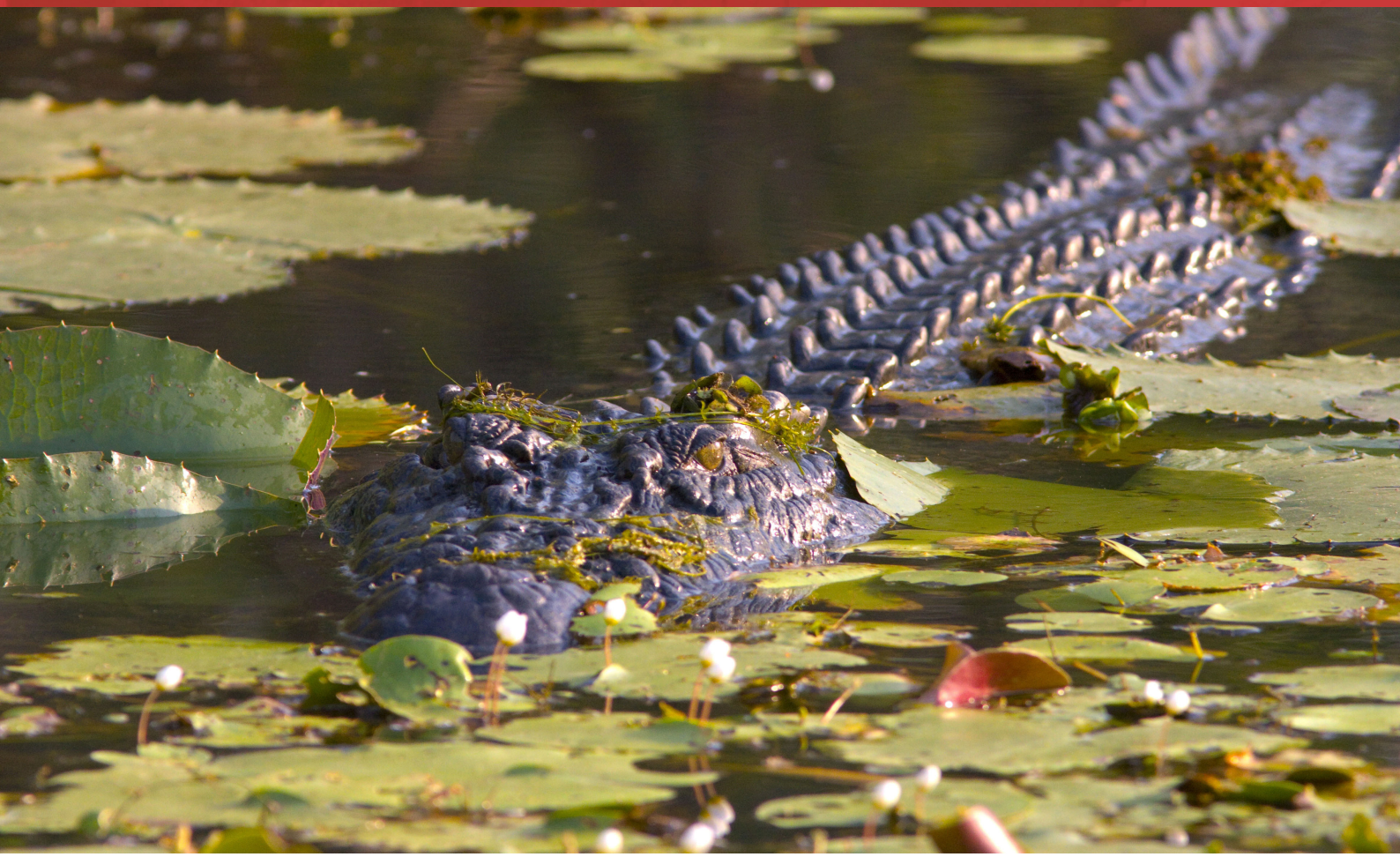
Supporting Information for the Lambells Lagoon Crocodile Farm EPL320 Amendment

PRI Farming Pty Ltd



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DOCUMENT CONTROL RECORD

Job	EZ19153
Document ID	205813-25
Author(s)	S. Barber

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	Emma Lewis	Emma Lewis	PRI Farming	10/11/2020
2	Ray Hall	Ray Hall	PRI Farming & NT EPA	24/03/2021
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Appendix B Baseline Surface Water Quality Results
Appendix C Baseline Groundwater Quality Results
Appendix D Irrigation Managemet Plan

ACRONYMS

AAPA	Aboriginal Areas Protection Authority
BOM	Bureau of Meteorology
BUD	Beneficial Use Declaration
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CCF	Cairns Crocodile farm
CEMP	Construction Environment Management Plan
CSM	Conceptual Site Model
DA	Development Application
DCF	Darwin Crocodile Farm
DENR	Department of Environment and Natural Resources (Northern Territory) – now DEPWS
DEPWS	Department of Environment, Parks and Water Security – formerly DENR
DITT	Department of Industry, Tourism and Trade – formerly DPIR
DIPL	Department of Infrastructure, Planning and Logistics – now DITT
DLRM	Department of Land Resource Management (Northern Territory) – now DEPWS
DOEE	Department of the Environment and Energy (Commonwealth)
DO	Dissolved Oxygen
EC	Electrical Conductivity
EPA	Environmental Protection Approval
EPL	Environmental Protection Licence
EPO	Environmental Protection Objective
ERT	Emergency Response Team
EPBC Act	Environment Protection and Biodiversity Conservation Act (1999) (Commonwealth)
ESCP	Erosion and Sediment Control Plan
GDE	Groundwater Dependent Ecosystem
GEL	Groundwater Extraction Licence
GHG	Greenhouse Gas
GSM	Global System for Mobile Communication
HDPE	High-density Polyethylene
IMP	Irrigation Management Plan
JCF	Janamba Crocodile Farm
LCF	Lagoon Crocodile Farm
MEDLI	Model for Effluent Disposal using Land Irrigation
NOI	Notice of Intent
NT	Northern Territory
NT EPA	Northern Territory Environmental Protection Authority
NT PFES	NT Police, Fires and Emergency Services
PEX	Cross-linked Polyethylene
PRI	Primary Resources Investments
PVC	Polyvinyl Chloride
SDS	Safety Data Sheets

SOCS	Site of Conservation Significance
SWL	Standing Water Level
TPWC Act	Territory Parks and Wildlife Conservation Act (Northern Territory)
TRH	Total Recoverable Hydrocarbons
WCD	Water control district
WMPC Act	Waste Management and Pollution Control Act (Northern Territory)
WoNS	Weed of National Significance

1 INTRODUCTION

PRI Farming Pty Ltd (PRI) propose to operate the Lambells Lagoon Crocodile Farm, here-in referred to as the "Project", for commercial production of saltwater crocodiles (*Crocodylus porosus*) for meat and skin products. The site is located in the Lambells Lagoon area on Section 1611 and 1688 Hundred of Guy, at the end of Alphatonia Road, 5.5 km north of the Arnhem Highway (Figure 2-1).

The Project is currently in construction and will be operated in two stages. Stage one encompasses the incubation, hatchery and auxiliary infrastructure. Stage two encompasses the grow-out pens, finishing pens, auxiliary infrastructure and water management infrastructure (Figure 2-2).

This document presents information to support an amendment to Environmental Protection Licence (EPL320) stage one - operation of the incubation and hatchery, to incorporate stage two – the growers, finishers and wastewater management system.

The document structure addresses the information requirements specified in the NTEPA's *Guide to Environment Protection Approvals and Licences Under the Waste Management and Pollution Control Act* (NTEPA, 2013).

1.1 Purpose and scope

The nature of the crocodile farming operation results in the generation of animal effluent, a listed waste under Schedule 2 of the Waste Management and Pollution Control (Administration) Regulations. In accordance with the requirements of the NT *Waste Management and Pollution Control (WMPC) Act 1998*, PRI is applying for an amendment to EPL320 to address the storage, treatment, recycling and disposal of animal effluent for the whole of farm system.

This supporting document has been developed as an Operational Environmental Management Plan (OEMP) to establish a framework for identification, management, monitoring and reporting of potential environmental impacts associated with the stage one project operations.

The objectives of this plan are:

- To prevent or minimise pollution or environmental harm from the stage one operational activities.
- Ensure that the premise is operated in a manner that provides for suitable storage, treatment and recycling of the wastewater from animal effluent and residues (a listed waste), so that the future operational activities can be licensed under the NT *WMPC Act.*
- To adhere to conditions of applicable licence approvals and permits.

1.2 Approvals

Environmental assessment

A Notice of Intent (NOI) was submitted to the NT EPA during February 2020 for assessment under the NT *Environmental Assessment (EA) Act 1982.* The NT EPA assessment of the NOI determined that the potential environmental impacts and risks associated with the proposal were not significant and that the proposal did not require assessment under the *EA Act.*

Development permit

Under the NT *Planning Act 1999*, a Development Permit (DP20/0217) was approved for Section 1611 and 1688 Hundred of Guy, 255 and 405 Alphatonia Road, Lambells Lagoon by the NT Development Consent

Authority, on the 27 August 2020. The DP20/0217 approved land use for the purpose of intensive animal husbandry (crocodile farm) in accordance with the DP conditions and endorsed plans.

Environmental Protection Approval and Licence

Construction and operation of the Project will be regulated under the *WMPC Act* because the water discharged from the crocodile pens will contain crocodile effluent, faeces, residual feed and other 'crocodile wastes', which are classified as 'animal effluent and residues' and therefore are a **listed waste** under the Act. An Environment Protection Approval (EPA) for works associated with construction of the premises has been granted on the 06 October 2020 (approval number EPA306-01). An Environment Protection Licence (EPL) has been granted for the operation of stage one hatchery on the 12 April 2021 (EPL320). An amendment to this EPL is required for the Crocodile farming operations to incorporate stage two – the growers and the finishers. The crocodiles in the hatchery are required to be transferred to the grower pens incrementally from November 2021. This document provides supporting information for the whole of farm operations (stage one and stage two). EPL amendment approval is required prior to the transfer of the crocodiles from the hatchery into the grower pens.

Land access

The land for the Project (Section 1611 and 1688), is privately owned, freehold land, purchased by PRI on the 21 September 2020. No other land access agreements are required.

Water Extraction

As a requirement under the NT *Water Act 1992,* a Groundwater Extraction Licence (GEL) is required for the extraction and use of water. PRI Farming is the licence holder of GEL Licence no. HGS10000 (Expiry 2050), which allows a maximum extraction entitlement total of 3,216 ML/year.

2 SITE DESCRIPTION AND EXISTING ENVIRONMENT

2.1 Location

The site of the Crocodile Farm is located in the Lambells Lagoon area on Section 1611 and 1688 Hundred of Guy, west of Alphatonia Road (Figure 2-1). The closest main highway is the Arnhem Highway (approximately 5.5 km away). The nearest town to the project area is Humpty Doo, approximately 17 km south west.

2.2 Site history and land use

The Project area is zoned horticulture, has been largely previously cleared and has a history of irrigated horticulture production with fertile, well-drained soil. Land to the west of section 1688 is zoned Agriculture (A) and is part of Koolpinyah Station. The Project area is located between two Conservations Reserves, the Black Jungle to the west and Lambells Lagoon to the east (Figure 2-1).

2.3 Surrounding land and sensitive receptors

The surrounding horticultural zoned land is comprised of fruit farming businesses (Darwin Fruit Farms) approximately 1 km to the north-east, and a nursery (Darwin Plant Wholesalers) and volunteer fire brigade station located approximately 1 km to the south. In addition to the horticultural infrastructure, there are multiple buildings on neighbouring properties to the south of the irrigation and farming operations areas, where neighbours may reside. Alphatonia Road is immediately to the east of section 1611 and 1688. Other surrounding land users accessing Alphatonia Road past the Project includes the Koolpinyah Station.

Because the project area is cleared of native vegetation, it does not support any significant sites or features. There are significant floodplain and wetland ecosystems in the surrounding areas, which are described below.

2.3.1 Adelaide River floodplain

The project area is located within the lower Adelaide River catchment and is surrounded by the Adelaide River coastal floodplains. The floodplain is designated as a Site of Conservation Significance (SOCS) by the NT Government. It is comprised of a mix of tidal and seasonal wetland habitats, with dominating vegetation such as grass and sedge communities and is edged by open woodland with pockets of monsoon forest. The floodplain is recognised as internationally significant due to its contribution to supporting a large number of water bird species, such as Magpie Goose (*Anseranas semipalmata*) and Whistling-Ducks.

The Adelaide River SOCS boundary encompasses the project area, which has been mostly cleared, except for approximately 23 ha of remnant Eucalyptus woodland vegetation. Because of the pre-existing clearing and landuse, the project area does not encompass habitats of recognised conservation value or significance within the SOCS.

2.3.2 Black Jungle and Lambells Lagoon

The Black Jungle Conservation Reserve borders the western boundary of the project area. Black Jungle is a surface water ecosystem that is supported by groundwater within the Howard Groundwater System during

the dry season (DENR 2018b). This reserve protects significant species and habitats, and access is currently restricted to scientific research, organised groups with permits, and licensed operators collecting crocodile eggs (Parks and Wildlife, 2014).

Lambells Lagoon Conservation Reserve borders the eastern boundary of the project area. The reserve is designated as a recreational hunting area and is a popular bird watching area outside of the hunting season (Parks and Wildlife, 2014).

2.3.3 Fogg Dam

Approximately 1.8 km east of the project area is the Fogg Dam Conservation Reserve, which protects a manmade dam that provides important year-round habitats for water birds. The wetland wildlife and habitats at Fogg Dam are a key tourist attraction in the region.

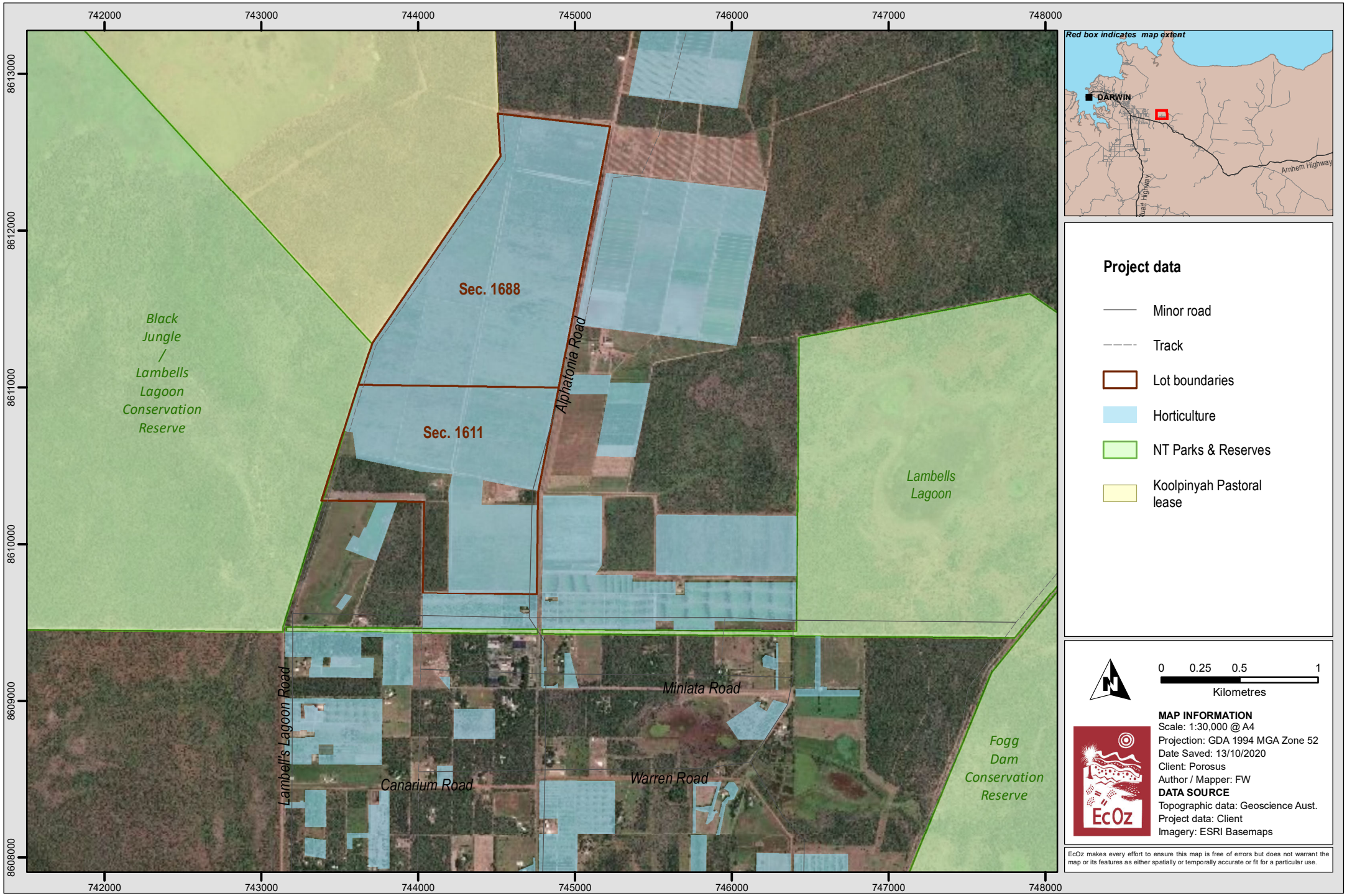


Figure 2-1. Map of Lambells Lagoon Crocodile Farm Project location

LEGEND

- PROPERTY BOUNDARY
- S — EXISTING SEWER
- W — EXISTING WATER
- E — EXISTING ELECTRICAL
- EXISTING SURFACE CONTOUR
- STAGE LIMIT OF WORKS

STAGE 2

RETENTION BASIN

PLANT ACCESS TRACK

RB 04

RB 05

GROWER AND FINISHER PENS

PL 04

PAD 01

PAD 03

PAD 02

STAGE 3 (NOT PART OF SCOPE)

ALPHATONIA ROAD

PROPOSED ACCESS TRACK ROAD 01

EXISTING ACCESS TRACK

PROPOSED ACCESS TRACK ROAD 02

EXISTING ACCESS TRACK

PROPOSED ACCESS TRACK ROAD 03

EXISTING DETENTION BASIN CULVERT OUTLET

EXISTING DETENTION BASIN

STAGE 1

EXISTING SEALED ACCESS

OPEN DRAIN

OUD 05

ROAD 0506

STAGE 2 (NOT PART OF SCOPE)

PROPOSED ACCESS TRACK

HAT 01

HATCHLING PAD

25 0 25 50 75 100 125 m

Scale 1 : 2500 @ A1

CONSTRUCTION

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AMENDMENTS

Project: CROCODILE FARMING PROJECT
Client: SITZLER
Address: SEC 1611 (255) ALPHATONIA ROAD, HUMPTY DOO NT 0836

Drawing:
Figure 2-2. Map of Lambells Lagoon Crocodile Farm site layout

Project Date:	Scale:	Designed/Drawn	Checked:	Sheet Size:
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Job No:	Sheet No:	Revision:
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2.4 Land suitability

2.4.1 Climate

The region of the project area experiences a tropical climate with a distinct dry season (May to October) and wet season (November to April). Typically, for this region, humidity, maximum and minimum temperatures are highest in the wet season, and annual evaporation far exceeds annual rainfall.

Rainfall and evaporation

Rainfall and evaporation data is sourced from the Bureau of Meteorology (BoM) weather monitoring station at Middle Point Rangers (station number 014090), located approximately 7 kms to the south-east of the Project area. Climate data from the Middle Point Rangers has been extracted from SILO, (a climate database managed by the Queensland Department of Environment and Science). Data used is from 1950 to 2019 to account for recent impacts of climate change that may affect the model outputs.

Average annual rainfall recorded at Middle Point Rangers station is 1481.1 mm with the highest rainfall occurring in January and the lowest in July. The average annual evaporation is 2,190.0 mm, exceeding the average annual rainfall. Evaporation is highest in October and lowest in February (Table 2-1).

Table 2-1. Average rainfall and evaporation (SILO)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Pan Evaporation (mm)	160.7	141.7	158.5	169.3	178.7	173.3	183.9	204.6	217.4	226.9	195.9	180	2190.9

Wind

Wind direction and wind speed (km / hr) data has been retrieved from the Darwin airport weather station (Site number: 014015). Wind rose data from January 1942 to April 2019 is available (refer to Table 2-2 and Table 2-3).

For the Darwin area, the wet season wind direction in the morning is predominantly calm (12%), with winds variable from westerly, easterly and south easterly direction. During the afternoon, the winds are predominantly north westerly, westerlies and to a lesser extent, northerlies. Dry season wind in the morning is predominantly south easterly and easterly direction, and in the afternoon, the winds are variable between north westerly, northerly and easterlies.

