding yards and unloading area, solids cleaned from sedimentation structures and the fibrous paunch contents from the so called "green stream" are to be subjected to composting.

Composting involves the microbial conversion of biodegradable organic matter over a minimum of 6 weeks into a relatively stable humus by thermophilic organisms under controlled conditions (Aust. Standard AS 4454-1999).

It is generally conducted under aerobic conditions facilitated by regular turning of material stockpiled in windrows to remove released moisture, remove excess heat, release the carbon dioxide generated by the process and to introduce atmospheric oxygen.

The end product of composting is generally described as having the following characteristics :-

- a stabilised product that can be stored or easily spread on farm land
- little odour nor fly breeding potential
- improved physical properties such as relatively uniform particle size, friable texture, reduced volume and weight and low moisture content (<35 %)
- weed seeds and most pathogens have been sterilised
- the three major plant nutrients Nitrogen, Phosphorus and Potassium are generally retained

8.3 Composting System Management

The objective in managing the overall composting system is to minimise any adverse environmental impacts.

The above discussion indicates that the composting site is to be constructed to operate as a fully contained area in relation to surface and groundwater impacts.

Following is an outline of the operational procedures to be implemented in composting :-

- organic matter from the various sources around the facility will be regularly collected, mixed and formed into windrows of ~2 metres high with a base of ~4-5 metres

- the mix of cattle manure and paunch contents will be managed to achieve the ideal Carbon:Nitrogen range for microorganism to decompose organic matter of about 20-30
- the initial pH of the mix will be assessed and if it is found to be too acid ie. < pH 6.0, then a buffering agent or lime will be provided to raise it closer to the ideal of pH 6.5 – 7.2
- temperature is the main determinant of the rate of composting so the temperature is to be regularly monitored using a portable electronic thermometer with a long probe to reach the centre of the pile
- the optimum temperature is ~50-60 ^{0}C so regular turning of the windrow will be employed to stimulate or control heat production
- typically the turning frequency will be as follows :-

1st week	3	turnings
2nd week	2	turnings
3rd week	2	turnings
4th week &		
5th week	1	turning
5th & above	0	turning

- the moisture content for aerobic thermophilic composting should be about 40-60 % so this will be regularly monitored and if the composting material is too dry supplemental water will be added

The minimum composting period is 6 weeks and depending on the composting operation windrows would generally go through a further curing period of another 6 weeks or so prior to transport off site.

9.0 EFFLUENT IRRIGATION SYSTEM

As discussed earlier the basic objective with any irrigation system is to supply sufficient water to meet the needs of the crop, prevent water stress and thereby help to maximise plant productivity and overall crop yield.

When operating an environmentally sustainable effluent irrigation system there are other requirements that have to be met ie. the system needs to match the nutrients applied in the effluent with that taken up by the crop or immobilised in the soil.

As is normally the case with a meat processing facility the critical design parameter here is the nutrient load in the effluent water which significantly increases the land area required over and above that needed based on the hydraulic loading and the local water balance.

Thus significantly more irrigation water is needed for this larger area (not ~27 but ~84 hectares of lucerne) for the crop to reach its yield potential.

It appears that this water will need to be sourced from stormwater runoff and be retained in a series of large storage dams until needed during the long dry season.

9.1 System Requirements

In deciding on an appropriate type of effluent irrigation system there are a number of factors that were considered including the local soil characteristics such as infiltration rate, soil depth, the water holding capacity and readily available water and nutrient immobilisation capacity (P sorption).

Agronomic issues included the type of crop and pasture to be grown, its growth pattern and seasonality, type of root system and rooting depth, as well as nutrient requirements have also been considered.

A key feature of an efficient irrigation system is that it has the capacity to deliver the required water uniformly across the irrigated area, can supply the required capacity needed during the peak summer period and at an application rate that is less than the infiltration rate of the soil.

For a large scale operation such as the one proposed this necessarily means a pressurised spray irrigation system, either a large mobile irrigation machine ie. a centre pivot, and/or a travelling gun irrigator, each dedicated to unique irrigation areas.

9.2 Spray Irrigation Systems

Spray irrigation systems are the most flexible and are generally recommended for effluent irrigation for a number of reasons including :-

- they are relatively easy to set up and manage
- they are suitable for the intended types of crops to be grown, the soil types and the topographic features of the land

Another important factor is that spray irrigation systems result in significant loss to the atmosphere of nitrogen from the system in gaseous form as a result of volatilisation. This is estimated at ~25 % at this location. The net effect of these nitrogen losses is the reduction in area of land needed to balance applied nitrogen with that taken up.