Table 2-2. Darwin Airport wet season wind rose

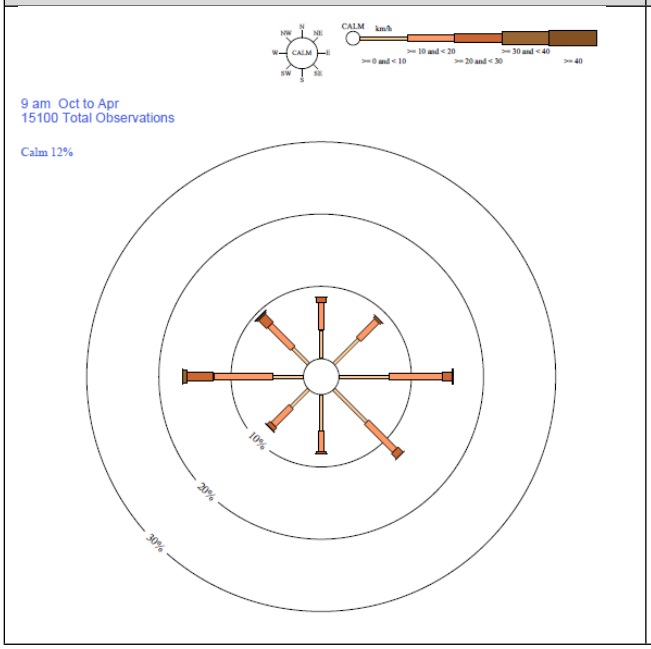
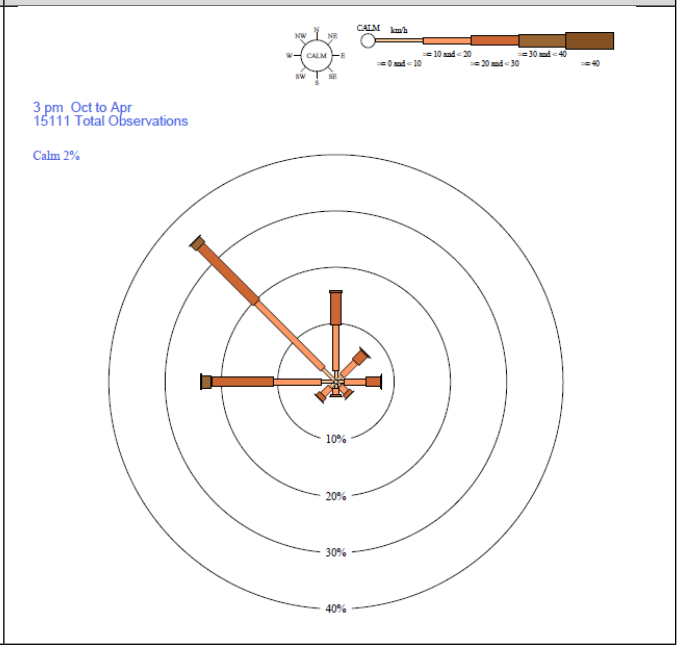
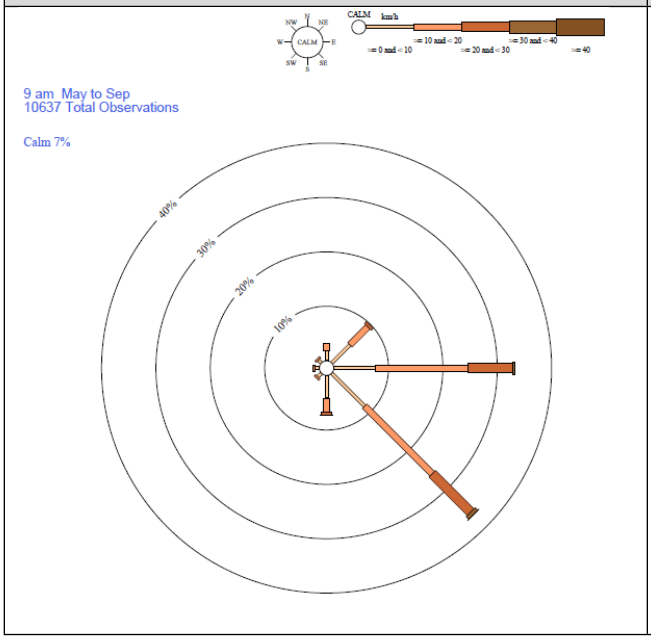
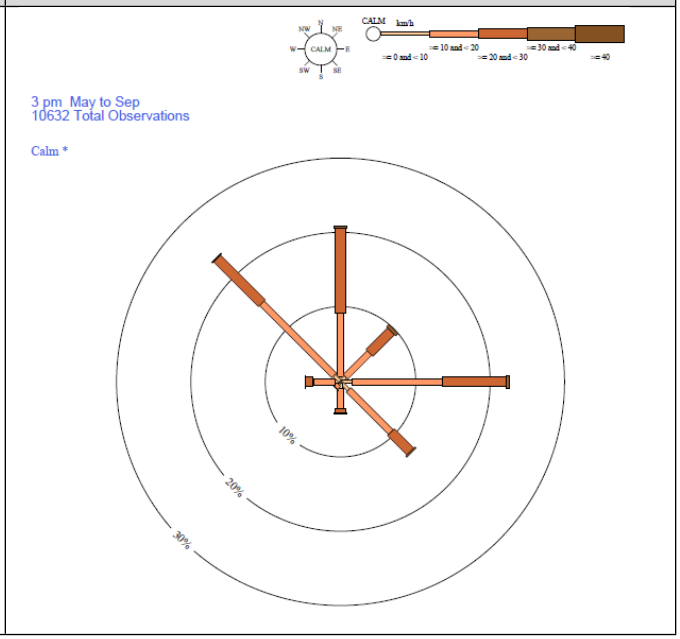
Wet Season (Oct to Apr) 9am	Wet Season (Oct to Apr) 3pm
	

Table 2-3. Darwin Airport dry season wind rose

Dry Season (May to Sep) 9am	Dry Season (May to Sep) 3pm
	

Source: Bureau of Meteorology, Commonwealth of Australia 2019.

2.4.2 Flooding

The Project area is unlikely to flood. The area has been currently cleared and has a series of well-established network of drains. The two Conservation Reserves in the adjacent land are wetland (floodplain) areas, and the receiving waters for surface shed from the project area.

2.4.3 Topography and drainage

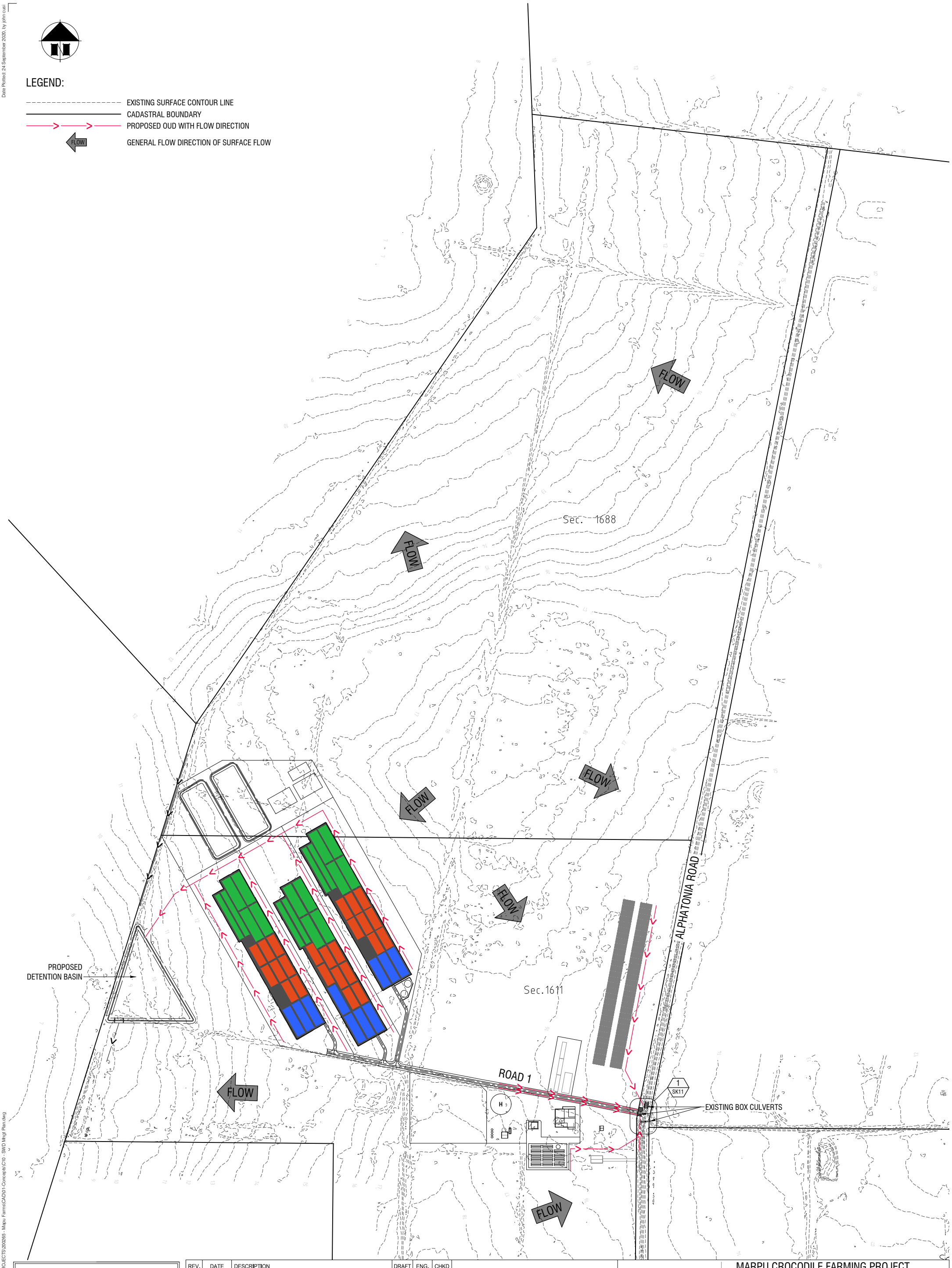
The majority of the Project area is relatively flat with a gradient of <2 %. The Project area is moderately well-drained allowing adequate infiltration and minimal surface water runoff. The established network of drains is designed with gentle sloping for the gradual movement of water shed off-site.

There are no water bodies or waterways in the Project area. There are existing constructed drainages that collect and direct overland flows towards the property boundaries (Figure 2-3). Surface water drainage from the stage one area sheds to the east through existing box culverts under Alphatonia road, flowing towards Lambells Lagoon. The northern portion of the project area (section 1688) flows to the north-west into Black Jungle Swamp. The south-west section of 1688 and western portion of section 1611 (primarily stage two) flows to the south-west into a drainage line flowing into Black Jungle CN. Overland flows in the eastern parts of sections 1611 and south-east corner of section 1688 drain to the east towards Lambells Lagoon.

Date Plotted: 24 September 2020, by john cusi

LEGEND:

- EXISTING SURFACE CONTOUR LINE
- CADASTRAL BOUNDARY
- PROPOSED OUD WITH FLOW DIRECTION
- GENERAL FLOW DIRECTION OF SURFACE FLOW



FOR INFORMATION ONLY

NOT FOR CONSTRUCTION

40 0 40 80 120 160 200 m

Scale 1 : 4000 @ A1

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	17.09.2020	ISSUED FOR INFORMATION	JC	RAH	RAH

Figure 2-3. Map of Lambells Lagoon Crocodile farm stormwater drainage

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MARPU CROCODILE FARMING PROJECT
SEC 1611 (255) ALPHATONIA ROAD
LAMBELLS LAGOON, HUMPTY DOO, NT 0836

STORMWATER DRAINAGE MANAGEMENT PLAN

A1		DRAWING NUMBER Project Number	Sheet No.	Rev.
Design JC	Drawn JC	200265	SK10	A

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2.4.4 Soil and vegetation

Overall, soil testing, site visual observations and the extensive history of the land utilised for irrigated horticulture, indicates that the soil and land is suitable for irrigated crop production.

Soil sampling undertaken (Figure 2-4) during January 2020 identified the following:

- Soil colour was predominantly classed very dark grey and very dark brown and soil texture is predominantly clay loam.
- The soils are non-saline, with a low Electrical Conductivity (EC) (<45 µS/cm) and average pH of 6.66.
- The soils are classified as non-sodic (<6) with an average exchangeable sodium percentage (ESP) of 0.5 %.
- Soils are dispersion class 3 (class 1 being complete dispersion), and 12 of the 13 sample results are emerson class number 3. Standard erosion and sediment controls will prevent soil loss through dispersion and runoff.
- Nutrient values are within the acceptable range compared to the National Environmental Protection Measure (NEPM) guidelines for soil (2013) and the preferred levels for crop/plant growth (NSW DPI, 2004) with the exception of Total Phosphorus (TP) levels, outside of the preferred levels for crop/plant growth (20 – 30 mg/L) with a range of 128 mg/L to 500 mg/L.
- All metals are within acceptable guideline limits compared to the National Environmental Protection Measure (NEPM) guidelines for soil (2013) and the preferred levels for crop/plant growth (NSW DPI, 2004).

See Appendix A for all soil quality results.

Approximately 90% of the project area is cleared and has in the past been planted with various horticultural crops. Predominantly, the remnant vegetation is Eucalyptus woodland and surrounding vegetation varies from open woodland, woodland and open forest.

2.4.5 Pests and weeds

Where areas have previously been cleared the land is heavily weed infested, with namely Gamba Grass (*Andropogon gayanus*) and Mission grass (*Cenchrus sp*.) and is encroaching on the remnant vegetation areas. Gamba grass and Perennial Mission grass (*Cenchrus polystachious*) are declared weeds, and Gamba grass is a Weed of National Significance (WoNS). Additional declared weeds at the Project area, as recorded on NR Maps include, Hyptis (*Hyptis suaveolens*) and Snake weed (*Stachytarpheta sp*.).

2.4.6 Biting insects

Floodplain environments, such as the surrounding area Adelaide River floodplain system, Lambells Lagoon and Black Jungle Conservation Reserves, are areas where biting insects (mosquitos, midges etc.) are common. Distribution and abundance vary seasonally. Water in the crocodile pens is unlikely to provide mosquito breeding habitat as it will be chlorinated and regularly replaced. The farm stormwater drainage design and operational procedures for wastewater irrigation will incorporate controls to minimise pooling of water that could lead to creation of mosquito breeding habitat. Management practices avoids the creation of shallow stagnant water where biting insects are likely to breed. This includes the routine cleaning schedule and constant water flows through the pens. Irrigation areas will be designed and managed to minimise the creation of mosquito breeding habitat (i.e. avoid oversaturation and pooling of water).

2.4.7 Surface water

Beneficial uses and water quality objectives

The project area is located within the lower Adelaide River catchment and is surrounded by the Adelaide River coastal floodplains. The surface water and groundwater resources in the area are covered by the Darwin Rural Water Control District declared under the *Water Act*. The NT Government Gazette No. G25, 11 June 2019 (DENR 2019), states the following declared beneficial uses:

- Agriculture
- Aquaculture
- Public water supply
- Environment
- Cultural
- Industry
- Rural stock and domestic
- Mining activity
- Petroleum activity.

The Darwin Harbour region water quality objectives for freshwater rivers and streams and lagoons are applied for the Project, given the drainage flows into Black Jungle and Lambells Lagoon Conservation Reserve.

Water quality

Baseline surface water samples were collected on the 22 January 2020. Locations were selected based on observed flow during the site visit at boundary drainage lines. SW01 flows to the east into Lambells Lagoon and SW02, SW03 and SW04 flows west into Black Jungle Conservation Reserve (Figure 2-4). Middle Point (station 014041) recorded 50.2 mm on the day prior to the sampling event and 60.6 mm on the day of the sampling event. The Project area was notably rapidly draining with no evidence of water pooling the following day on the 23 January 2020.

The results are compared with the ANZG 2018 Aquatic ecosystem - freshwater protection value of 95% (ANZG GV's) and the Darwin Harbour Region Water Quality Objectives (WQO) for freshwater rivers and streams and lagoons and summarised below:

- The pH is slightly acidic, below ANZG GV's of 6.00 pH, ranging from 5.52 to 5.38 which is typical of rainwater in the NT, however within Darwin harbour WQO for lagoons, guideline value of 5.0 to 6.0 pH.
- The water is classed as freshwater with an average EC of 18.95 µS/cm, within Darwin harbour WQO for freshwater rivers and streams guideline value of 20 to 200 µS/cm and average salinity of 0.01 ppt.
- All metals are below laboratory detection limits and also well below the ANZG 2000 trigger values for 95% species protection.
- Total Phosphorus (TP) and reactive Phosphorus levels exceed the Darwin harbour WQO guideline value of <0.01 mg/L for freshwater rivers and streams (except for SW02), with a range of 0.06 to 0.12 mg/L. This may indicate previous use of high Phosphorus fertilisers. Nitrate + Nitrite (NOx) also exceeded the Darwin harbour WQO of 0.008 mg/L, ranging between <0.001 mg/L and 0.04 mg/L, however is reasonable for stormwater runoff. Total Nitrogen (TN) exceeded the ANZG 2000 trigger values for 95% species protection of 0.2 to 0.3 mg/L at SW03 (0.5 mg/L), however remained within Darwin harbour WQO for freshwater rivers and streams (<0.23 mg/L).

See Appendix B for surface water quality results. A baseline surface water monitoring program has been undertaken to establish site specific trigger values.

2.4.8 Groundwater

Beneficial uses and water quality objectives

The Project lies within the Darwin Rural Water Control District and groundwater is extracted from the Howard Groundwater System for the production process. The project area is underlain by the Howard Groundwater system, which includes the Koolpinyah Dolostone aquifer. The aquifer is high yielding and is an important water source for agricultural development, rural and public water supply for a large portion of Darwin's rural area. The aquifer is considered to be over-allocated and a Water Allocation Plan is under development by the NT Government pursuant to the Water Act.

The Howard Groundwater System is a fill and spill system, which relies on annual wet season rainfall to replenish the source. Hydrographs for monitoring bores in the Lambells Lagoon area (DENR, 2020) indicate that groundwater is generally 4-5 m below ground level during the wet season. During the dry season, groundwater is typically 13-14 m below ground level, but levels have dropped to as low as 18.8 m in 2016 after two poor wet seasons.

The Howard groundwater system discharges to several surface water ecosystems including Howard Springs, Howard River, Melacca Creek and Black Jungle, supporting important flora and fauna conservation values in those areas. Protection of these environmental values is a key focus of water allocation planning in the Darwin rural area and an allocation plan for the Howard Groundwater system is under development.

The Black Jungle Conservation Reserve is classified as an aquatic Groundwater Dependent Ecosystem (GDE) as it relies on discharge from the Howard Springs aquifer during the dry season. Lambells Lagoon is a Moderate potential aquatic GDE.

Water quality

Groundwater extracted from the bores in the Project area is suitable for the proposed use in crocodile farming and as a potable water supply.

Background groundwater quality has been obtained from seven bores across the Project area, including RN030418, RN024671, RN036485, RN029096, RN029097, RN030413 and RN029098 (Figure 2-4), during three sampling occasions on the 23 January, 27 February and 9 July 2020. The results are compared with the ANZG 2018 Primary Industries Long-term Trigger Values (LTV) for Irrigation, the Darwin Harbour Region Water Quality Objectives (WQO) for groundwater, and the Australian Drinking Water Guideline (ADWG, 2011) as a conservative assessment for potable water use.

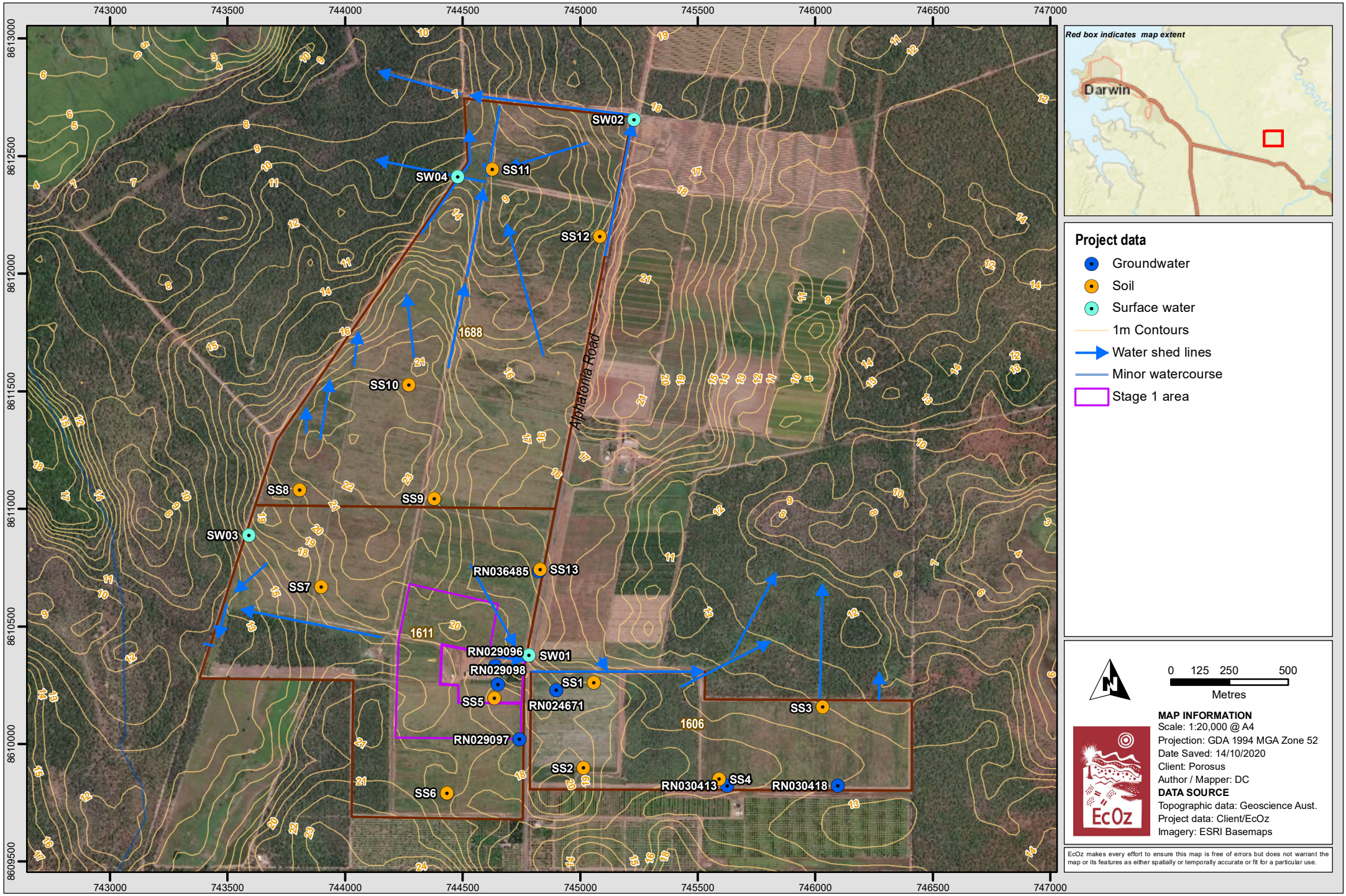
Overall, the average water quality is a neutral pH, on one occasion reading below the ANZG 2018 guidelines for Primary Industries LTV for Irrigation of 6.00 pH. The water is classed as freshwater with an average EC of 269.1 µS/cm. All bores are within the Darwin harbour WQO for groundwater guideline value of 350 µS/cm, with the exception of one bore RN24671 (with a value of 380 µS/cm). All results for dissolved metals and nutrients were within the guideline limits with the exception of one parameter, Total Phosphorus (TP) exceeding the ANZG 2018 Primary Industries LTV for Irrigation (0.05 mg/L).

See Appendix C for all groundwater quality results. A baseline groundwater monitoring program has been implemented to establish site specific trigger values.

Surrounding groundwater users

GEL (HGS10000) is in force over the Project area which allows a maximum extraction entitlement total of 3,216 ML/year. A GEL permits water use from selected bores at specified total quantities as per licence conditions. This allowed water use is to be monitored to ensure quantities extracted remain within

sustainable levels, regulated under the Water Act. There are nine existing bores across the project area associated with the existing GEL.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19153 - MARPU Project Environmental Approvals\01 Project Files\Map of current surface water, groundwater and soil monitoring.mxd

Figure 2-4. Map of previous monitoring locations, surface drainage and contours

2.5 Social and economic environment

The Crocodile Farm site is located at Lambells Lagoon on the outer edge of Darwin's rural area. The property is at the end of the bituminised Alphatonia Road, which is accessed from the Arnhem Highway. The highway is also the main access route to Darwin for the towns and communities of Humpty Doo, Marrakai, Corroboree, Jabiru and Arnhem Land communities. The town of Humpty Doo is the closest service centre, approximately 20 km by road from the Project area. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the Project area.

The conservation land to the west (around Black Jungle) is not developed for visitor use; however, the land to the east (Lambells Lagoon) receives regular visitor access for hunting and bird watching.

The neighbouring horticultural properties to the south and east of the project area have buildings where people may live or regularly spend time for work. The NT EPA Guideline: Recommended Land Use Separation Distances (2017) suggest that an activity with livestock / holding pens containing >10,000 animals per year should be separated from sensitive land uses by a 1,000 m radius.

3 PROJECT DESCRIPTION

3.1 Overview

Key operational activities include animal husbandry activities from incubation, hatchlings through to grow-out and finishers, when they are culled for skin and meat products. Wastewater is produced from the hatchlings, grower and finisher pens, increasing in volume as the crocodile's grow. Wastewater produced is managed through land irrigation crop application.

PRI have a Parks and Wildlife Commission *Permit to Keep Protected Wildlife in the Northern Territory, To Bring Protected Wildlife into (Import) and Take Protected Wildlife out of (Export) the Northern Territory*, pursuant to section 56 of the *Territory Parks and Wildlife Conservation Act,* for the Lambells Lagoon Crocodile Farm.

PRI also hold an export permit under the Convention of International Trade in Endangered Species (CITES) of Wild Fauna and Flora (Permit No. PWS2020-AU-001710), pursuant to s303CG of the *Environment Protection and Biodiversity Conservation Act 1999*.

3.2 Site layout and design

3.2.1 Stage one

Stage one is located within parcel 1611, immediately south of the existing access road within an area of approximate 7 ha. The immediate surrounding land will be used for stage one irrigation, requiring a minimum area of 15 ha (Figure 3 1).

Office and cold store

The office and cold store area include multiple office space designed to accommodate 40 personnel, staff kitchen, lunchroom and amenities, admin, outdoor area, septic tank, parking area, fridge/freezer, meat prep room (thawing and staging area), dry and chemical stores, unloading area for deliveries and loading area for crocodile food distribution.

Incubation building

The incubation building located within the existing shed, includes a loading bay, delivery, clean and wash area, receive and prep room, incubation rooms with high humidity regulated atmosphere and a hatching room. Eggs collected from the wild and alternate crocodile farm breeding pens will be placed into the incubation room for approximately three months until they hatch.

Hatchery pens

The hatchery area includes a series of hatchery pens. Hatchlings from the hatchery room within the incubation building, are transferred to the hatchery pens where they will remain for approximately six to nine months. Waste produced from the hatchery pens is flushed through to the effluent collection sump.

Effluent collection sump

The effluent collection sump collects all waste produced from the hatchery. The sump is located adjacent to the hatchery where water is pumped from the sump to the primary screen.

Primary treatment - Screening

Primary coarse screening removes solids from the wastewater. The primary screen is comprised of a step screen system to remove solids. Following the initial screening of solids, the wastewater passes through a fine screen to remove finer solids prior to secondary treatment or direct irrigation.

Wastewater drains from the hatchery pens to Pump Station 1 (PS1). PS1 regulates the flow into the step screen where the solids are removed from the wastewater (Figure 3-2). From the step screen the wastewater gravity feeds into Pump Station 2 (PS2). From PS2 it is pumped to the 15 Ha centre pivot irrigator. Four 25 kL emergency storage poly tanks are installed to cater for any pumping breakdowns.

Wastewater storage

A wastewater storage tank of 100 kL capacity (minimum) will contain the wastewater prior to land application via irrigation. Wastewater produced from the hatchery will increase gradually from 10 kL / day in April (early in the growth phase) to 100 kL / day in October (later in the hatchlings growth phase). The storage tank will be an open concrete tank approximately 6m x 6m x 3m which will also comprise the step screen system.

Secondary treatment – Particulate Air Separation System (PASS)

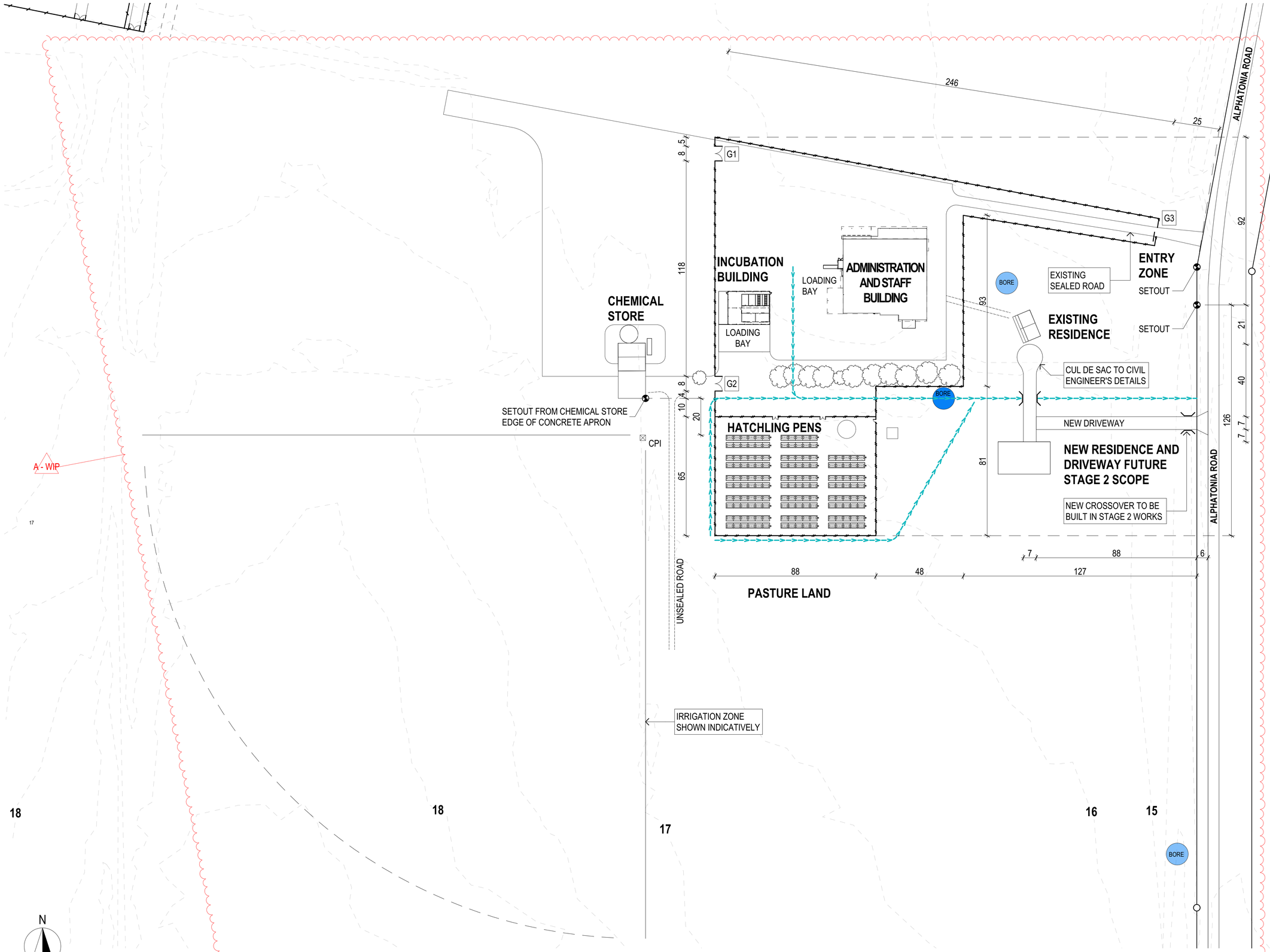
Wastewater following the primary treatment will either be stored in preparation for irrigation or be directed through a PASS treatment plant prior to irrigation or potential reuse. Design and implementation of the secondary treatment system will be undertaken (if required) within the first five years to allow interim site-specific performance monitoring of the primary treatment and irrigation.

Irrigation area

The cleared land immediately south the stage one farm area is utilised as an irrigation area for all wastewater produced from the hatchery. The minimum land requirements for irrigation is 15 ha as determined by the Model for Effluent Disposal using Land Irrigation (MEDLI) Modelling, based on 100 kL water inputs per day. A centre pivot system is used to irrigate the wastewater (Figure 3-3).

Security fencing

Security fencing will be established surrounding stage one operations.



KEY:

- STORMWATER SWALE DRAIN. REFER TO CIVIL ENIGEER'S FOR DETAILS
- NEW CROSSOVER AND CULVERT DRAIN TO ENGINEER'S DETAILS
- CPI
- G1 G2 — 8M WIDE DOUBLE SWING GATE WITH PROPRIETARY LATCHES AND DROP BOLT SYSTEM.
- 1/4 CENTRE PIVOT IRRIGATION ZONE 4Ha TO BE RELOCATED AT COMPLETION OF STAGE 2 CONSTRUCTION.
- G3 — 5M WIDE SLIDING GATE INSTALLED TO MANUFACTURER'S SPECIFICATIONS.

bennett design

ARCHITECT

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CLIENT:

SITZLER

PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

Figure 3-1. Map of Lambells Lagoon Crocodile Farm stage one site layout

PRELIMINARY: DB2634

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SCALE: AS SHOWN SHEET SIZE: A1	A18	REVISION: A - WIP

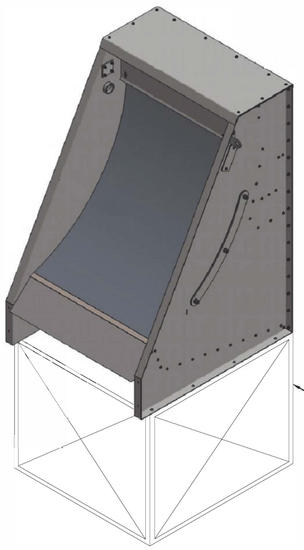
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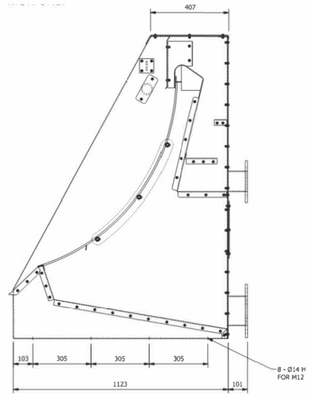
EQUIPMENT SCHEDULE	
SEWER PUMP STATION 1	5000 ENVIROLIFT LITRE CONCRETE SEWER PUMP CHAMBER TO SUIT 225mm INLET PIPE
SEWER PUMP STATION 2	4800 GRAF CARAT TANK TO SUIT 150mm INLET PIPE
SUMP PUMPS (2 OFF)	DUAL DAVEY DT37.K PER CHAMBER. PUMPS, 3-PHASE 3.7kW MOTOR. PUMPS TO OPERATE IN SEQUENCE.
PUMP CONTROLLER (2 OFF)	MODELEC AUSTRALIA MODEL FPL36020. 240 VOLT POWER, CONTROLLER TO HAVE 4G SMS ALARM SENDER
STORAGE TANK (4 OFF)	RELOCATION AND MODIFICATION OF EXISTING 22kL POLY TANKS.
STEP SCREEN	JOHNSON SCREENS RUN DOWN ASSEMBLY c/w SIEVE BEND. MODEL 900/316; 900mm WIDE SIEVE BEND

NOTE

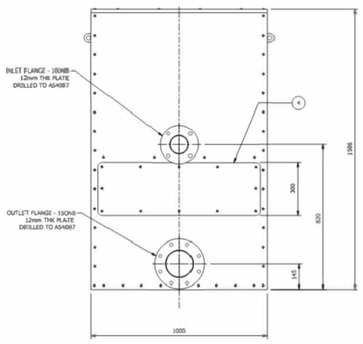
1. EXISTING 22kL WATER TANKS TO BE TIED DOWN IN ACCORDANCE WITH STRUCTURAL ENGINEERS REQUIREMENTS FOR CYCLONIC REGION.
2. SEWER PUMP STATION CONTROLLERS TO BE MONITORED. (5)



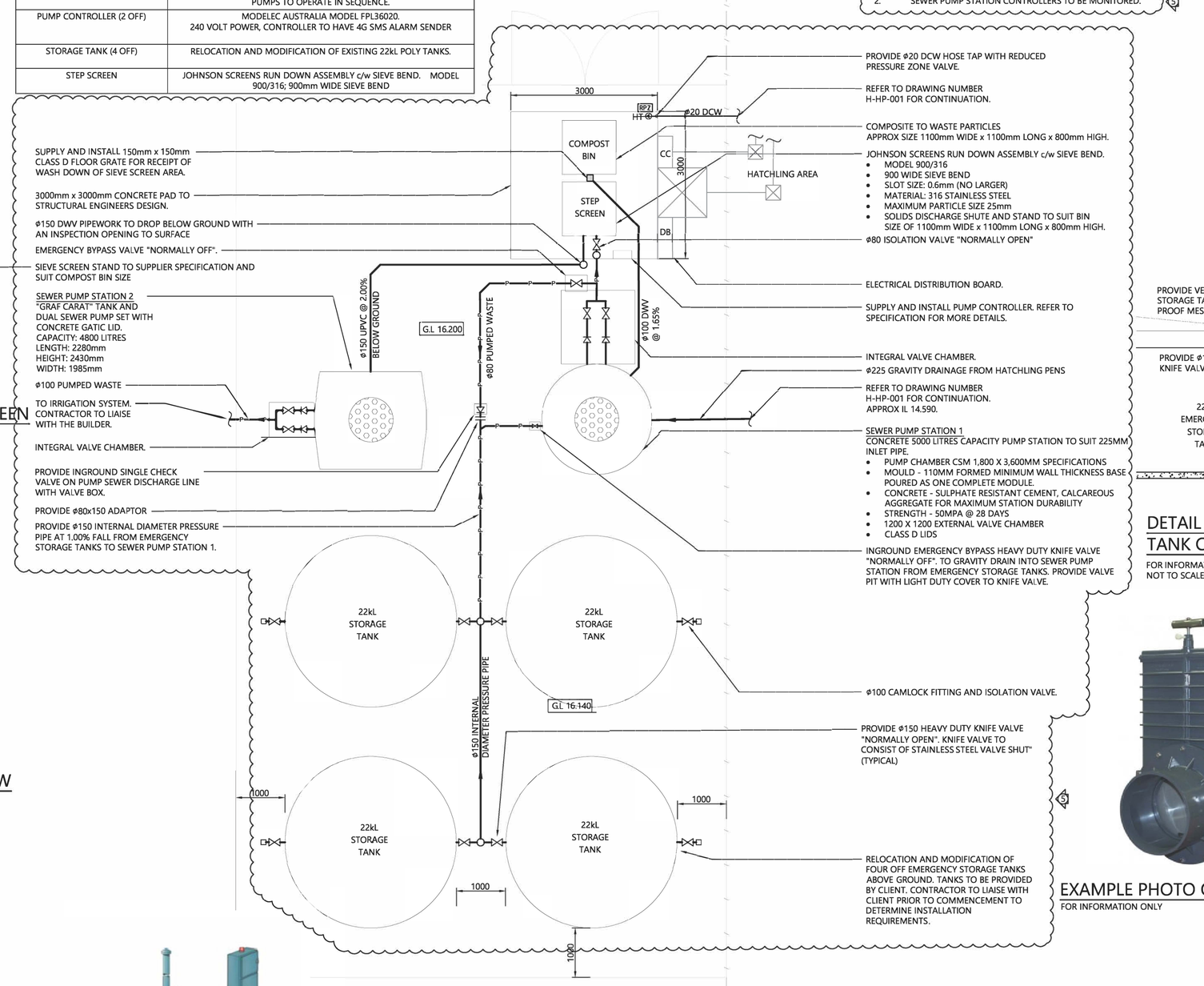
EXAMPLE PHOTO OF STATIC RUN DOWN SCREEN
FOR INFORMATION ONLY



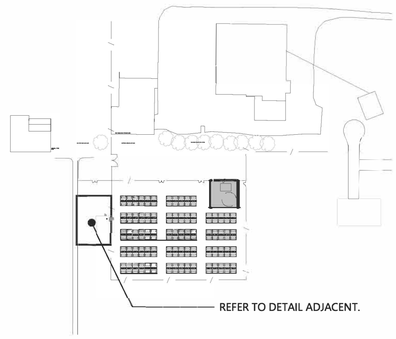
STATIC RUN DOWN SCREEN - SIDE VIEW
FOR INFORMATION ONLY



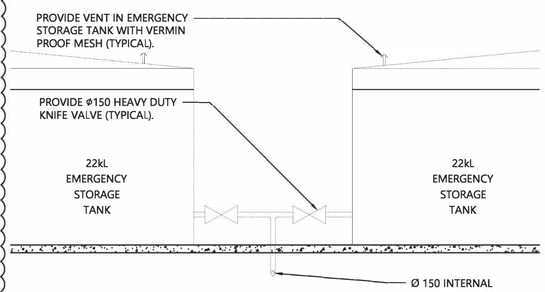
STATIC RUN DOWN SCREEN - REAR VIEW
FOR INFORMATION ONLY



STAGE 1 - STEP SCREEN, STORAGE TANKS AND SEWER PUMP STATION DETAIL
SCALE 1:50



STAGE 1 - KEY PLAN
NOT TO SCALE



DETAIL OF EMERGENCY STORAGE TANK CONNECTION
FOR INFORMATION ONLY
NOT TO SCALE

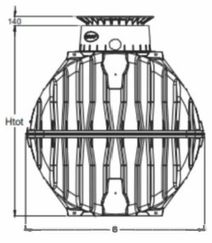


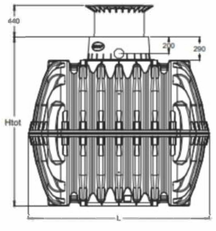
EXAMPLE PHOTO OF KNIFE VALVE
FOR INFORMATION ONLY



EXAMPLE PHOTO OF CONCRETE PUMP STATION
FOR INFORMATION ONLY







SIDE AND ELEVATION OF GRAF TANK
FOR INFORMATION ONLY

CONSTRUCTION

REV'N	DESCRIPTION	DATE	CHK'D
5	ISSUE FOR CONSTRUCTION	01.04.21	PL
4	ISSUE FOR CONSTRUCTION	01.03.21	PL
3	ISSUE FOR CONSTRUCTION	17.12.20	PL
2	PRELIMINARY ISSUE	11.12.20	PL
1	PRELIMINARY ISSUE	02.12.20	PL

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PROJECT
CROCODILE FARMING PROJECT
SEC 1611 (255) ALPHATONIA ROAD
LAMBELLS LAGOON, HUMPTY DOO NT 0836

DRAWING
Figure 3-2. Stage one primary treatment design: Step screen, storage tanks and sewer pump station