Centre Pivot Machines

These large mobile irrigation machines, being self propelled, require less labour than alternative systems. As well, centre pivot machines are particularly useful for the frequent watering needed when water is limiting and, as in this case, where a strategy of "deficit irrigation" is to be employed.

Another obvious advantage with centre pivot machines is that after completing a duty circuit the machine is back at its starting point and in place to begin the next watering.

Travelling Irrigators

Travelling irrigators have a single spray head with a large rain gun and rely on the irrigator head being moved across the field by a winch arrangement driven by a water turbine which obtains its power from the flow of water on its way to the irrigator.

Because they require high water pressure they have high operating and power costs.

A problem can be that the large jet of water can be affected by medium to strong wind leading to uneven watering and the risk of nuisance to neighbours from spray drift. This can be overcome by only watering during calm weather and ensuring adequate buffer distances to property boundaries.

Travelling irrigators are popular because of the relative simplicity of their mode of operation.

10.0 IRRIGATION MANAGEMENT

This section outlines a number of key operational requirements for managing the effluent irrigation system.

10.1 Nutrient Management

The management of the nutrients in treated effluent, not the water, is the main issue for sustainable effluent irrigation.

Earlier sections of the report have discussed the fact that processing effluent contains high levels of both nitrogen and phosphorus. The treatment ponds do not remove significant quantities of nitrogen or phosphorus but mainly act in reducing the BOD (reflective of organic matter) in effluent and convert organic nitrogen (proteins) into ammonium.

Nitrogen goes through a number of transformations ie. proteins are mineralised to form ammonia and ammonia is transformed by nitrification into nitrates. It is this nitrate form of nitrogen that is the plant available form ie. it is in solution where it can be taken up via plant roots.

Thus nitrate nitrogen can also become a pollutant because it is readily transported by runoff to natural watercourses or through drainage from soils to groundwater. This is why it is important to carefully balance the nitrogen irrigated in effluent with that quantity taken up and removed from the soil/plant system in haymaking operations.

With regard to the other major nutrient in effluent ie. phosphorus, the main way that phosphorus becomes a pollutant is when soil material is transported off site by soil erosion.

Because phosphorus compounds in solution are readily sorbed to clay particles they can become fixed or immobilised within the soil profile.

Note that laboratory test results confirm these soils have a good P sorption capacity (Refer to the Site and Soils Report submitted as part of the application documents).

Preventing soil erosion eg. by using land according to its capability, minimising soil disturbance and being mindful of the need to retain a protective surface cover, is important in operating an environmentally sustainable irrigation system.

To determine the key constituents in treated effluent and to facilitate proper irrigation management practices it is intended that the effluent be regularly analysed. Refer to Table 8. which lists the effluent analysis parameters.

Decisions on the area over which irrigation will be undertaken ie. allowing for sustainable nutrient application rates, as well as consideration of the water volumes available will determine the need for special irrigation practices such as "deficit irrigation". Refer to Section 10.3.

Table 8. Effluent Analysis Parameters

Test Parameter	Comment
Total Nitrogen	Measures nitrogen for calculating N balance ie. that applied & removed in hay
Ammonium-N	Measures nitrogen available or potentially lost through volatilisation
Nitrate-N	That nitrogen in solution & readily available to plants
Total Phosphorus	Measures phosphorus for calculating P balance ie. that applied & removed in hay
Electrical Conductivity & Chloride	Effluent salinity
Sodium Absorption Ratio	Effluent sodicity

10.2 Irrigation Scheduling

The key to irrigation cropping is in scheduling the application of water so that the crop always has sufficient water for growth ie. normally water lost by evapo-transpiration is replaced when the soil moisture holding capacity is depleted by about 50 %.

As discussed, irrigating with effluent is different to this scenario because it is dictated by nutrient application rates and the shortage of water will mean operation of a deficit irrigation regime.

Practical operation of the irrigation system requires knowledge of the soil type and profile depth, rooting depth of the crop or pasture and the available water capacity of the soil ie. mm water/metre depth of soil.

AACo plans to establish a water balance measurement and recording system to track soil moisture and help make decisions on when and how much irrigation water to apply.

Naturally, within the design and limits of the irrigation system, the operation will endeavour to avoid under watering and thus retarding crop growth, as well as over watering, causing surface ponding, runoff and/or deep drainage of applied water from the soil profile.

10.3 Deficit Irrigation

The effluent irrigation system will operate under a deficit irrigation regime.