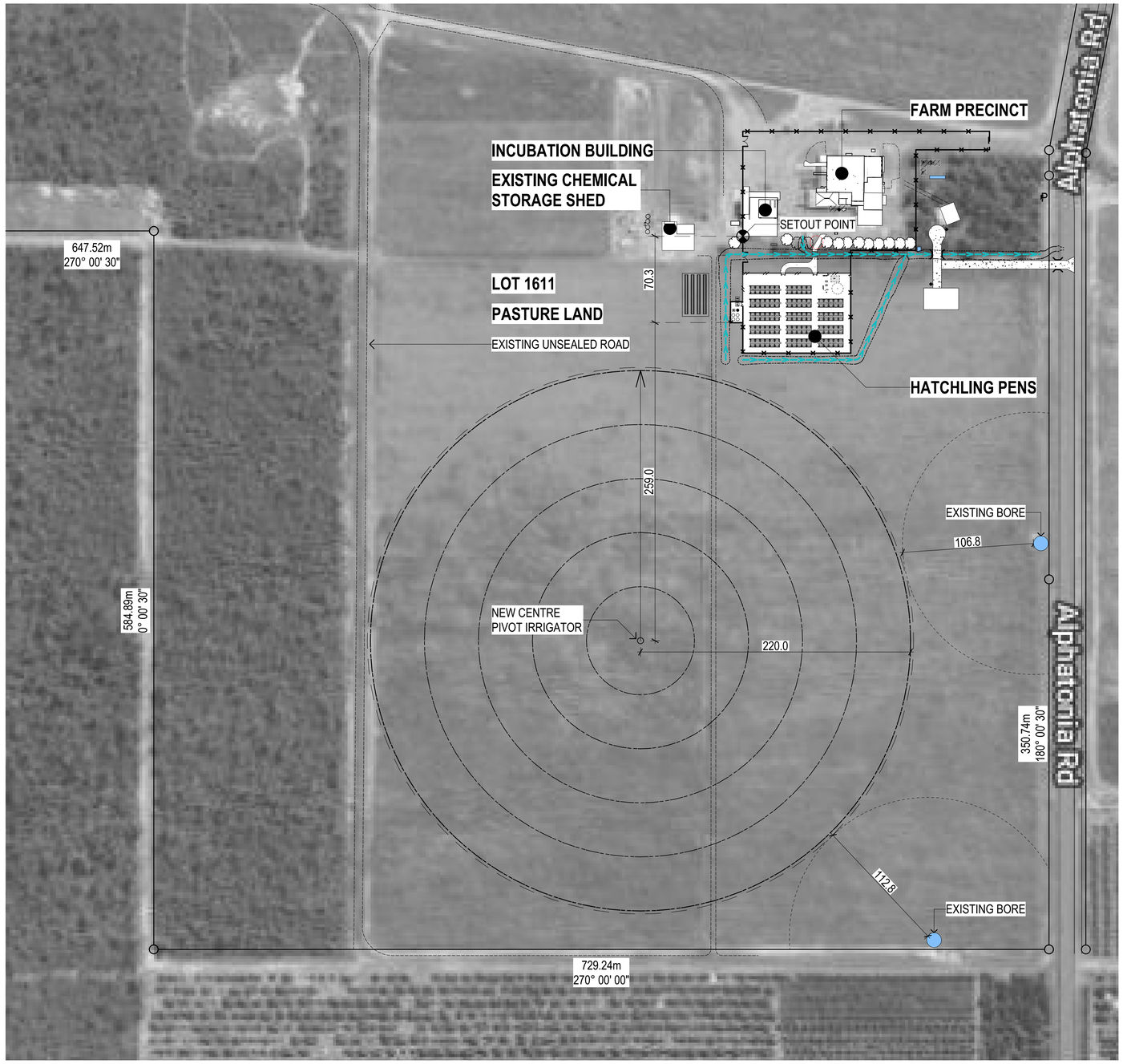
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DESIGNED	DRAWN	No. IN SET
CF	WK	9 OF 15

HYDRAULIC SERVICES

DRAWING NUMBER	REVISION
H-SW-009	5

LUCID
These drawings have been prepared by LUCID Consulting Engineers Pty Ltd.
Date: 01/04/2021
Hydraulic Engineer: PAUL LIND
Signature:
Registration Number: 206523PU



N

STAGE 1 IRRIGATION PLAN

SCALE @ A1 - 1:2000

0 50 100 150 200 250m

SPECIFICATIONS:

- 600 MICRON WEDGE WIRE JOHNSON SIEVE BED SCREEN.
- 5ml PER m^2 IRRIGATION RATE.
- 16ha (220M RADIUS) CENTRE PIVOT IRRIGATOR.
- 8ha TRIAL AREA WITH CAPACITY TO INCREASE TO 16HA.
- 110kL DAILY EXPECTED FLOW AT MAX CAPACITY.
- 4 X 25m^3 STORAGE TANKS FOR EMERGENCY REDUNDANCY.
- 9800L CAPACITY IN PUMP STATIONS.

NOTE:

- ALL DIMENSIONS TO BE CHECK ON SITE AND CONFIRM LOCATION WITH SUPERINTENDENT. CENTRE PIVOT IRRIGATION AND EXISTING BORES ARE INDICATIVELY DRAWN.
- SETOUT POINT STARTS FROM EDGE OF CONCRETE HARDSTAND OF THE INCUBATION BUILDING.

KEY:

- STORMWATER SWALE DRAIN. REFER TO CIVIL ENGINEER'S FOR DETAILS.
- EXISTING UNSEALED TRACKS.
- PERIMETER OF CENTRE PIVOT IRRIGATOR.
- CONCENTRIC IRRIGATION LINES.
- DASHED LINES DENOTES CLEARANCE DISTANCES BETWEEN EXISTING BORES AND IRRIGATION AREA.
- FLOW DIRECTION OF IRRIGATION.

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REV	DESCRIPTION	DATE	INIT.
00	ISSUE FOR CONSTRUCTION	01/04/2021	DV

AMENDMENTS

PROJECT: CROCODILE FARMING PROJECT
CLIENT: SITZLER
ADDRESS: SEC 1611 (255) ALPHATONIA ROAD, HUMPTY DOO NT 0836

DRAWING: **Figure 3-3. Map of stage one irrigation area**

PROJECT DATE:	SCALE:	DESIGNED/DRAWN:	CHECKED:	SHEET SIZE:
OCT 2020	AS SHOWN	DV	PW	A1

SITZLER DRAWING No:	SHEET No:	REVISION:
A-SW-012	012 of 11	00

C:\DPR\191017 2021 BA2665 STAGE1 IRRIGATION PLAN_DP

3.2.2 Stage two

Stage two is predominantly located within the northwest section of parcel 1611, immediately south of the existing access road within an area of approximate 50 ha (Figure 3-4). Surrounding land north of stage one, west of Alphatonia Road will be used for stage two irrigation, starting with 20 ha.

Grower and finishing pens

The stage two area is split into three teams, each team consisting of grower and finisher pens (Figure 3-4). The effluent will drain into separate pump stations for each team.

Effluent collection

Wastewater drains from each of the three teams to separate team pump stations. Each team pump station will cater for a 1 in 100 year, 5 min intensity rainfall event. From the pump stations the wastewater is transferred to the primary screens.

Primary treatment - Screening

The primary screen is comprised of a step screen system to remove solids with a peak flow capacity of 150L/s, filtering all solids before draining into a Retention Basin for disposal via irrigation. The step screen is a 3.6m wide step screen with 0.9 mm slots (Figure 3-5).

Wastewater storage

Wet weather storage (WWS) pond is a 60,000m^3 retention basin, used to store water for irrigation (Figure 3-6). Water storage facilities is constructed with low permeability foundations to prevent potential seepage to groundwater. Water storage volumes have been assessed in the MEDLI modelling conducted to date. A 60,000 m^3 WWS pond is being constructed with provisions to increase the storage capacity in the future. MEDLI modelling will be re-run throughout operations with site-specific input data to calibrate the model. If MEDLI indicates this volume is insufficient, additional storage capacity will be constructed.

Secondary treatment

Based on existing water quality on other Crocodile farms, secondary treatment is unlikely to be required for the stage two wastewater and is suitable for direct irrigation.

Irrigation area

The cleared land immediately north of the stage one farm area (west of Alphatonia Road) will be utilised as the initial 20 ha irrigation area for all wastewater produced from the growers. In accordance with the MEDLI model for stage two, the land requirements for irrigation of the growers and finishers is 100 ha. The irrigation will be expanded each year over a 5-year period in accordance with MEDLI modelling as the crocodile population increases until full capacity is reached, at 50,000 animals.

Security fencing

Security fencing will be established surrounding stage two operations.



TERMINATE OUTLETS WITH Ø300 PVC FLAP VALVE THROUGH RETENTION BASIN WALL TO PREVENT ENTRY OF VERMIN - TWO (2) OFF.

PROVIDE Ø100 SCOUR VALVES AND AIR RELIEF VALVES C/W CAST IRON BOX AT ALTERNATING 60m INTERVALS ALONG PUMPED WASTE LINE. ARRANGEMENT SHOWN INDICATIVELY AND DOES NOT REPRESENT TRUE QUANTITY REQUIRED.

Ø150 3.2ML TANK OVERFLOW TO SWALE.

3.2ML TANK. REFER TO BORE WATER STRATEGY.

PROVIDE Ø100 GULLY TRAP UNDER HOSE TAP AT PUMP STATION. (TYPICAL)

DRAINAGE TO BE ENCASED IN CONCRETE WHERE MINIMUM COVER OF 600mm TO TOP OF PIPE CANNOT BE ACHIEVED UNDER SWALE.

PROVIDE Ø100 SANITARY DRAINAGE BRANCH TO SERVICE MECHANICAL PLANT.

PROVIDE ONE (1) OFF Ø50 CONDUITS FROM PUMP STATION TO CONTROL PANEL LOCATION. CONTROL PANEL TO BE MOUNTED ON 2xØ100x2.0m HIGH ABOVE SURFACE GALVANISED STEEL SUPPORT POSTS WITH 3x50mm WIDE SPACE BARS SET IN CONCRETE. Ø80 PUMP STATION CHAMBER VENT TO BE MOUNTED ON GALVANISED STEEL SUPPORT AND TERMINATED MIN. 3000mm ABOVE FINISHED SURFACE LEVEL - PROVIDE SHOP DRAWINGS FOR APPROVAL.

DRAINAGE TO BE ENCASED IN CONCRETE WHERE MINIMUM COVER OF 600mm TO TOP OF PIPE CANNOT BE ACHIEVED UNDER SWALE.

PROVIDE MAINTENANCE SHAFT COMPLETE WITH Ø225 RISER TERMINATED WITH HEAVY DUTY CLASS-D COVER AT FINISHED FLOOR LEVEL AND CONFINED SPACE SIGNAGE (TYPICAL) - 130m SPACINGS.

TWO OFF Ø300 DWV UNTRAPPED OUTLETS FROM PRIMARY SCREENS TO DISCHARGE TO RETENTION BASIN. FINAL RETENTION BASIN AND PRIMARY SCREEN LOCATION TBC.

PUMPED WASTEWATER PIPEWORK TO DISCHARGE TO SCREENING PLANT.

PROVIDE 600Wx3600L CHANNEL DRAIN COMPLETE WITH HEAVY DUTY GRATE TO SERVICE SCREEN BUND. EXTEND TWO (2) Ø150 OUTLETS AND INTERCONNECT WITH WASTE DRAINAGE.

IN GROUND PUMP CHAMBER. REFER TO SPECIFICATION AND DRAWING H-SW-104 FOR DETAILS.

GROWING PEN TYPE A

EACH BRANCH REPRESENTS TWO (2) OFF Ø150 CONNECTIONS. REFER TO DRAWING 'H-GP-101 - GROWING PEN TYPE A HYDRAULIC ARRANGEMENT PLAN' FOR INTERNAL DRAINAGE ARRANGEMENTS.

DRAINAGE TO BE ENCASED IN CONCRETE WHERE MINIMUM COVER OF 600mm TO TOP OF PIPE CANNOT BE ACHIEVED UNDER SWALE.

GROWING PEN TYPE B

EACH BRANCH REPRESENTS 2 OFF Ø150 CONNECTIONS. REFER TO DRAWING 'H-GP-101 - GROWING PEN TYPE B HYDRAULIC ARRANGEMENT PLAN' FOR INTERNAL DRAINAGE ARRANGEMENTS.

FINISHING PEN TYPE A

EACH FINISHING PEN TYPE A TO BE PROVIDED WITH 1x Ø150 CONNECTION. REFER TO DRAWING H-FP-101 FOR INTERNAL DRAINAGE ARRANGEMENT.

FINISHING PEN TYPE B AND C

EACH FINISHING PEN TYPE B AND TYPE C TO BE PROVIDED WITH 1x Ø150 CONNECTION. REFER TO DRAWING H-FP-101 FOR INTERNAL DRAINAGE ARRANGEMENT.

NOTE:

1. REFER TO CIVIL DRAWING FOR PROPOSED STORMWATER SWALE LAYOUT.
2. FOR FURTHER DETAIL ON PUMP STATIONS REFER DRAWING H-SW-104.

CONSTRUCTION

REV'N	DESCRIPTION	DATE	CHK'D
7	REVISED ISSUE FOR CONSTRUCTION	14.05.21	PL
6	REVISED ISSUE FOR CONSTRUCTION	23.04.21	PL
5	REVISED ISSUE FOR CONSTRUCTION	26.03.21	PL
4	ISSUE FOR CONSTRUCTION	05.03.21	PL
3	90% PRELIMINARY ISSUE	17.12.20	PL
2	PROGRESS ISSUE	11.12.20	PL
1	PRELIMINARY ISSUE	27.11.20	PL

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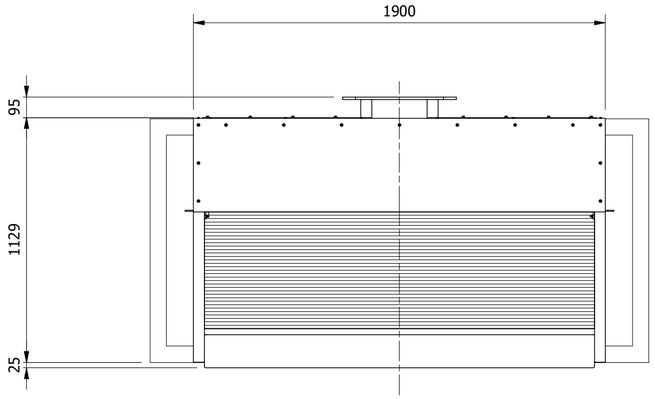
PROJECT
CROCODILE FARMING PROJECT
SEC 1611 (255) ALPHATONIA ROAD
LAMBELLS LAGOON, HUMPTY DOO NT 0836
LCE19484

DRAWING
Figure 3.4. Map of stage two site layout

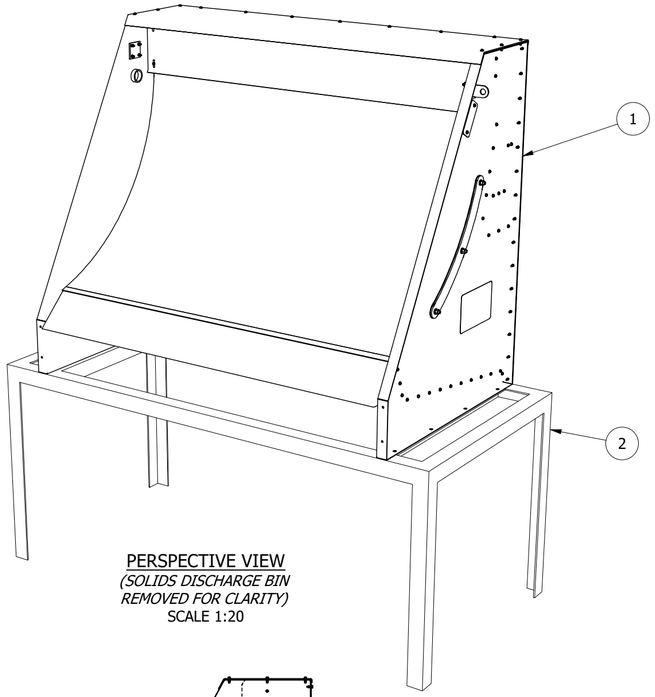
HYDRAULIC SERVICES - STAGE 2

SCALE	DATE		
1:1500@A1	MAY 2021		
	DESIGNED	DRAWN	No. IN SET
	PL	TJ	5 OF 9
DRAWING NUMBER			REVISION
H-SW-105			7

ITEM	DESCRIPTION	MATERIAL SPEC.	ESTIMATED DRY WEIGHT	QTY
1	SRD ASSY 1800W 250-350NB 0.9 63 316	316SS	480 kg	1
2	SRD 1800W SUPPORT FRAME	316SS	TBA	1



TOP VIEW
(SOLIDS DISCHARGE BIN REMOVED FOR CLARITY)
SCALE 1:20



PERSPECTIVE VIEW
(SOLIDS DISCHARGE BIN REMOVED FOR CLARITY)
SCALE 1:20

NOTES:

1. SUPPORT FRAME DETAILS TO BE ADVISED.

Code 1 - **APPROVED**
PROCEED WITH FABRICATION

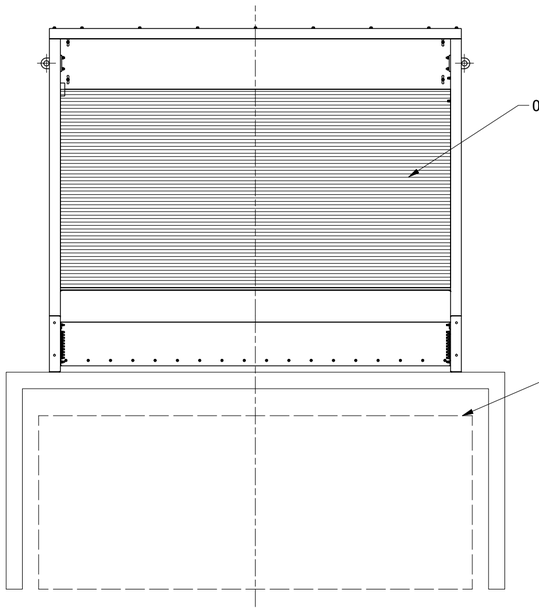
Code 2 - **APPROVED AS NOTED**
PROCEED WITH FABRICATION IN ACCORDANCE WITH THE COMMENTS HEREON AND RE-SUBMIT.
Comments subject to Aqseptence Group Review / Acceptance

Code 3 - **NOT APPROVED**
REVISE AND RE-SUBMIT

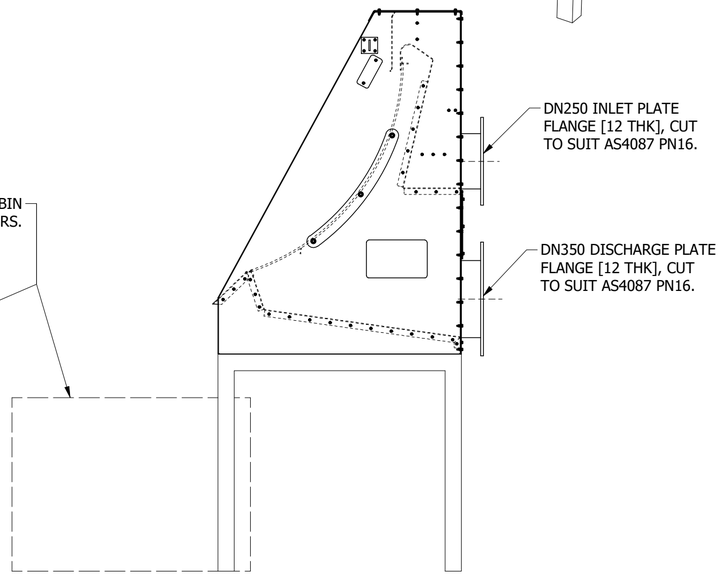
Any changes after approval, by client or client's agent, will be at the clients expense unless Aqseptence Group otherwise agree in writing. Acceptance of these terms and approval as marked above is confirmed by the signature below or through the use of client's approval mark.

Authorised By: ..... Dated:.....

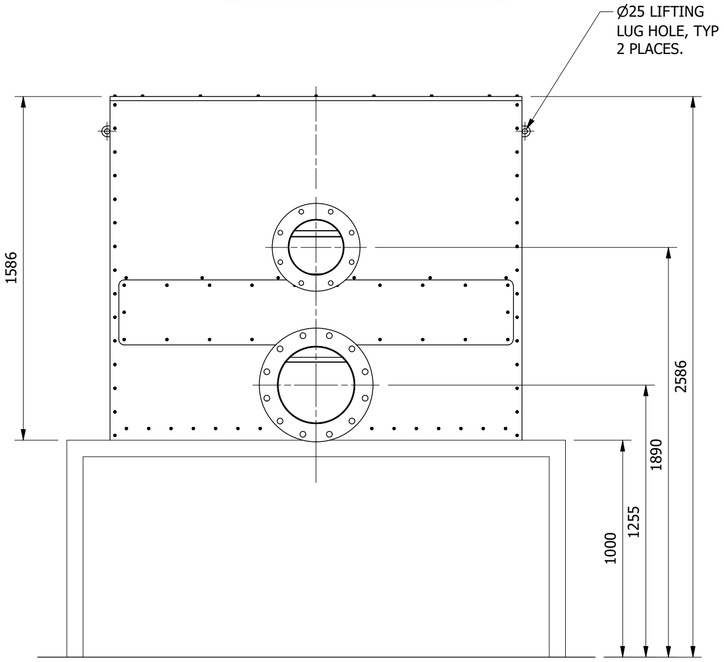
Apply company stamp as required



FRONT VIEW
SCALE 1:20



SIDE VIEW
SCALE 1:20



BACK VIEW
(SOLIDS DISCHARGE BIN REMOVED FOR CLARITY)
SCALE 1:20

Figure 3-5. Stage two primary treatment design

IF IN DOUBT ASK	
LINEAR DIMENSIONS: mm	
TOLERANCES UNLESS NOTED	
FABRICATION	MACHINING
0-1500 ± 3 mm	X ± 0.5
1500-3000 ± 6 mm	X.X ± 0.1
Over 3000 ± 12 mm	X.XX ± 0.02
Angles ± 0.5°	X.XXX ± 0.005
6.3 MACHINED FACES SURFACE FINISH UNLESS NOTED OTHERWISE	

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Johnson Screens
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DESIGN LOCATION: GEEBUNG, QLD. AUSTRALIA

DRAWN BY	GA	DATE 25/08/2021
CHECKED BY		DATE
EXT APPROVAL / MFG CHECK		DATE
APPROVED BY		DATE
REFERENCE		
THIRD ANGLE PROJECTION		

CUSTOMER: PROJECT PLUMBING

TITLE: GENERAL ARRANGEMENT STATIC RUNDOWN SCREEN 1800W

SIZE	DWG NO	REV
A2	1000493443_999	0

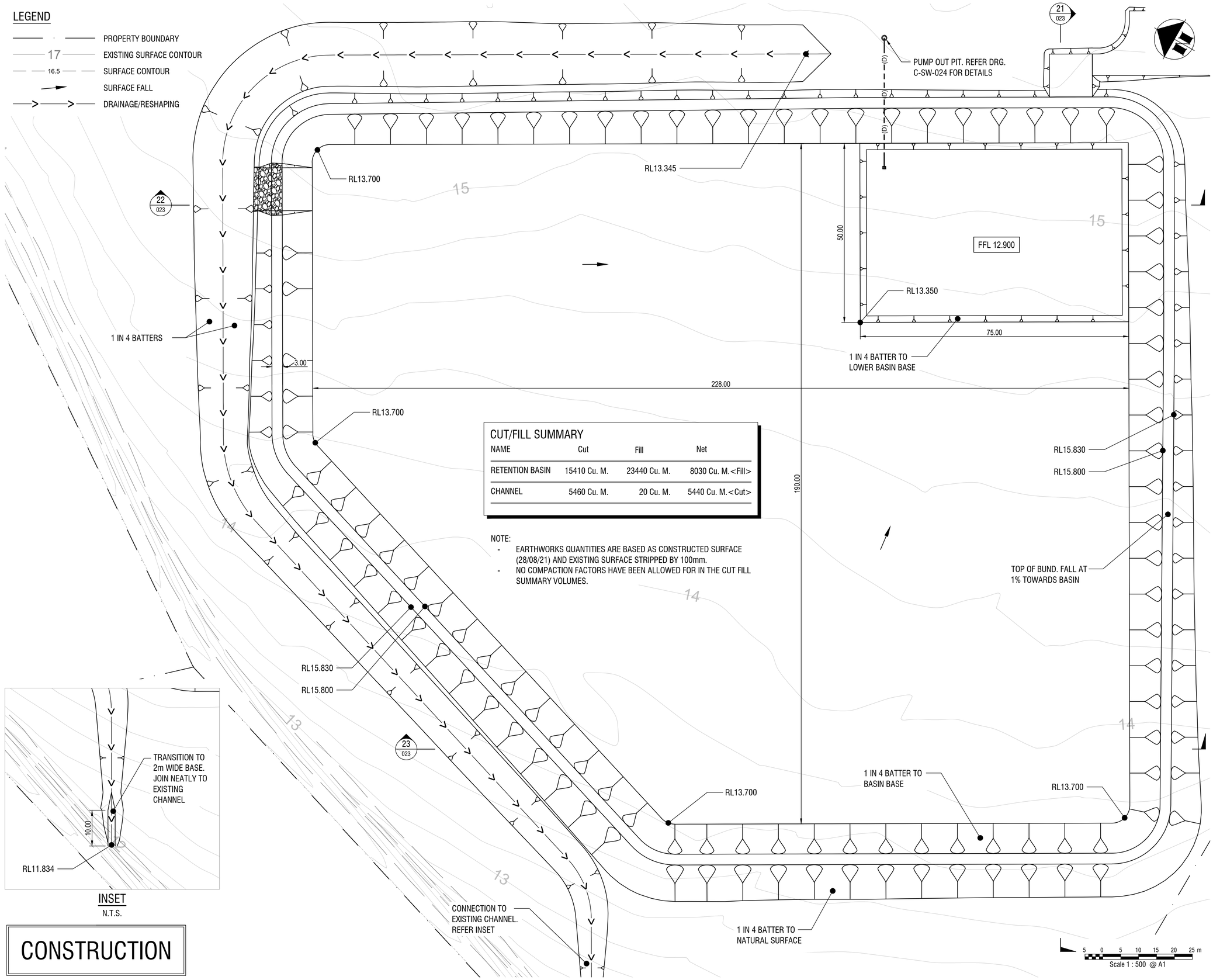
CONTENT

SCALE	PROJECT NO	SHEET
1:20		1 OF 1

FILE PATH: C:\Vault Working Folder\Designs\WaterProcess\RunDownScreen\Customer\1800 W\190067_Project Plumbing\1000493443_999.idw

LEGEND

- PROPERTY BOUNDARY
- 17 EXISTING SURFACE CONTOUR
- 16.5 SURFACE CONTOUR
- SURFACE FALL
- DRAINAGE/RESHAPING



CUT/FILL SUMMARY

NAME	Cut	Fill	Net
RETENTION BASIN	15410 Cu. M.	23440 Cu. M.	8030 Cu. M.<Fill>
CHANNEL	5460 Cu. M.	20 Cu. M.	5440 Cu. M.<Cut>

NOTE:
- EARTHWORKS QUANTITIES ARE BASED AS CONSTRUCTED SURFACE (28/08/21) AND EXISTING SURFACE STRIPPED BY 100mm.
- NO COMPACTION FACTORS HAVE BEEN ALLOWED FOR IN THE CUT FILL SUMMARY VOLUMES.

INSET
N.T.S.

CONSTRUCTION

WGA
WALLBRIDGE GILBERT AZTEC RFP
Suite 7/9, Keith Lane, Fannie Bay
Northern Territory 0820
Telephone 08 8941 1678
Email rfp@rfpeng.com

CLIENT: SITZLER

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REV	DESCRIPTION	DATE	INIT.
5	ISSUED FOR CONSTRUCTION	14.09.2021	CD
4	ISSUED FOR REVIEW	03.09.2021	CD
3	BASIN LAYOUT AMENDED	31.08.2021	CD
2	BASIN LAYOUT AMENDED	27.08.2021	CD
1	ISSUED FOR REVIEW	26.08.2021	CD
0	ISSUED FOR CONSTRUCTION	06.07.2021	CD

AMENDMENTS

Project: CROCODILE FARMING PROJECT
Client: SITZLER
Address: SEC 1611 (255) ALPHATONIA ROAD, HUMPTY DOO NT 0836

Drawing: **RETENTION BASIN PLAN**

Figure 3-6. Map of stage two wastewater storage

Project Date:	Scale:	Designed/Drawn	Checked:	Sheet Size:
06.07.2021	-	CD	RH	A1

Job No:	Sheet No:	Revision:
200265	C-SW-022	**5**

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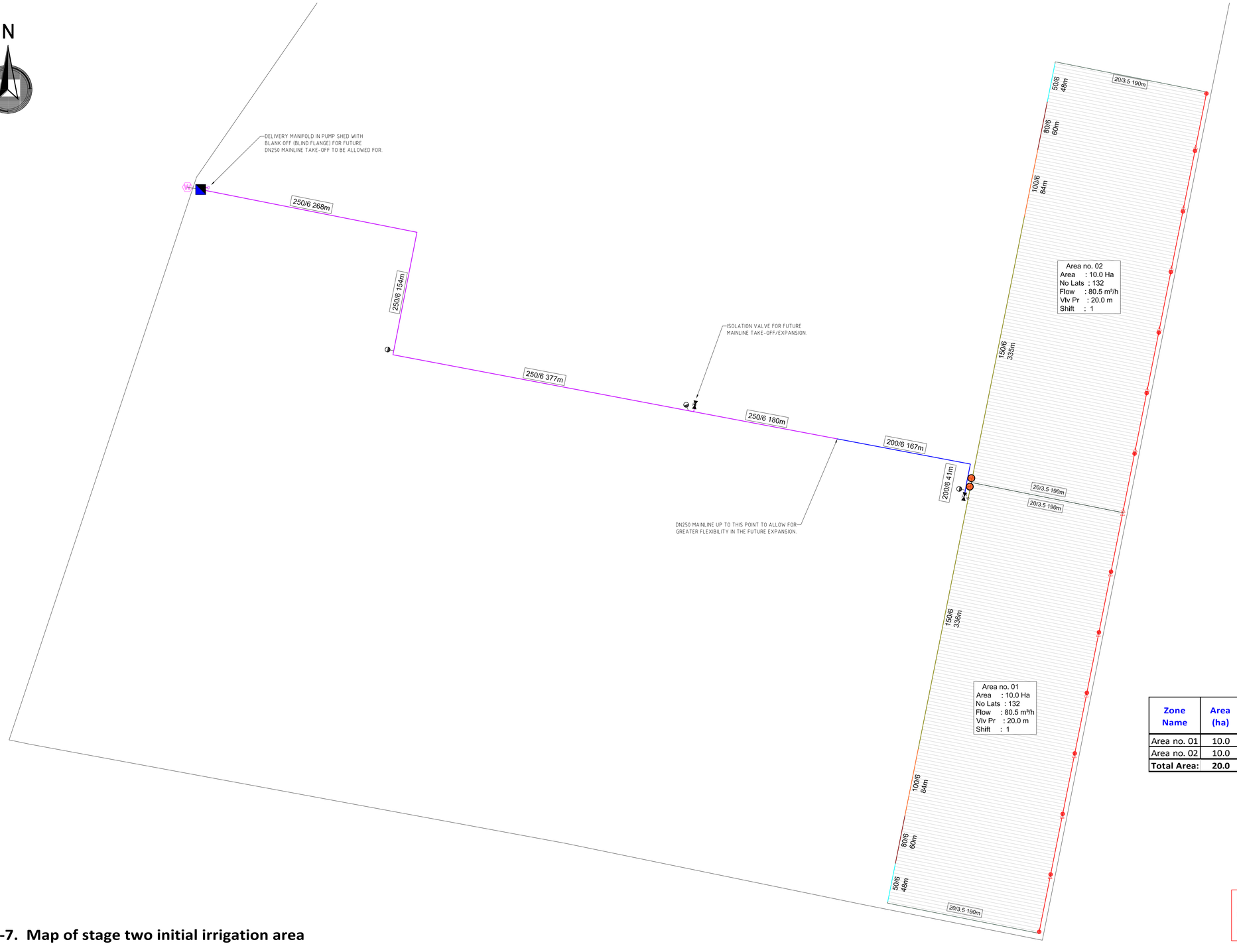


Figure 3-7. Map of stage two initial irrigation area

IRRIGATION DATA TABLE			
Description	**Units**	**Initial 20 ha**	**Final 200 ha**
Crop		Mahogany Tree	
Irrigation Area (Net)	ha	20.0	200.0
Row/Beds Spacing	Mtr.	4.0	4.0
Plants Spacing	Mtr.	2.0	2.0
Irrigation System		In-line Drip	In-line Drip
Emitter Type		Uniram 20010 AS	Uniram 20010 AS
Minimum Emitter Pressure	Mtr.	13.0	13.0
Emitter Discharge	L/H	1.60	1.60
Emitter Spacing	Mtr.	0.50	0.50
Laterals Average Spacing	Mtr.	4.0	4.0
No. of Laterals per Row/Bed	No.	1	1
Application Rate	mm/h	0.80	0.80
Max. Daily Consumption	mm/day	4.0	4.0
Irrigation Cycle	Days	1	1
Duration of one Operation	Hrs.	5.0	5.0
Number of Operations	No.	1	4
Max. Daily Operation Duration	Hrs.	5.0	20.0
Available Daily Duration	Hrs.	24	24
Mainline Flexibility		Medium/Maximum	
Max Number of Laterals per Flush Tap	No.	20 Laterals Per Manifold & Tap	
Pump Duty (Excludes Backflush Requirements)		**Initial 20 ha**	**Final 200 ha**
Maximum Discharge Required	m3/h	**161.0**	**414.0**
Maximum Discharge Required	lps	**44.7**	**115.0**
Required Pressure at Water Source	Mtr.	**38.0**	**55.0**
Required Pressure After Filtration	Mtr.	**26.0**	**43.0**
Assumed Filter Station RL:	Mtr.	0.0	0.0
Assumed Lowest Water RL:	Mtr.	-2.0	-2.0

Allowances For Calculation of Total Dynamic Head:			
Suction Line	Mtr.	**3.0**	**3.0**
Filtration - (Disk)	Mtr.	**7.0**	**7.0**
Miscellaneous/Headworks	Mtr.	**2.0**	**2.0**
Field Valve Assembly	Mtr.	**4.0**	**4.0**

Allowances in Calculation of Total Dynamic Head Required (TDH) - Final 200 ha

TDH For Final Pump Duty (m)	Critical (Furthest) Valve Pressure Required (m)	Total Mainline loss (m)	Total Mainline Distance (m)	Elevation (m)	Valve Assy Loss (m)	Headworks Losses (m)
55.0	22.0	11.0	2200.0	6.0	4.0	12.0
	Loss Allowed/100m=	0.5				

Zone Name	Area (ha)	Valve Size	Flow (m3/h)	Reg Pressure (m)	Min Pressure (m)	Max Pressure (m)	Mean Flow (lph)	Flow Var. (%)
Area no. 01	10.0	100mm	80.5	20.0	13.2	20.0	1.6	0.0
Area no. 02	10.0	100mm	80.5	20.0	13.2	20.0	1.6	0.0
Total Area:	**20.0**	**(ha)**						

NOTE: **SYSTEM DESIGNED FLAT**
LIMITED SITE DATA HAS BEEN PROVIDED TO NETAFIM TO CARRY OUT THIS DESIGN. NETAFIM TAKES NO RESPONSIBILITY FOR ERRORS THAT ARISE FROM THE USE OF THIS DATA AND RECOMMENDS THAT ACCURATE HYDRAULIC DESIGNS REQUIRE A FULL SITE SURVEY TO BE CARRIED OUT BY A LICENSED SURVEYOR.

- Uniram 20010 AS 1.6 lph @ 0.5m
- 50mm PVC Class 6
- Collect Manif - 50mm PVC Class 6
- 80mm PVC Class 6
- 100mm PVC Class 6
- 150mm PVC Class 6
- 200mm PVC Class 6
- 250mm PVC Class 6
- Suction/Delivery Manifold
- Valve Take Off - TBD

DIAL BEFORE YOU DIG www.1100.com.au The Essential First Step

- 100mm Valve Assy
- 50mm Air Valve Assy (AV50-xx)
- 50mm Threaded AV-10 Vacuum Breaker
- 50mm Collection Manifold (CF50-01)
- 150mm Purge Valve Assy (PV150-xx)
- Pump / Disc Filter Station
- Isolation Valve - Line Sized
- Water Supply

CERTIFIED IRRIGATION DESIGNER — IRRIGATION AUSTRALIA — ADM2570 — AGRICULTURAL DRIP MICRO

NOTES:
1. ALL NOTES SHALL BE READ IN CONJUNCTION WITH THE CONTRACT SPECIFICATIONS, DESIGN DRAWINGS, TECHNICAL SPECIFICATIONS AND OTHER RELEVANT STANDARDS. PRECEDENCE IS GIVEN TO SPECIFICATIONS AND STANDARDS, THEN DRAWINGS, THEN NOTES.
2. THE PLANS ARE A SCHEMATIC REPRESENTATION OF THE DESIGNED IRRIGATION SYSTEM.
3. RETAIN AND PROTECT ALL EXISTING SERVICES. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO LOCATE AND IDENTIFY ALL SERVICES PRIOR TO COMMENCEMENT OF WORK AND PROTECT ALL DURING WORK. PRIOR TO COMMENCEMENT OF WORK THE CONTRACTOR SHALL PERFORM A 'DIAL BEFORE YOU DIG' ENQUIRY. IT IS NOT GUARANTEED THAT ALL SERVICES HAVE BEEN SHOWN ON THE DRAWING.
4. ALL CONTROL CABLE CROSSING HARDSTAND AREAS TO BE INSTALLED WITHIN CONDUIT.

0 25.0 50.0 100.0 150.0 200.0
ORIGINAL SCALE @ A1 : 1:2500

ISSUED FOR CONSTRUCTION

REVISION	DATE	REVISION DESCRIPTION	BY
D	14/09/21	ISSUE FOR CONSTRUCTION	GV
C	21/07/21	REVISED AND APPROVED ISSUE FOR TENDER	GV
B	21/06/21	APPROVED ISSUE FOR TENDER	GV
A	17/06/21	PRELIMINARY ISSUE FOR REVIEW	GV

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NETWORKS DESIGN • SERVICE • PROJECTS

Project:	Description:
Mahogany's Anzac Parade	Stage 1
Client:	System: / Location:
Water Dynamics	Irrigation / Lambells Lagoon NT

Sheet:	Design by:	Drawn:	Checked by:	Size:	Scale:	Date:	Rev:	Job No:	Org No.
1 of 1	GV	GV	KK	A1	1:2500	17/06/2021	D	0621002p1	01

3.3 Key operational activities

3.3.1 Schedule

Stage one includes the incubation building refurbishment, hatchery pens, administration building refurbishment, water management infrastructure (water supply tank, effluent collection sump, wastewater storage tank, wastewater screening and an interim irrigation area), and associated infrastructure. Construction was completed in two stages:

- Stage 1a. Stormwater civil works as part of the Erosion and Sediment Control Plan (ESCP), refurbishment of the incubation building and admin building and building pad for hatchling pens.
- Stage 1b. Hatchling pens and associated wastewater management infrastructure (water holding tanks, wastewater collection sump, irrigation network).

Stage two includes the growers, finishers and wastewater system and has been divided up into two distinct stages being Stage 2a and Stage 2b.

- Stage 2a. Civil works and plumbing works required prior to concreting the pens. The hydraulic works included the drainage and water supply services in and around the pens. It also includes the site wide reticulation and drainage systems that lead to pump stations and Step Screens.
- Stage 2b. Concreting and shade structures along with the wastewater treatment solution.

Stage two crocodile production process will involve animal husbandry activities for growing crocodiles through grow-out and finishing stages until the animals are harvested around two years of age. The production process for stage one is detailed in Table 3-1.

Table 3-1. Crocodile production process

Production process	Description
Egg collection	Eggs are collected from breeding pens (other farms) and the wild. Viable eggs transferred to the incubator room.
Incubation	Eggs are maintained in a temperature-controlled incubator until they hatch, then are immediately transferred to hatching pens.
Hatchery	The hatchlings are raised in the hatching pens
Grow-out	When animals are of suitable size, they are transferred from hatchery to grower pens
Finishing	When animals approach a size suitable for market, they are transferred to finishing pens to ensure best possible skin and meat condition.

3.3.2 Farming routine

The farming routine involves a cycle of feeding, flushing and cleaning.

3.3.3 Water supply and demand

The Project holds a GEL no. HGS10000, which allows a maximum extraction entitlement total of 3,216 ML/year from nine existing bores. The bores are all located within the property boundary, underlain by the Howard Groundwater system, which includes the Koolpinyah Dolostone aquifer.

Water demand for the hatchery at full-capacity (late 2021 dry season) is expected to be 100 kL/day. Water will be sourced from two main bores located in proximity to the hatchery area (Table 3-2). Bore water will be pumped into the main water supply tank (approximate capacity 2,100 kL). The primary use of water on site is for regular flushing of the hatchery pens to maintain hygiene and health of the hatchlings. From the main water storage tank, the bore water will be pumped into the hatchery storage tank (approximately 260 kL capacity) where it is heated and dosed with chlorine via an automated system, and then reticulated around the hatchery pens.

A new water supply bore is currently being installed (proposed to be operational mid-November 2021) within the stage two area. This bore will be the primary supply of water for all of stage two operations. The total water use for the whole of farm system (stage one and stage two) is expected to be 1365kL/day. The water usage is reduced by half in the wet season (i.e. down to 632.5kL/day during the higher rainfall months of December to March), due to the change in crocodile behaviour. During the drier months (i.e April to November), the forecast water use is 1,265kL/day for the growers and finishers.

The primary use of water on site is for regular flushing of the grower pens to maintain hygiene and health of the growers.

Table 3-2 below identifies the primary bores for use in stage one and stage two. The remainder of the GEL bores may be utilised as back-up bores as required.

Table 3-2. Groundwater supply bores

Bore (RN)	Bore ID	Location	Depth (m)	Yield (L/s)	Use	Average annual extraction (ML)
029096	GW1	Main area - Incubation	47	20	Stage one - amenities, firefighting, admin/residence and backup supply for hatchery.	10
029098	GW2	East of Hatchery	44.5	10	Stage one - main supply for hatchery	36.5
*TBA	GW7	Stage two, within the team two area to the east of the retention basin	TBA	TBA	Stage two - main water supply	TBA

* TBA - new bore to be constructed mid-November 2021

3.3.4 Wastewater management

Stage one

Wastewater from hatchery is directed to the effluent collection sump prior to primary treatment through coarse screening of solids followed by fine screening. Wastewater will either undergo secondary treatment through PASS or directly irrigated to land. A 100 kL wastewater storage tank is required to manage the wastewater for irrigation (See Appendix D).

No compost will occur on-site at the commencement of stage one operations until the compost facility is constructed. Solid waste will be removed from the effluent collection sump and taken off-site for disposal by a licensed waste removal company.