An irrigation system employing a deficit irrigation strategy generally has the following characteristics :-

- water is applied more frequently than normal (every 2-3 days) and in smaller quantities
- the top 30 cm of soil is maintained at >50 % of the moisture storage capacity for the first 2-3 weeks after planting a crop
- in dry weather, frequent irrigations are carried out aiming to maintain the moisture content of the top 30 cm of soil above 30 % of capacity
- irrigation only ever supplies up to 85 % of the soil moisture storage capacity
- the limited water is applied at the crop growth stage when it is of most benefit eg. the sensitive stage for lucerne and perennial pastures is just after hay is made and with cereal crops it is generally at flowering and seed formation
- almost full crop production can be achieved with a 15-30 % saving on the normal irrigation requirement (MRC, 1995)

Calculations in Section 4. indicate that to achieve a nutrient balance using treated effluent the land area required is approximately three (3) times the area needed to balance the hydraulic loading ie. ~84 hectares versus ~27 hectares.

The monthly water balance (Table 2.) indicates that ~12 megalitres of irrigation water per hectare is required during the dry cropping season.

Even adopting a deficit irrigation strategy it is apparent that additional irrigation water in the order of ~ 500-600 megalitres is required.

To address this situation it is intended that a series of three (3) ~200 ML storage dams will be designed and constructed. These dams are to be sited downgradient of each of the irrigation areas to harvest wet season stormwater runoff.

10.4 Irrigation Management Plan

AACo intends that a site specific Irrigation Management Plan will be developed detailing the necessary procedures to maintain optimal performance of the effluent irrigation system and ensure that any adverse environmental impacts are minimised.

Best management practices will be employed to ensure that the system is environmentally sustainable including nutrient management, irrigation scheduling and deficit irrigation strategies and the all important monitoring program (Refer to Section 13.) to demonstrate the environmental performance of the system.

In addition to, and to compliment the targeted monitoring of the soils, groundwater and surface waters detailed in Section 13. a documented operational, management and control system will be developed including details on the following :-

- the effluent treatment system performance
- irrigation operations including the water balance & irrigation scheduling
- quantification of nutrients generated & nutrient balancing
- crops/pasture yields (harvested as hay or forage)
- the salt balance and leaching
- crop/pasture management including a 3-5 year rotational plan
- soil erosion control
- buffer zones & vegetative screens
- composted solids
- reporting on scheme performance

In discussing the sustainability of the effluent irrigation system it is noted that grazing of cattle is not a viable nutrient removal practice because over 90 % of the nutrient in feed is returned to the land in manure.

11.0 SEWERAGE TREATMENT SYSTEM

Similar to other cattle processing facilities around the country the sewerage treatment system will comprise concrete sealed primary septic tanks where the outflow will be piped direct to the effluent treatment ponds for further treatment.

As per information outlined in Section 4. the system allows for in excess of 30 days of effluent treatment, useful for pathogen control. Importantly, the effluent irrigation system is not to be used for food production but will be used on crops grown for haymaking for cattle feed.

Safeguards and public health controls will include :-

- Irrigation areas will be left for a minimum withholding period of 4 hours or until the area has dried out before they are accessed

- Effluent application controls will help prevent spray drift
- Vegetated buffer zones will be established between irrigation areas, the property boundary and public areas
- Irrigation areas will be fenced with signage to restricting public access

12.0 SALT EVAPORATION SYSTEM

As in other similar facilities salting of hides is to be carried out in a separate fully contained and bunded hide shed located adjacent to the rendering plant.

This area would occasionally undergo a washdown process where the salty effluent would be collected and transported in a sealed tank to the salt evaporation structure.

The salt evaporation pans will comprise a concrete lined and fully covered two (2) celled structure where evaporation and filling takes place periodically in the alternative sections. The properly sealed concrete evaporation structure is to have double ended trafficable entry/exit ramps to facilitate recovery of the dried salt.

Dried salt will be transported off site for either recycling or go to an approved waste disposal facility.

13.0 ENVIRONMENTAL MONITORING PROGRAM

A Monitoring Program has been proposed with the objective of keeping a check on the effectiveness of the operational and management practices employed on site and to detect trends that may develop eg. re soil fertility of the irrigation areas, quality of the groundwater and the quality of the surface water naturally discharging from the site.

The intention is that AACo will establish and maintain documented procedures to regularly monitor and measure the key characteristics of its operations and activities that can have a significant impact on the environment. A documented record system of information that tracks performance will be established.

Additionally, a system for periodic review of performance against AACo's environmental objectives and targets will be implemented and will incorporate an evaluation of compliance with relevant environmental legislation and regulations.

Monitoring and recording will be undertaken relating to the following environmental parameters :-

- soils across the effluent irrigation area, both topsoils and subsoils
- groundwater ie. via a network of piezometers site both upgradient and down of the key components of the facility
- surface waters ie. again both up and down gradient of key components of the facility

The basic philosophy with the program is to monitor to detect any significant change and to follow up with more detailed analysis as necessary.