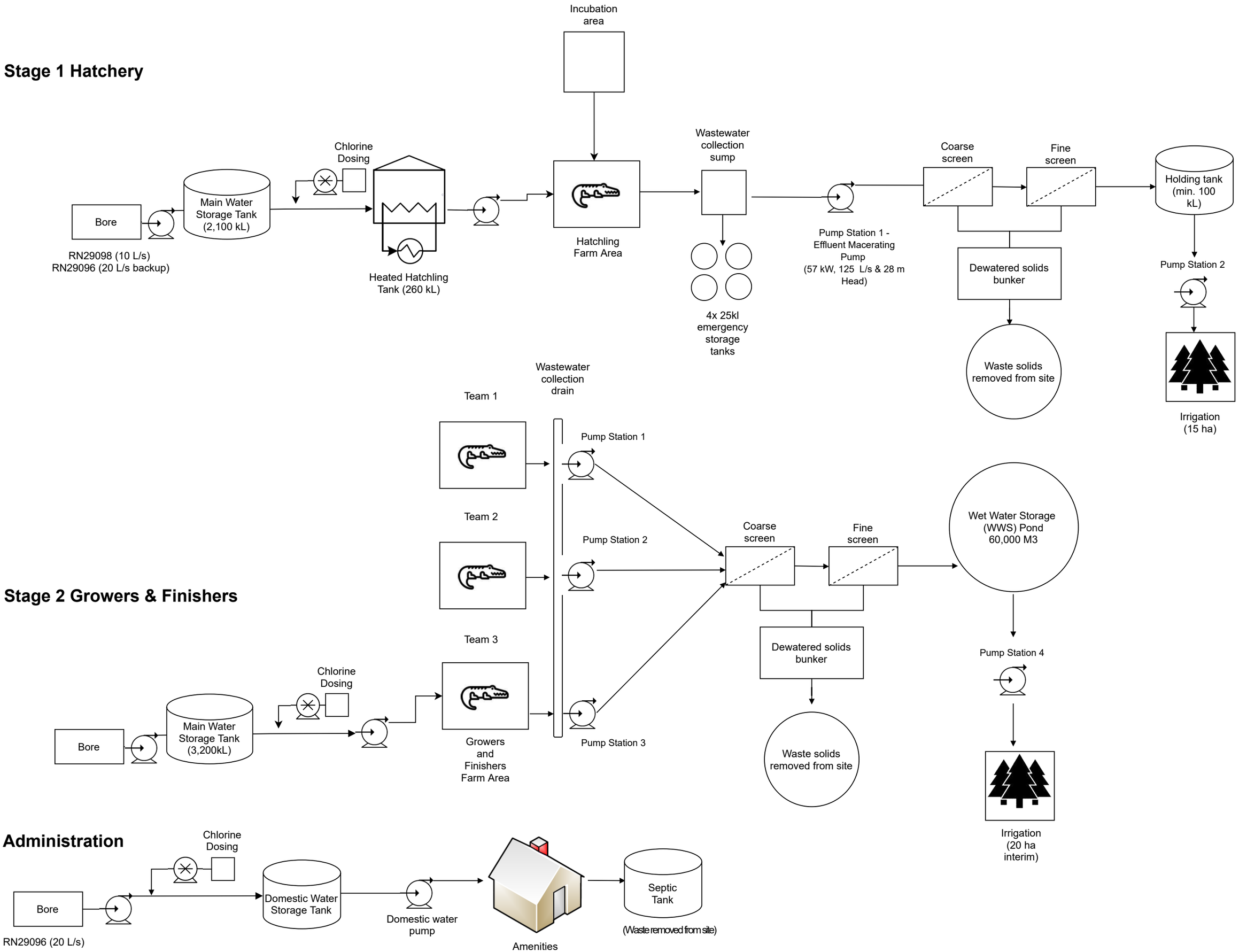
A water and nutrient balance for stage one has been undertaken using the MEDLI model. The MEDLI Model calculated 100 kL of wastewater storage is required as a minimum (closed system) and a minimum of 15 ha to manage crop and soil nutrients loading.

Stage two

Wastewater from the growers and finishers will be directed to the stage two effluent collection sump prior to primary treatment through coarse screening of solids followed by fine screening. The wastewater is then pumped to the retention basin for irrigation to the stage two irrigation area. As the number of crocodiles increase over the 5 year period, that irrigation areas will increase from initially 20 ha to 100 ha as per the outputs of the stage two MEDLI.

Figure 3-8 below details the process flow schematic for the overall farm.

Figure 3-8. Process flow schematic



3.3.5 Pollutants and wastes

Pollutants and wastes produced during operations are listed in Table 3-3, with details of treatment and disposal methods.

Table 3-3. Waste management

Pollutant/waste	Treatment / Mitigation	Disposal
Odour emissions	Appropriate separation distances to sensitive receptors. Irrigate in accordance with the approved IMP.	NA
Crocodile mortalities	NA	Stored in closed waste bin and collected by a licensed waste contractor and disposed off-site to a licensed facility
Solid animal effluent and feed waste	Primary water treatment screenings	Collected by a licensed waste contractor to an off-site compost facility until the on-site compost facility has been constructed.
Wastewater from crocodile pens	Primary and secondary treatment	Discharged to land for irrigation of crops or secondary treatment for reuse on-site.
Domestic / putrescible waste	NA	Stored in lidded waste receptacles around site and removed off-site by a waste contractor
Used chemical containers	NA	Off-site by licensed contractor
Waste oils from light maintenance activities	NA	Off-site by licensed contractor
Sewage	On-site septic tank	Pump out by licensed contractor
Stormwater discharges	Retention basin	Controlled discharge to surface waters via stormwater drains and collection sump.

An estimate of annual waste volumes generated and removed from Lambells Lagoon Crocodile farm is provided in Table 3-4 below. This is based on figures from Janamba Crocodile Farm and is expected to increase at full production.

Table 3-4. Estimate of annual waste volumes generated

Waste type	Annual volume
Animal waste – solids	100 tonnes
Animal waste – grit & sludge	25 tonnes
Septic (liquid)	3,000 litres
General waste	2 tonnes
Waste oil	100 litres

3.3.6 Hazardous materials storage and handling

A 5000 L diesel fuel storage tank (double skinned), used for re-fuelling of farm equipment, a back-up generator and a 3,000 L LPG storage tank, is located within the stage one operational area. LPG is used to provide heating of the water for the hatchery due to the sensitivity of hatchlings to the temperature profile.

Liquid chlorine is the primary hazardous material stored on site, used to disinfect the water in the main header tank prior to distribution to the hatchery pens. Bulk chlorine (max. 2000 L) is kept in the chemical's storage located to the west of the incubation building.

Other chemicals stored and used on site for stage one includes:

- Cleaners and disinfectants (maximum of 100 L)
- F10SC Veterinary disinfectant, foaming sanitiser
- Herbicide for weed treatment (Glyphosate, maximum of 20 L)
- Oils/lubricants for farm equipment (maximum of 100 L)
- Paints and thinners (maximum 100 L)
- Epoxy sealants (maximum 1000 L for short periods).

A hazardous substance register will be maintained, which will include storage location, summary of hazardous/dangerous goods status and links to Safety Data Sheets (SDSs). The register will be located in the site office as well as in the chemical store. Storage and handling will comply with Australian Standard 1940 – Storage and handling of flammable and combustible liquids. Copies of Safety Data Sheets (SDS's) of all chemicals will be kept in the store.

4 DISCHARGE SPECIFICATIONS

4.1 Discharges to air

Odours may be produced from stage one, stage two, water treatment and irrigation areas. Aerosols may also be dispersed through irrigation of wastewater.

The key measures that will minimise odour emissions are listed below:

- Primary treatment of wastewater to remove solids
- Removal of solids off-site
- Monitoring of treatment system performance to ensure wastewater entering the treated wastewater storage tank meets water quality criteria for irrigation.
- Operational procedures for irrigation of wastewater as per Irrigation Management Plan (IMP) (See Appendix D).

4.2 Discharges to land

All stage one wastewater produced will be irrigated to established crops (Mariner Rhodes grass). The wastewater storage tank will be the monitoring location for the irrigation extraction point and authorised discharge point one (ADP1) to ensure wastewater meets water quality criteria for irrigation prior to discharge to land. The irrigation area for stage one is located south of the stage one farm operations area over a minimum of 15 ha.

Stage two wastewater will be irrigated to an established African Mahogany plantation. An initial 20 ha will be utilised for irrigation located north of stage one, to the west of Alphatonia road. The wastewater pumping station from the retention basin will be the monitoring location for the irrigation extraction point and authorised discharge point two (ADP2) to ensure wastewater meets water quality criteria for irrigation prior to discharge to land. The African Mahogany plantation is intended to be used as a carbon sink and will not harvested for approximately 20 years.

Irrigation details such as irrigation rate and water balance are included in the IMP (Appendix D). Suitability of the existing land for cropping and irrigation of wastewater is detailed in section 2.4.

Table 4-1. Water discharge point

Discharge point ID	Latitude	Longitude	Description
ADP1	-12.562519°	131.250281°	Stage one wastewater pump station authorised discharge point
ADP2	-12.553989°	131.244869°	Stage two wastewater retention basin pump station authorised discharge point

4.3 Discharges to water

Surface water drainage from site will be monitored as detailed in section 8. Surface water shed pathways are shown in Figure 2-3.

5 CONCEPTUAL SITE MODEL

A diagrammatic conceptual site model (CSM) has been developed (Figure 5-1) for the project operations to identify:

Potential contaminants

- Chemicals - the use of cleaning products in the pens include multipurpose cleaners and disinfectant sanitisers which contain chlorine and ammonium-based compounds.
- Hydrocarbons – bulk storage for on-site fuel use
- Bacterial and nutrients - Nitrates, phosphates, ammonia, bacteria and pathogens (i.e. *E.coli*, *enterococci* or faecal coliforms) from the farming of animals.
- The generation of airborne contaminants and nuisance odour.

The release of these contaminants could result in an increased biochemical oxygen demand, reduced dissolved oxygen, changes in pH, increased electrical conductivity, turbidity or total suspended solids, an increase in chlorophyll-a and/or an increase in hydrocarbons. Amenity impacts may also occur due to irrigation, such as an increase in odour or spray drift.

Inferred sources

- Feed inputs
- Faecal matter (crocodile pens, effluent collection sump and wastewater treatment)
- Cleaning products used in pens
- The storage of bulk hazardous chemicals and hydrocarbons
- Airborne molecules from irrigation activities.

Pathways and mechanisms for transport

- Wind dispersing odour
- Irrigation of wastewater – aerosol droplets transferred through wind dispersion
- Surface water runoff
- Groundwater seepage

Potential sensitive receptors

- People – employees and neighbours
- Surrounding land and crops
- Black Jungle and Lambells Lagoon Conservation Reserve - the receiving terrestrial and aquatic organisms with potential impacts to water quality of drawdown.
- Recreational users
- Howard groundwater system - the receiving terrestrial and aquatic organisms, GDEs and surrounding groundwater users with potential impacts to water quality of drawdown.

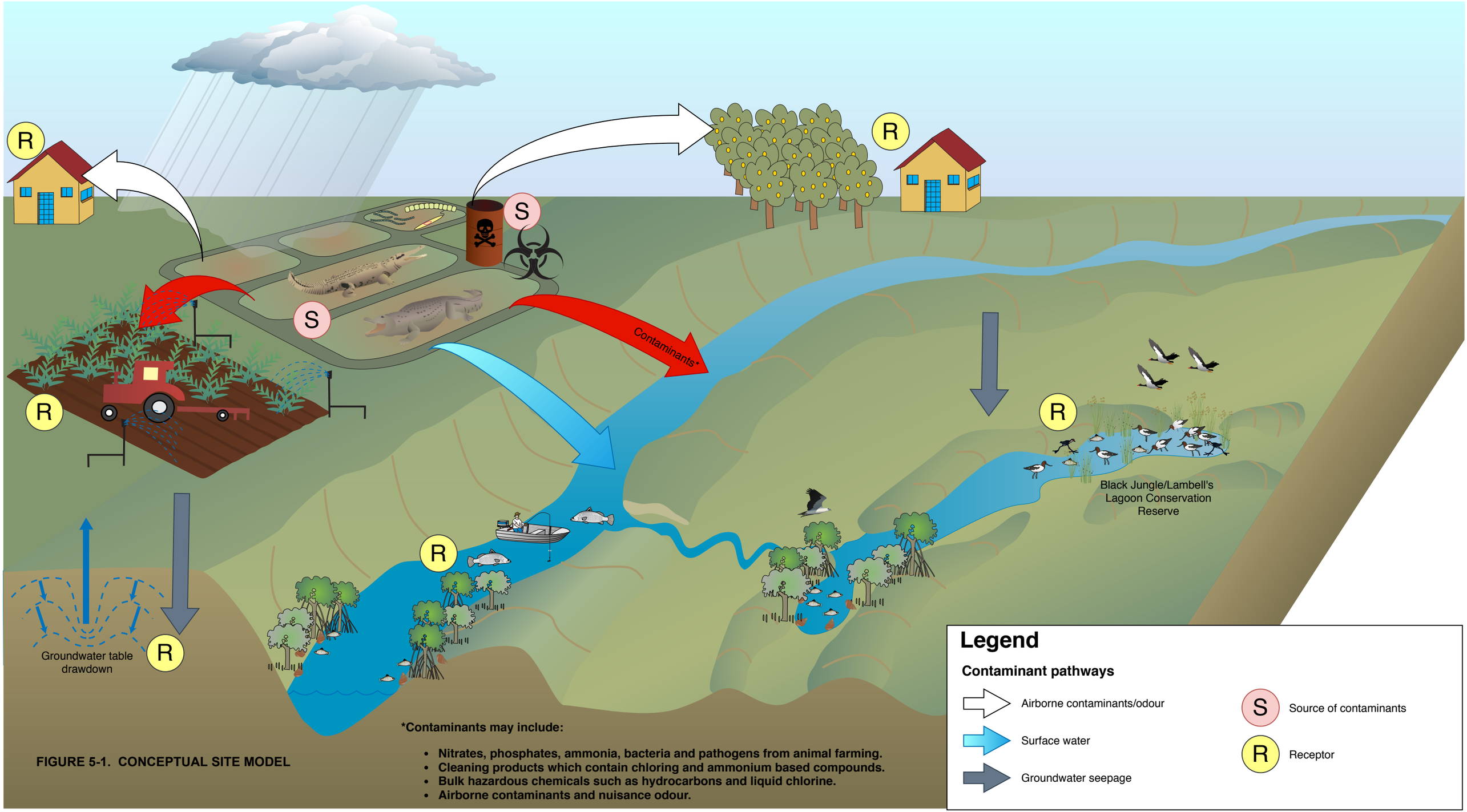


FIGURE 5-1. CONCEPTUAL SITE MODEL

***Contaminants may include:**

- **Nitrates, phosphates, ammonia, bacteria and pathogens from animal farming.**
- **Cleaning products which contain chloring and ammonium based compounds.**
- **Bulk hazardous chemicals such as hydrocarbons and liquid chlorine.**
- **Airborne contaminants and nuisance odour.**

6 ENVIRONMENTAL RISK ASSESSMENT

The CSM outlined in Section 5 above has been used to inform environmental risk assessment of the overall farm operations and derive corresponding mitigation measures for identified risks. An Operational Aspects and Impact Register is presented in Table 6-4.

6.1 Operational risks

The potential environmental risks associated with operation of the Project, have been considered and addressed in an environmental aspect and impact register. The likelihood and consequence categories adopted are provided in Table 6-1 and Table 6-2, and were combined to derive an overall risk rating using the matrix in Table 6-3 below. The environmental aspects and impacts register is provided in Table 6-4.

Table 6-1. Likelihood categories

Level	Descriptor	Likelihood Description
1	Rare	The impact is very unlikely to occur. The impact has not occurred on similar projects and/or in similar environments.
2	Unlikely	The impact is not expected to occur. The impact occurs very infrequently on similar projects and/or in similar environments.
3	Possible	The impact could occur in some circumstances. The impact has occurred infrequently on similar projects and/or in similar environments.
4	Likely	The impact will probably occur in most circumstance but there is some uncertainty about the likelihood. The impact has association with similar projects and/or in similar environments.
5	Almost Certain	The event/impact will occur or is expected to occur. The impact occurs regularly in association with similar projects and/or in similar environments.

Table 6-2. Consequence categories

Level	Descriptor	Description
1	Insignificant	No noticeable or measurable impact.
2	Minor	Low intensity short-term impact that is very limited in extent i.e. confined to the direct disturbance footprint.
3	Moderate	Localised impact that alters environmental quality without compromising ecological integrity. Impact occurs periodically or is experienced over short periods of time i.e. months.
4	Major	Impact/damage that occurs at a regional scale. Impact compromises the integrity of environmental values and is felt for many years (i.e. is long-term)
5	Severe	Widespread and permanent/irreversible damage to receiving environment will occur - unlikely to ever be fixed (e.g. extinctions).

Table 6-3. Risk matrix

			CONSEQUENCE				
			1	2	3	4	5
			Insignificant	Minor	Moderate	Major	Severe
LIKELIHOOD	5	Almost Certain	Medium	Medium	High	Very High	Very High
	4	Likely	Medium	Medium	High	Very High	Very High
	3	Possible	Low	Medium	Medium	High	Very High
	2	Unlikely	Low	Low	Medium	Medium	High
	1	Rare	Low	Low	Low	Medium	High

Table 6-4. Operational environmental risk assessment

				INITIAL RISK					RESIDUAL RISK		
Activity	**Aspect**	**Impact**	**Background information and assumptions**	**Likelihood**	**Consequence**	**Risk Score**	**Controls**	**Relevant Documents**	**Likelihood**	**Consequence**	**Risk Score**
Filling and replenishing ponds	Extraction of groundwater	Drawdown on the Howard Springs aquifer, resulting in reduction of environmental flows in the Black Jungle or Lambell's Lagoon, which are aquatic GDEs	LLCF operate under existing GEL HGS10000 which allows for 3,216 ML to be extracted annually. Total sustainable extraction volumes are estimated at 3,000 ML/yr. The five existing licences in place for the aquifer allocate 3,696 ML/yr, which exceeds the 20% limit set in the NT Water Allocation Planning Framework. The Howard Groundwater System is as fill and spill system, which relies on annual wet season rainfall to replenish the source. Hydrographs for monitoring bores in the Lambells Lagoon area (DENR, 2020) indicate that groundwater is generally 4-5 m below ground level during the wet season. During the dry season, groundwater is typically 13-14 m below ground level, but levels have dropped to as low as 18.8 m in 2016 after two poor wet seasons. The total water use for the whole of farm system (stage one and stage two) is expected to be 1365kL/day, well within the total sustainable extraction volumes estimates.	3	2	**Moderate (8)**	Groundwater extraction to be conducted in accordance with GEL HGS10000 and 'announced annual allocations'. Meter and monitor water extraction rates to ensure volumes are within licence conditions. Standing water level monitoring to occur.	GEL HGS10000 Marpu Project Notice of Intent and Response to NT EPA additional Information.	2	2	**Low (4)**
Discharging wastewater (effluent)	Surface water quality	Reduction in water quality downstream of discharge point (addition of nutrients), and subsequent impacts on aquatic ecosystem health downstream of discharge point.	The main potential contaminants will be nutrients (ammonia and nitrate) from metabolic waste products and food products and bacteriological (*E.coli)*. Discharges are most likely in the wet season when the property discharge area is unable to absorb the combined inputs of effluent and catchment runoff. The Project area does not contain any water bodies, creek lines, wetlands or riparian vegetation that would support aquatic ecosystems. There are existing constructed unlined drainages that collect and direct overland flows towards the property boundaries. Overland flows in the western parts (sections 1688 and 1611) drain towards Black Jungle Swamp and in the south-eastern part towards Lambells Lagoon. The Black Jungle and Lambells Lagoon Conservation Reserves provide important year-round habitat for aquatic fauna.	4	2	**Moderate (8)**	Provide adequate wastewater storage for wet season runoff events. Establish irrigation area (vegetated and actively managed) for discharge of wastewater. Irrigation design to incorporate appropriate irrigation rates to prevent surface water ponding and generation of runoff. Treat wastewater prior to discharge/reuse. Only discharge from authorised discharge points. Establish a monitoring program, which incorporates monitoring quality of wastewater prior to, during and following discharge. Record all water quality results in a database and compare to guideline values. Monitor and record discharge volumes.	Environment Protection Licence Irrigation Management Plan Water Quality Database Water Quality Monitoring Plan	3	2	**Low (6)**

				INITIAL RISK					RESIDUAL RISK		
Activity	**Aspect**	**Impact**	**Background information and assumptions**	**Likelihood**	**Consequence**	**Risk Score**	**Controls**	**Relevant Documents**	**Likelihood**	**Consequence**	**Risk Score**
							Record and respond to any complaints received in regards to discharges.				
Discharging wastewater (effluent)	Groundwater quality	Contamination of groundwater by wastewater percolation through soil profile to aquifer.	The main potential contaminants will be nutrients (ammonia and nitrate) from metabolic waste products and food products. Discharges are most likely in the wet season when the property discharge area is unable to absorb the combined inputs of effluent and catchment runoff. The National GDE Atlas (Bureau of Meteorology 2018) does not identify any subterranean or aquatic GDE's within the project footprint. Black Jungle is a known aquatic GDE and Lambell's Lagoon as a Moderate potential aquatic GDE. The ecological integrity of these areas is reliant on surface expression of groundwater from the Howard Springs groundwater system.	4	2	**Moderate (8)**	Provide adequate wastewater storage for wet season runoff events. Establish irrigation area (vegetated and actively managed) for discharge of wastewater. Irrigation design to incorporate appropriate irrigation rates to prevent groundwater infiltration. Treat wastewater prior to discharge/reuse. Only discharge from authorised discharge points. Establish a monitoring program, which incorporates monitoring quality of wastewater prior to, during and following discharge. Record all water quality results in a database and compare to guideline values. Monitor and record discharge volumes. Record and respond to any complaints received in regard to discharges.	Environment Protection Licence Irrigation Management Plan Water Quality Database Water Quality Monitoring Plan	3	2	**Low (6)**
Irrigation of wastewater	Odours Overspray/mist generation	Impacts on comfort of neighbouring properties. Windborne particles spreading potential contaminants	The nearest stakeholders to the LLCF is the Darwin Fruit Farm and Darwin Plant Wholesalers, who will be included in ongoing consultation and communications. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the project area.	4	2	**Moderate (8)**	Irrigation design to include provision for large droplet size to prevent mist generation. Irrigation activities confined to approved irrigation areas and appropriate buffers maintained.	Environment Protection Licence - Irrigation Management Plan	3	2	**Low (6)**