As more data becomes available, and if no significant adverse trends develop, then the frequency of monitoring can become more relaxed to annual or biennial sampling and laboratory analysis.

13.1 Risk Assessment

This monitoring program is the result of a risk assessment process that considered :-

- the site and soil limitations (Refer to Site & Soils Investigation Report to be submitted as part of the application documents)
- the mass of by-products to be generated
- the proposed design and management of the reuse area
- the level of risk of adverse environmental impacts from the reuse system.

The main outcome of the risk assessment process is targeted environmental monitoring to measure environmental sustainability. See Table 9, 10 & 11.

The monitoring program also reflects experience with regulatory practices typically applied to a number of similar existing facilities.

Table 9. Soil Analysis Parameters

Test Parameter	Depth	Frequency	Comment
pH	S & P	Annually	A large influence on nutrient availability
Electrical Conductivity	S & P	"	Indicates soil salinity
Effective Cation Exchange Capacity	S & P	"	Indication of overall soil fertility
Exch. Cations	S & P	"	Important to know proportions of cations
Total Nitrogen	S & P	"	A measure of soil fertility
Nitrate-Nitrogen	S & P	"	Measures nitrogen available for plant uptake
Avail. Phosphorus	S & P	"	Measures phosphorus available for plant uptake
P sorption capacity	P	Initial test then 3 years	Indicates the ability of clayey soils to immobilise phosphorus
Organic Carbon	S	"	Influences soil stability

S – Surface 0.0 – 0.1 metres
P – Profile @ Base of Root Zone (~0.8-1.0 metres)

There are a number of general principles for sustainable effluent and solids reuse that have been considered in determining the level of risk associated with the proposed reuse operations.

These general principles are outlined as follows :-

<u>Resources Use</u>

The resources in the processing effluent and solid by-products such as water, nutrients & organic matter should be identified and quantified and an agronomic system developed to beneficially use these valuable resources.

Soil Protection

An effluent irrigation or solids reuse system should be ecologically sustainable ie. it should at least maintain the capacity of soil to grow crops or pastures and not result in soil degradation, for example, through soil structural decline, salinisation, chemical contamination, soil erosion or otherwise.

Groundwater Protection

An effluent irrigation or solids reuse system should be designed and operated as a beneficial reuse system, not degrade groundwater and ensure that current and potential future utilisation of groundwater resources is not diminished by reuse.

Protection of Surface Waters

An effluent irrigation or solids reuse system should be designed and operated to ensure that surface waters do not become contaminated by effluent, sediment overflow or contaminated stormwater runoff.

Prevention of Public Health Risk

An effluent irrigation or solids reuse system should be sited, designed and operated so as not to compromise public health with consideration given to provision of an adequate buffer distance or vegetative barrier to help prevent human exposure to pathogens or contaminants.

Community Amenity

The system should be located, designed and operated to avoid unreasonable interference with any residential and commercial activity or the comfortable enjoyment of life and property off-site with special consideration given to odour, dust, insects and noise.

Table 10. Groundwater Monitoring

Test Parameter	Unit of Measure	Frequency [1]	Comment
pH	no units	Annually	A measure of acidity or alkalinity
Available Phosphorus	mg/L	"	Measures phosphorus available for plant uptake
Electrical Conductivity	dS/m	Quarterly	Indicates salinity
Nitrate-Nitrogen	mg/L	"	Nitrate-N is readily transported in water
Standing Water Level	metres	"	Often fluctuates seasonally

1. Piezometers should be installed to establish baseline data

13.2 Suitability of Reuse Areas

Overall, the risk assessment determined that the reuse areas satisfy a number of the preferred soils and land resource requirements eg. the soils have the following characteristics :-

- loam to medium clay texture
- moderately deep to deep
- not subject to erosion
- well drained
- flat to gently sloping
- slightly alkaline to slightly acidic pH
- suitable for growing pastures or forage crops

13.3 Annual Reporting

It is proposed that the results from the monitoring program will be presented in an Annual Environmental Monitoring and Management Report.

It would include an interpretation of the data collected, indicate the effectiveness of the reuse system and outline a Plan of Management for the ensuing year.

Table 11. Surface Water Monitoring

Test Parameter	Unit of Measure	Frequency [1]
pH	no units	Medium – High Flow
Total Phosphorus	mg/L	"
Available P	mg/L	"
Electrical Conductivity	dS/m	"
Total Nitrogen	mg/L	"
Nitrate-Nitrogen	mg/L	"

1. Surface waters to be analysed several times before reuse commences, during medium-high flows & following rainfall (carefully), to help establish baseline data

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