				INITIAL RISK					RESIDUAL RISK		
Activity	**Aspect**	**Impact**	**Background information and assumptions**	**Likelihood**	**Consequence**	**Risk Score**	**Controls**	**Relevant Documents**	**Likelihood**	**Consequence**	**Risk Score**
Storage and use of chemicals, hydrocarbons and hazardous substances	Spills of chemicals, hydrocarbons or hazardous substances	Spills of chemicals, hydrocarbons or hazardous substances	All refuelling of vehicles occurs within a designated area. No hazardous chemicals are added to the ponds from which discharge occurs. Fuel storage on site - diesel tank All other chemicals stored in small quantities in designated bunded area	4	2	**Moderate (8)**	Training and site inductions provided to all employees. Appropriate hazardous substance storage and handling procedures. All products will be stored in accordance with AS:1940(2004) and NOHSC:1015 (2001), including bunding or self-bunded containers. All fuels are stored in double lined and bunded fuel tanks. Spill kits will be onsite, adequately sizes and stocked to respond to a spill if required. Safety Data Sheets will be kept onsite and in storage areas for all products. Chemical register is kept up to date for all chemicals, their volumes and storage locations. Following the 3 C's (contain, communicate, clean-up). Toolbox talks. Routine site inspections on all chemicals and hazardous goods containers. Robust incident reporting system/culture. Conduct water sampling as per the Water Quality Monitoring Plan	Chemical register and SDSs Spill response Incident reporting Water Quality Monitoring Plan	3	2	**Low (6)**

				INITIAL RISK					RESIDUAL RISK		
Activity	**Aspect**	**Impact**	**Background information and assumptions**	**Likelihood**	**Consequence**	**Risk Score**	**Controls**	**Relevant Documents**	**Likelihood**	**Consequence**	**Risk Score**
Waste generation	Waste	Pollution caused from poor waste management such as wind-blown waste and illegal dumping / incorrect disposal of waste. Waste attracting fauna and pests.	Waste to be disposed of at the nearest licensed waste management facility / transfer station accepting commercial waste, such as Humpty Doo or Shoal Bay Waste Management Facility.	4	1	**Low (4)**	Waste to be disposed of as required at an approved licenced waste management facility and in accordance with the NT WMPC Act. All waste streams to be segregated where possible. Listed waste (i.e. asbestos, tyres, hydrocarbon mixtures/emulsions, septic tank sludge), is to be transported and disposed of by an approved listed waste handler. All waste bins to be secure and fitted with a lid to prevent wind-blown waste, contaminated water and occurrences of pests and vermin. Waste management to prevent the introduction and spread of pest and vermin. Putrescible waste to be kept in a lidded bin and removed from site regularly. Prevent water from pooling in sumps, pits, depressions for extended periods of time. A waste management register will be used to document the type and volumes of waste. On-site concrete mixing will occur in a contained area to manage excess water and prevent wastewater from entering drainage areas.	Environmental Management Plan Waste management register Incident reporting Audit reports	3	1	**Low (3)**
General farm operations - movement of vehicle and operating farm equipment	Dust and GHG emissions	Degradation of air quality, including dust and emissions	Particulate matter including dust, plant and equipment emissions will be produced from plant and equipment operation. All works will be confined to the boundaries of LLCF. The nearest stakeholders to the LLCF is the Darwin Fruit Farm and Darwin Plant Wholesalers, who will be included in ongoing consultation and communications. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the project area.	4	1	**Low (4)**	All machinery will be regularly maintained to ensure that it is in good working order and in accordance with manufacturer's specifications. Work hours will be confined daylight hours. Avoid activities generating excessive dust and if required, implement dust mitigation measures. Traffic management	Environmental Management Plan - Consultation and Communication Plan Incident reporting	3	1	**Low (3)**

				INITIAL RISK					RESIDUAL RISK		
Activity	**Aspect**	**Impact**	**Background information and assumptions**	**Likelihood**	**Consequence**	**Risk Score**	**Controls**	**Relevant Documents**	**Likelihood**	**Consequence**	**Risk Score**
							measures implemented such as reducing speed limits and restricted access areas. Burning of material/waste will not be permitted on-site, preventing smoke and potential odour issues.				
General farm operations -pen maintenance	Excessive odours	Excessive odour - disturbance to neighbouring properties.	The nearest stakeholders to the LLCF is the Darwin Fruit Farm and Darwin Plant Wholesalers, who will be included in ongoing consultation and communications. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the project area.	4	1	**Low (4)**	Adherence to pen cleaning schedule. All putrescible waste to be stored appropriately prior to removal from site by a licensed waste contractor.	Environmental Management Plan	3	1	**Low (3)**
General farm operations - movement of vehicles	Spread of weeds	Spread of weeds – degradation of environment quality / native flora.	The small portion of remnant vegetation on site is impacted from encroaching weeds from the cleared areas. The cleared areas are largely degraded with weeds resulting from years of agricultural use (i.e. irrigated horticulture) and unmaintained prior to acquisition of the land.	5	2	**Moderate (10)**	Weed management in accordance with the NT *Weed Management Act.* Implementation of good weed hygiene practices, such as; - cleaning if plant equipment, all machinery and equipment to be certified weed free prior to mobilisation on site - prevent driving through weed infested areas - clearing of areas avoided during seeding to prevent spread - no offsite movement of soil or vegetation materials contaminated with weeds. - herbicide spraying program undertaken annually to control weed species within construction areas. - regular slashing prior to seeding - regular inspections	Environmental Management Plan	3	2	**Low (6)**

				INITIAL RISK					RESIDUAL RISK		
Activity	**Aspect**	**Impact**	**Background information and assumptions**	**Likelihood**	**Consequence**	**Risk Score**	**Controls**	**Relevant Documents**	**Likelihood**	**Consequence**	**Risk Score**
General farm operations - flushing of pens with water, water ponds and drains	Biting insects	Increased presence of and/or increased breeding sites for biting insects causing discomfort of employees/neighbours and increased mosquito borne disease risk.	The location of the LLCF, surrounded by wetlands, means the area will be exposed to high mosquito numbers and standard precautions will be required to protect employees from mosquito borne diseases.	3	2	**Low (6)**	Surface water drainage assessed during site audits ensuring water is not pooling or stagnant for extended periods of time. Effluent collection sump water levels kept to a minimum and bunded to prevent surface water ingress. All bunds and other potential water holding receptacles to be covered during the wet season. Appropriate PPE will be issued to employees for mitigation of existing biting insects due to proximity of project location to floodplains. Additional measures to be adopted during the wet season. Adherence to pen cleaning schedule.	Environmental Management Plan Audit reports	2	2	**Low (4)**
General farm operations - movement in and out of farm	Social and economic	Increased traffic to and from the LLCF impacting surrounding users of Lambells Lagoon.	Access via existing access road off Alphatonia Rd. Minor traffic associated with commencement of Stage one operations. Limited other road users to access past LLCF (Koolpinyah Stn and the Darwin Fruit Farm), road ends at Koolpinyah Station gates.	3	2	**Low (6)**	Continued consultation and communications with surrounding stakeholders and interested parties. Complaints register; - Date and time of complaint - Method complaint was made - Contact details of complainant - Details of complaint - Follow-up actions taken - Monitoring to ensure complaint has been resolved	Environmental Management Plan - Consultation and Communication Plan Traffic Management Plan	3	1	**Low (3)**

				INITIAL RISK					RESIDUAL RISK		
Activity	**Aspect**	**Impact**	**Background information and assumptions**	**Likelihood**	**Consequence**	**Risk Score**	**Controls**	**Relevant Documents**	**Likelihood**	**Consequence**	**Risk Score**
General farm operations - operation of equipment / pumps	Noise and vibration	Increased noise and vibrations generated from operation of the LLCF - impact on surrounding land users within Lambells Lagoon and reduced habitat quality.	Operational activities will only occur during the day. There are three neighbouring horticultural properties with operations areas/infrastructure that fall within a 1 km buffer. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the project area.	3	2	**Low (6)**	Noise will be managed in accordance with the NT EPA (2018) Noise Management Framework Guidelines, NT EPA (2014) Operational activities will only occur during daylight hours Farm equipment will be used as per manufacturers guidelines and modified (i.e. mufflers) as required to meet appropriate noise emission levels. All vehicles and equipment will be regularly serviced and maintained. Vehicles and equipment will not be left running when not in use. All complaints will be recorded in the complaints register and immediately assessed to prevent future noise complaints. If a noise complaint is received, the site / equipment will be assessed to ensure noise levels are within acceptable guidelines.	Environmental Management Plan - Consultation and Communication Plan	3	1	**Low (3)**
Farming of live animals	Mortality Odour	Quarantine issues or spread of diseases. Odour issues impacting neighbouring properties	Strict quarantine practices as required by the NT Government. Antibiotics administered in hatchery as necessary Pens cleaned as per farming regime and any animal waste processed according to listed waste requirements	3	2	**Low (6)**	Established quarantine practices within LLCF. Established monitoring and surveillance program to identify any potential disease outbreak. Established cleaning regime and listed waste handling procedures	Biosecurity plan	3	1	**Low (3)**
Land disturbance	Erosion and sediment control	Discharge of sediment laden water to the Black Jungle and/or Lambells Lagoon, post construction earthworks during the wet season.	Erosion and sedimentation risks are unlikely to be significant in extent as the land is relatively flat (slope <2 %).	4	2	**Moderate (8)**	A site-specific ESCP developed to align with the Best Practice Erosion and Sediment Control Guidelines (IECA, 2008), prepared by a suitably qualified person remaining active post construction to ensure erosion and sediment loss is ALARP during the wet season. . Only land required for Stage one construction was cleared	Environmental Management Plan ESCP developed for construction of stages still applied as required until appropriate levels of cover are achieved.	3	2	**Low (6)**

				INITIAL RISK					RESIDUAL RISK		
Activity	Aspect	Impact	Background information and assumptions	Likelihood	Consequence	Risk Score	Controls	Relevant Documents	Likelihood	Consequence	Risk Score
							to minimise land disturbance.				

7 ENVIRONMENTAL MANAGEMENT AND COMPLIANCE

The risk assessment process detailed in Section 6 identified controls that will be implemented to minimise the risks to the environment during operational activities. This Environmental Management Plan (EMP) provides a consolidated plan for environmental management to mitigate the environmental risks. Section 7.1 identifies the potential impacts of operations on the environment and includes environmental objectives, management and mitigation measures, performance criteria and target indicators, corrective actions and contingencies, monitoring and reporting and record-keeping mechanisms for each aspect.

7.1 Environmental provisions

Table 7-1. Environmental management plan

ACTIVITY	POTENTIAL IMPACT	OBJECTIVE / OUTCOME	MANAGEMENT ACTION	TARGET / PERFORMANCE INDICATOR	MONITORING	CORRECTIVE ACTIONS AND CONTINGENCIES	REPORTING AND RECORD-KEEPING
Filling and replenishing pens	• Reduction in groundwater availability	• No reduction in groundwater availability due to extraction.	• Extract water within permitted volumes.	• No exceedance of licenced groundwater extraction volumes	• Meter and monitor water extraction rates to ensure volumes are within licence.	• Revise meter monitoring procedure and introduce a more frequent meter reading schedule. • Review potentials for water reuse. • Assess extraction limits.	• Water usage is recorded in a database • Groundwater usage detailed in Annual Report
Discharging wastewater (effluent)	• Reduction in water quality downstream of discharge point (addition of nutrients), and subsequent impacts on aquatic ecosystem health downstream of discharge point.	• No reduction of water quality in receiving environments.	• Establish irrigation area (vegetated and actively managed) for discharge of wastewater • Irrigation design to incorporate appropriate irrigation rates to prevent surface water ponding and generation of runoff • Provide adequate wastewater storage for wet season runoff events • Irrigation of stored water during dry periods to maximise storage capacity through wet periods.	• No exceedance of approved trigger levels • No recorded incidents of wastewater runoff from irrigation area	• Establish a monitoring program, which incorporates monitoring quality of wastewater prior to and following irrigation. • Monitor and record irrigation volumes.	• Review irrigation system capabilities and opportunities for improvement. • Review potentials for water reuse • Review alternative treatment methods • Review monitoring program to allow for further detection of potential contaminants	• Record all water quality results in a database and compare to guideline values and historic/ baseline data. • Record and respond to any complaints received in regard to discharges. • Reporting undertaken through Monitoring Report and Annual Return
Discharging wastewater (effluent)	• Reduction in water quality of underlying aquifers.	• No reduction of water quality in underlying aquifers.	• Establish irrigation area (vegetated and actively managed) for discharge of wastewater • Irrigation design to incorporate appropriate irrigation rates to prevent groundwater infiltration • Provide adequate wastewater storage for wet season runoff events • Irrigation of stored water during dry periods to maximise storage capacity through wet periods.	• No change in quality of inlet water from bores in comparison to historical data	• Establish a monitoring program, which incorporates monitoring quality of wastewater prior to, during and following discharge. • Monitor and record discharge volumes.	• Review irrigation system capabilities and opportunities for improvement. • Review potentials for water reuse • Review alternative treatment methods • Review monitoring program to allow for further detection of potential contaminants	• Record all water quality results in a database and compare to guideline values and historic data. • Record and respond to any complaints received in regard to discharges. • Reporting undertaken through Monitoring Report and Annual Return
Irrigation of wastewater	• Overspray/mist generation	• No impacts on neighbouring properties from irrigation	• Irrigation design to include provision for large droplet size to prevent mist generation. • Irrigation activities confined to approved irrigation areas and appropriate buffers maintained (>50m from neighbouring properties).	• No complaints received in regard to mist generation	• Establish a monitoring plan which incorporates visual inspections of irrigation areas	• Review Irrigation Management Plan, including irrigation rates, areas, and timing	• Record and respond to any complaints received • Reporting undertaken through Monitoring Report and Annual Return

ACTIVITY	POTENTIAL IMPACT	OBJECTIVE / OUTCOME	MANAGEMENT ACTION	TARGET / PERFORMANCE INDICATOR	MONITORING	CORRECTIVE ACTIONS AND CONTINGENCIES	REPORTING AND RECORD-KEEPING
			• Irrigation restrictions pending weather conditions (rain and/or wind)				
Irrigation of wastewater	• Odour generation	• No impacts on neighbouring properties from odour during irrigation	• Irrigation design to include provision for large droplet size to prevent odour generation. • Irrigation activities confined to approved irrigation areas and appropriate buffers maintained (>50m from neighbouring properties). • Irrigation restrictions pending weather conditions (wind)	• No complaints received in relation to odour	• Establish a monitoring plan which incorporates odour monitoring by site staff • Establish a monitoring program, which incorporates monitoring quality of wastewater prior to and following irrigation	• Review Irrigation Management Plan, including irrigation rates, areas and timing • Review water quality and implement additional treatment if required (e.g. to reduce odour from BOD, oil and grease, bacteria)	• Record and respond to any complaints received • Reporting undertaken through Monitoring Report and Annual Return
Storage and use of chemicals, hydrocarbons and hazardous substances	• Uncontrolled discharge of dangerous goods or hazardous substances. • Contamination of ponds, and discharge of contaminated water into receiving environment. • Reduction in water quality downstream of discharge or spill point, and subsequent impacts on aquatic ecosystem health downstream of discharge point. • Reduction in water quality of underlying aquifers.	• No contamination to farm water, sediments or surface water as a result of chemical, hydrocarbon or hazardous substance spill.	• All refuelling of vehicles occurs within a designated area. • No hazardous chemicals are added to the ponds from which discharge occurs. • Fuel storage within self-bunded container • All other chemicals stored in designated bunded area • Training and site induction provided to all employees • Appropriate spill kits kept on-site and stocked in chemical storage and refuelling areas	• No indication of spills of chemicals or hazardous substances. • Any spill of stored product is contained and remediated through the spill response procedure. • No leaks from equipment.	• Regular inspections of chemical and hazardous substance storage areas through operational activities. • Water quality performance will be monitored through the monitoring program.	• Review storage and handling practices for chemicals and hazardous substances. • Increase the amount of bunding and containment for chemical and hazardous substance storage areas. • Increase the number, capacity or type of spill kit materials.	• Incident reporting records • Water quality database • Reporting undertaken through the Monitoring Report and Annual Return • Chemical and SDS register maintained • Hazardous material tracking undertaken through invoicing process
Waste generation	• Poorly managed site attracting native fauna and pests • Contamination to land/soils	• No introduction of pest species or increase in native fauna as a result of poor waste management practices • No contamination as a result of poor waste management practices	• Ensure waste is stored/disposed of in appropriate containers for waste type prior to disposal. • Removal of waste products by licensed waste contractors.	• No recorded incidents of pests or native fauna accessing waste • No indication of land/soil contamination	• Monitoring of waste disposal areas.	• Review waste handling and disposal practices	• Inspection records • Incident reporting records
General farm operations - movement of vehicle and operating farm equipment	• Degradation of air quality, including dust and emissions from operating farm equipment	• Minimise air emissions	• Maintenance of equipment to minimise air emissions as far as possible. • Avoid activities generating excessive dust and if required, implement dust mitigation measures.	• No complaints in relation to air quality	• Maintenance regime for all plant and equipment. • Visual monitoring during periods of dry weather and high winds.	• Review maintenance regime • Review dust control measures and implementation	• Record and respond to any complaints received
General farm operations - pen maintenance	• Disturbance to neighbouring properties associated with excessive odours	• Minimise odour	• Adherence to pen cleaning schedule. • General housekeeping around farm to reduce	• No complaints in relation to odour	• Daily pen inspections. • Inspections of waste management areas.	• Review of cleaning schedule • Review of waste management practices	• Record and respond to any complaints received

ACTIVITY	POTENTIAL IMPACT	OBJECTIVE / OUTCOME	MANAGEMENT ACTION	TARGET / PERFORMANCE INDICATOR	MONITORING	CORRECTIVE ACTIONS AND CONTINGENCIES	REPORTING AND RECORD-KEEPING
			odour sources. • All putrescible waste to be stored appropriately prior to removal from site by a licensed waste contractor.				
General farm operations - movement of vehicles	• Spread of weeds	• To prevent spread of established weeds within and off the property • To prevent introduction of new weed species to the property	• Regular control of weeds by herbicide spraying. • Regular slashing.	• No increase in the distribution of existing weed species. • No introduction of new weed species.	• Undertake regular weed outbreak inspections.	• Review weed control activities and frequency	• Inspection records • Incident reporting records
General farm operations - flushing of pens with water, water ponds and drains	• Creation of mosquito breeding habitat impacting on comfort of employees/neighbours and increased disease risk	• To prevent mosquito breeding opportunities • To reduce the potential for contact between mosquitoes and people	• Minimise any stagnant water by ensuring containers are kept out of rain. • Adherence to pen cleaning schedule.	• No prolonged areas of ponding water on-site • No incidence of mosquito borne disease	• Regular inspections of site to identify areas of ponding water and subsequent rectification.	• Review stormwater controls and site flow paths. • Review inspection regime.	• Inspection records • Record and respond to any complaints received
General farm operations - movement in and out of farm	• Increased traffic to and from the LLCF impacting surrounding users of Lambells Lagoon.	• No nuisance impacts on neighbouring properties from increased traffic	• Continued consultation and communications with surrounding stakeholders and interested parties. • Operational traffic management plan if required	• No complaints in relation to increased vehicle movements	• Sign in/out register to monitor movement of personnel to and from site	• Review traffic management plan	• Record and respond to any complaints received • Visitor register
General farm operations - operation of equipment / pumps	• Increased noise and vibrations generated from operations of the LLCF - impact on surrounding land users within Lambells Lagoon and reduced habitat quality.	• No impacts on neighbouring properties from noise or vibration.	• Operational activities will only occur during daylight hours • Equipment maintained and serviced regularly	• No complaints in relation to noise or vibration	• Maintenance regime for all plant and equipment	• Review maintenance regime • Review noise control measures and implementation	• Record and respond to any complaints received
Farming of live animals	• Quarantine issues or spread of diseases.	• No introduction or spread of disease across the farm or into the receiving environment.	• Established quarantine practices within Lambells Lagoon Crocodile Farm.	• No recorded incidents of disease spread/outbreak	• Established monitoring and surveillance program to identify any potential disease outbreak.	• Review quarantine practices • Review monitoring program	• Inspection records • Incident reporting records
Land disturbance	• Discharge of sediment laden water to the Black Jungle and/or Lambell's Lagoon, post construction earthworks during the wet season.	• To minimise erosion and sedimentation of receiving waterways	• Erosion and sediment control structures maintained for the duration of the first wet season following land disturbance activities during construction	• Minimal loss of topsoil • Minimal erosion observed • Minimal sedimentation impacts downstream	• Surface water monitoring program monitor turbidity, TDS and erosion and sedimentation observations. • Regular inspections of site to identify areas of erosion and sedimentation issues. Monitor efficacy of erosion and sediment control structures.	• Review stormwater controls and site flow paths. • Maintenance of erosion and sediment control structures. De-silt as required.	• Inspection records • Incident reporting records • Surface water quality data

7.2 Training and awareness

All new site personnel, contractors, and unaccompanied visitors will complete a site induction prior to commencing work on-site. The induction will include details of the emergency procedures, site familiarisation, environmental awareness, incident reporting, spill response, and familiarisation of the EMP. Induction and training activities will be reviewed regularly to ensure they contain the most up-to-date information and procedures.

A training and induction register will be maintained. All personnel required to operate machinery and complete their required duties will be appropriately trained, licenced and suitably qualified. Relevant staff will have training provided so that they are able to undertake the environmental management and monitoring activities specified in this plan including first aid and spill response. In-house training will be provided by relevant contractors (consultants) in specific environmental monitoring tasks.

A daily pre-start meeting is held where all issues, including those pertaining to the environment, are discussed. Staff members are able to raise any concerns or issues.

Scheduled regular toolbox meetings will keep employees informed of environmental issues, as well as safety awareness and hazards in the workplace. This will ensure that personnel are continually aware of environmental management activities on the site and enable any issues to be identified and resolved.

7.3 Roles and responsibilities

Unless otherwise specified, the provisions within this EMP are the responsibility of the Farm Manager.

7.4 Non-conformance and corrective actions

The specific environmental actions stipulated in this section provide the overarching performance indicators for the site, against which management methods can be assessed. If it is identified that the safeguards are not being met, or unexpected issues arise, a process must be in place to implement corrective actions and adapt management methods.

Any non-conformance will be documented through site inspections/audits stating the nature of the non-conformance and the mechanisms implemented to correct the incident.

The Farm Manager should be notified of any non-conformance within 24 hours of it occurring. Corrective / preventative action should be completed within a timely manner (e.g. within seven days of the event occurring) to ensure that the incident is addressed. Records will be kept of all environmental incidents that occur, and corrective actions implemented. If management controls are not implemented and completed in the designated manner, additional training may be required for the Farm Manager, employees and/or subcontractors.

In the event results of environmental monitoring show levels exceeding the developed trigger values, an investigation will determine the cause and further sampling may be required to determine extent of impact and corrective actions and adapt management methods will be implemented.

Auditing of the site operational efficacy will be based of the monitoring requirements meeting the SSTV's and conditions as per approved environmental monitoring plans.

8 ENVIRONMENTAL MONITORING PLAN

8.1 Objectives

The following environmental protection objectives (EPOs) under the *WMPC Act* and *Water Act* are applied to the Project:

- environmental quality is to be maintained, enhanced, managed or protected
- pollution, or environmental harm resulting from pollution, is to be assessed, prevented, reduced, controlled, rectified or cleaned up
- effective waste management is to be implemented or evaluated
- protect the beneficial use of the Darwin Rural Water Control District as declared under the *Water Act.*

The monitoring program will provide early-warning of surface and groundwater quality and soil quality issues and inform adaptive management of the operational water management including the wastewater treatment system, to achieve water quality criteria; and monitor off-site impacts to receiving surface waters and groundwater.

8.2 Operational monitoring program

During farm operations, environmental sampling will be conducted on surface water, irrigation water, groundwater bores and soil. Program details are outlined below.

The site sampling locations for surface water and groundwater are shown on Figure 8-1.

8.2.1 Surface water

There are no well-defined watercourses flowing onto the site (representing background/reference). An adjacent creek to the west of the Project area has been identified as a suitable upstream control site and a location further downstream within Black Jungle conservation reserve, monitoring potential impacts, receiving discharge water from the western boundary. The monitoring sites at the property boundary is indicative of the quality of water leaving the site.

Surface water sampling is to be undertaken through the wet season when site runoff is generated. Sampling shall be undertaken at upstream and downstream locations each sampling event when the sites are flowing (not stagnant).

Table 8-1. Surface water monitoring program

Monitoring sites	Easting*	Northing*	Control / Impact	Description	Parameters	Frequency
SW01	744770	8610323	Impact	Drainage line west of Alphatonia Rd. at Property entrance, receiving water runoff from Stage one – parcel 1611, flowing east to Lambells Lagoon.	*Field measurements* • pH • EC *Laboratory analysis:* • Total nitrogen • Total	3 times during the wet season (start, during, end)
SW02	745229	8612655	Control	Drainage line west of Alphatonia Rd. at the north-east corner of		

Monitoring sites	Easting*	Northing*	Control / Impact	Description	Parameters	Frequency
				parcel 1688. Receiving surface water runoff from Alphatonia Rd flowing west along the northern boundary into Black Jungle CN.	phosphorous • *E.coli, Enterococci,* total coliforms	
SW03	743417	8610332	Impact	Drainage line on south-west boundary corner of parcel 1611 flowing west to Black Jungle CN. Downstream stormwater drainage from stage two.		
SW04	744480	8612413	Impact	Drainage line north-west of parcel 1688 flowing west to Black Jungle CN. Surface water runoff from irrigation area proposed for stage two.		
SW05	742993	8610872	Impact	Monitoring creek flows downstream of SW3 to receiving Black Jungle CN		
SW06	742978	8609442	Control	Upstream creek on western side of Project, flowing into Black Jungle CN. Upstream of SW03 discharge point.		

*GDA94 Zone 52L

8.2.2 Groundwater

Groundwater sampling is proposed from five bores and standing water level (SWL) from an additional bore (Table 8-2), to detect any potential migration of contaminants from the irrigation areas and farm operations and monitor SWL. Where these bores do not provide for adequate monitoring of seepage from the irrigation areas, there may be a requirement to install additional bores downstream of the irrigation areas. An NTG Water Resources investigation bore (RN30344), located on the western boundary, collects and records SWL data from 1996 to current. Whilst the SWL data is available publically for download on the NT Water Data Portal, water quality monitoring is unable to be undertaken.

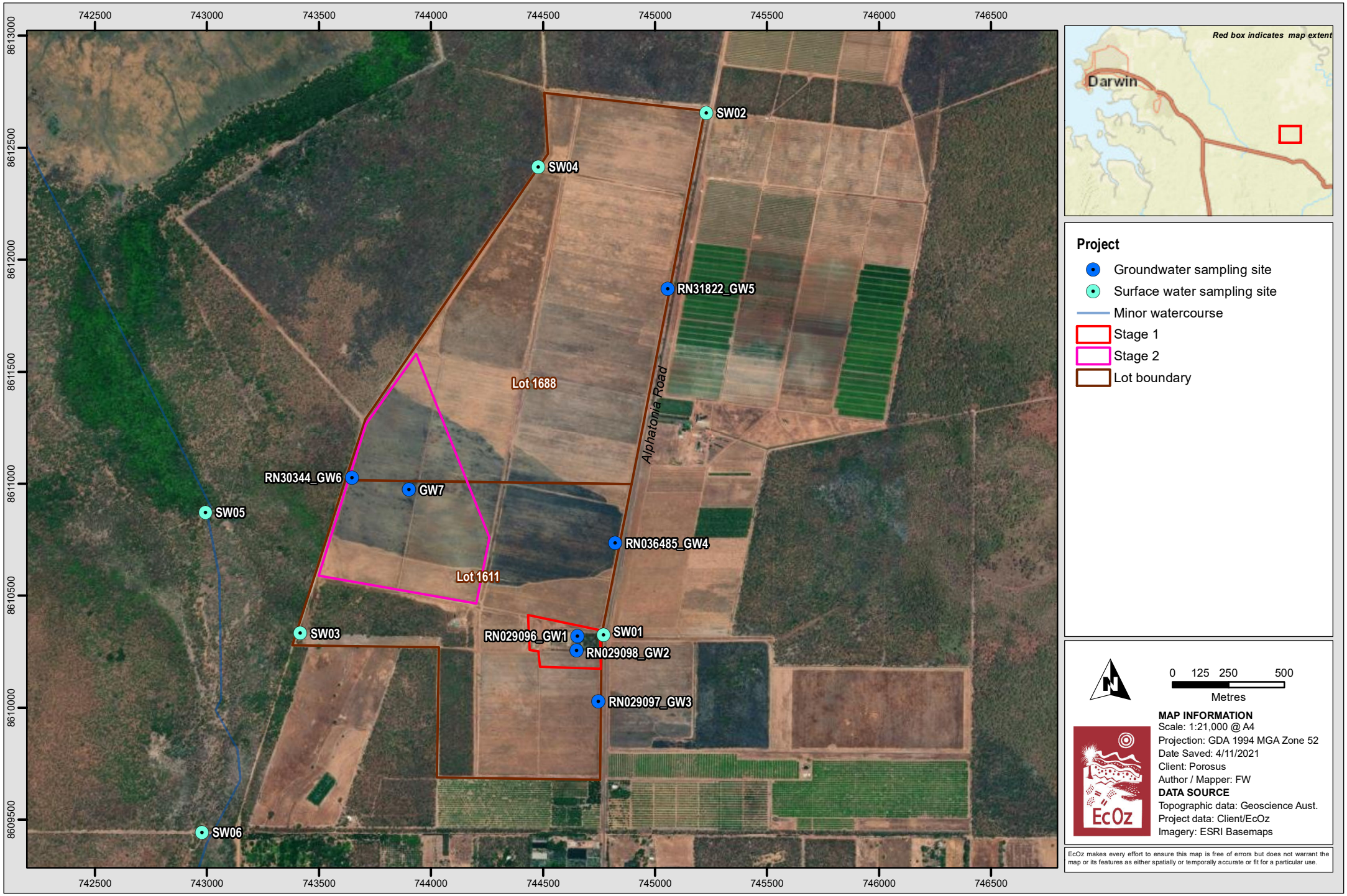
Table 8-2. Monitoring program for groundwater sites

Monitoring sites	RN	Easting	Northing	Completion depth (m)	Location and description	Parameters	Frequency
GW1	RN029096	744654	8610320	47	Bore located adjacent to the existing office facilities and east of incubation	*Field measurements* • pH • EC • Standing water level (SWL)	Quarterly

Monitoring sites	RN	Easting	Northing	Completion depth (m)	Location and description	Parameters	Frequency
					building. Water supply bore.	*Laboratory analysis:* • Total nitrogen • Total phosphorous • *E.coli, Enterococci,* total coliforms • Cations and anions (Ca, Mg, Na, K, SO4, Cl, $CaCO_3$).	
GW2	RN029098	744649	8610254	44.5	Bore located adjacent to the proposed hatchery. Water supply bore.		
GW3	RN029097	744748	8610026	103.3	Bore located west of Alphatonia rd. within south-east section of parcel 1611.		
GW4	RN036485	744823	8610734	62.2	Bore located west of Alphatonia rd. within north-east section of parcel 1611.		
GW5	RN31822	745056	8611871	87.6	Bore located west of Alphatonia rd. within parcel 1688.		
GW6	RN30344	743648	8611027	36.5	Water Resources Bore equipped with water level logger. Located on the western side of Project on boundary, SW corner of parcel 1688 downstream Stage 2.	SWL (data accessed online)	As determined by NT Water Resources –logger – 4 logged intervals per year.

Monitoring sites	RN	Easting	Northing	Completion depth (m)	Location and description	Parameters	Frequency
GW7	*TBA	*743902	*8610973	*TBA	New bore located in stage two area near retention basin. Water supply bore for stage two operations.	*Laboratory analysis:* • Total nitrogen • Total phosphorous • *E.coli, Enterococci,* total coliforms • Cations and anions (Ca, Mg, Na, K, SO4, Cl, $CaCO_3$).	Quarterly

* TBA – new bore to be installed mid-November 2021 (coordinates estimate only)



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19153 - MARPU Project Environmental Approvals\01 Project Files\Figure 8-1 Map of proposed surface and groundwater operational monitoring bores.mxd

Figure 8-1. Map of proposed surface and groundwater operational monitoring locations

8.2.4 Irrigation water

Treated effluent quality and volumes will be monitored at the irrigation extraction points / authorised discharge points at stage one and stage two prior to irrigation (Figure 8-1).

The monitoring parameters and frequencies of sampling for the irrigation water are outlined in Table 8-3

Table 8-3. Monitoring parameters and frequencies for irrigation water

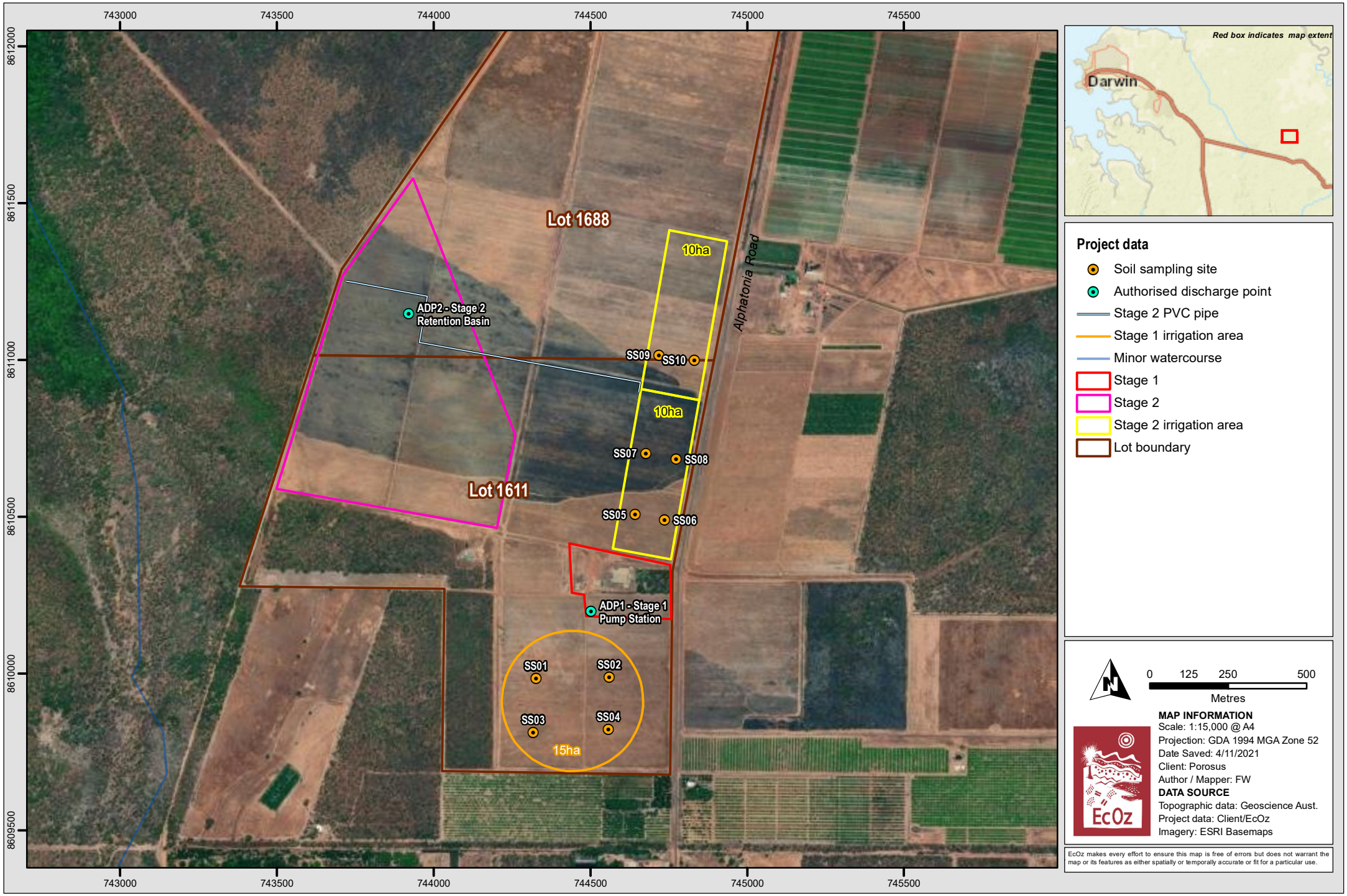
Monitoring sites	Parameter	Sampling frequency
Irrigation extraction points / authorised discharge points (ADP1 and ADP2)	pH	Monthly when discharging and quarterly when not discharging
	EC	
	Total P	
	Total N	
	Cations & anions (Ca, Mg, Na, K, SO4, Cl, CaCO3)	
	E.coli, Enterococci, Total coliforms	
	Herbicides (Glyphosate)	Annually
	Nitrate, Ammonia and organic N	Quarterly (required to calculate nutrient loading)

8.2.5 Soil

Soil samples will be taken from the area where Stage one and stage two irrigation areas (Figure 8-1 and Table 8-4. Soil monitoring program The number of soil sampling sites will increase when the irrigation area is increased for the full-scale system of 100 ha.

Table 8-4. Soil monitoring program

Monitoring sites	Easting (52L)	Northing (52L)	Description	Parameters	Frequency
SS01	744326	8609983	Stage one irrigation area (15 ha)	• pH • Electrical conductivity (EC) • Total nitrogen & phosphorous • P-sorption • Nitrogen oxides	Annual
SS02	744560	8609986			
SS03	744317	8609812			
SS04	744557	8609821			
SS05	744683	8610449	Stage two irrigation area (20 ha)		
SS06	744679	8610651			
SS07	744772	8610801			
SS08	744725	8610971			
SS09	744811	8611124			
SS10	744811	8611299			



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19153 - MARPU Project Environmental Approvals\01 Project Files\Figure 8-2 Map of proposed authorised discharge points and soil monitoring locations.mxd

Figure 8-2. Map of proposed authorised discharge points and soil monitoring locations

8.3 Assessment criteria

8.3.1 Surface water

Water quality from downstream locations will be compared against the upstream location and previously sampled baseline data to determine any significant changes in quality that may be attributable to site operations. For all ongoing monitoring, where the results indicate a difference of 10% or greater, the Darwin Harbour Water Quality Objectives for freshwater rivers and streams and lagoons will be used as a guidance for trigger values (Table 8-5). If the results indicate contamination from site, further investigation is to be undertaken and the NT EPA notified under the conditions of the EPL.

Site specific trigger values (SSTVs) will be developed as part of the baseline monitoring. If baseline monitoring determines existing conditions exceed the 10% threshold, alternative trigger limits will be determined for the affected parameters.

Table 8-5. Darwin Harbour water quality objectives for freshwater rivers and streams and lagoons

Parameter	Trigger value – freshwater rivers and streams	Trigger value –lagoon
pH	6.0-7.5	5.0-6.0
EC	<200 µS/cm	<25 µS/cm
Total P	<0.01 mg/L	<0.02 mg/L
Total N	<0.23 mg/L	<0.55 mg/L

8.3.2 Groundwater

Groundwater quality will be compared against the trigger values identified in Table 8-6. The listed trigger values have been adopted from the Darwin Harbour Water Quality Objectives for groundwater. Where there are significant increases in the parameters measured, further assessment will be undertaken to determine potential sources of contamination.

Groundwater quality will be compared against baseline conditions. The Hazen percentile calculator will be used to calculate 80th percentile parameters across the bores from the current data available, in order to develop trigger values for comparison.

Table 8-6. Trigger values for groundwater

Parameter	Trigger value
pH	7.0 – 8.5
EC	<400 µS/cm
Total P	Any increase from previous monitoring round
Total N	
E.coli, *Enterococci*, Total coliforms	
Cations and anions	N/A

8.3.3 Irrigation water

Ongoing monitoring will be undertaken to ensure that the quality remains within the acceptable limits for irrigation in the nominated area.

Trigger values were derived from the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 3 – Chapter 9 – Primary Industries* (ANZG, 2000) guidelines. Where there are significant increases in the parameters measured, further assessment will be undertaken to determine the impact on irrigation.

Table 8-7. Monitoring program and trigger values for irrigation water

Monitoring sites	Parameter	Indicative Trigger values
Irrigation Extraction Point (s)	pH	6-9[1]
	EC	1,300 µS/cm [1]
	Total P	12 mg/L [1]
	Total N	125 mg/L[1]
	Cations & anions (Ca, Mg, Na, K, SO4, Cl, CaCO3)	N/A
	E.coli, Enterococci, Total coliforms	> 1,000 cfu/100mL (fodder) [1]

Note: [1] Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 3 – Chapter 9 – Primary Industries (ANZG, 2000) irrigation water quality Short Term Trigger Values.

8.3.4 Soil

Soil quality will be compared against existing baseline conditions. Where there are significant increases in the parameters measured, further assessment will be undertaken to determine the impact on irrigation.

Table 8-8. Irrigation area soil baseline conditions

Parameter	Trigger value*
pH	6 – 8
EC	Any increase from baseline soil data
Total Phosphorus	
P sorption capacity	
Total Nitrogen	
Nitrate + nitrite (NOx)	

Annual nutrient balance calculations should be undertaken and compared with the soil monitoring results to assess the sustainability of the effluent irrigation system. If the wastewater is managed so that the nitrogen and phosphorous input and output levels remain consistent, the overall soil nutrient concentrations should remain consistent. The key parameters of soil, including; TN, TP, salinity and sodicity, should be graphed and compared annually, to identify any nutrient application issues or irrigation practices that may need to be altered.

8.4 Quality assurance and quality control

All sampling and handling of samples is to be undertaken in accordance with the relevant standards and guidelines as outlined below:

- Australian Standard on Water Quality Sampling - Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS 5667.1:1998);
- Australian Standard on Water Quality Sampling – Part 6: Guidance on sampling of rivers and streams (AS/NZS 5667.6:1998);
- Australian Standard on Water Quality Sampling – Part 10: Guidance on sampling of wastewaters (AN/NZS 5667.10:1998)
- Australian Standard on Contaminated Soil Sampling – Guide to the sampling and investigation of potentially contaminated soil – Part 1: Non-volatile and semi-volatile compounds (AS4482.1-2005)
- ANZG & ARMCANZ 2000, Australian Guidelines for Water Quality Monitoring and Reporting, National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- ANZG & ARMCANZ 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Monitoring equipment will be calibrated prior to use and calibration checks performed to be within an acceptable range. Sampling will be collected, preserved, stored and transported in accordance with above standards and sampled by a suitably qualified sampler. All samples will be tracked with a chain of custody and sample receipt/record of delivery. Adequate sampling frequency, duplicates, triplicates, blanks and inter-laboratory checks will be undertaken as per sampling methodology.

All samples will be analysed in accordance with National standards, and an accredited National Association of Testing Authority (NATA).

8.5 Audits and inspections

Internal and external audits are undertaken on a yearly basis. These audits include compliance with the EMP and occupational health & safety and environmental aspects of the operation. The auditor reports findings to the Farm Manager and the Managing Director.

Pen areas are inspected daily and any issues are recorded in a daily report. Inspections include the following environmental aspects:

- Water levels in pens and input requirements
- Wastewater outbreaks or leaks
- Animal health and potential disease outbreaks

Visual inspections of the irrigation areas for mist/overspray, odour and potential runoff will be undertaken daily during irrigation activities.

Response to environmental incidents and complaints is details in section 9.2 and section 10.2 respectively.

8.6 Reporting and records

8.6.1 Internal

Reporting requirements are in accordance with the EMP. The EMP will be reviewed annually to reflect any changes in operations.

Details of environmental incidents, non-conformances or other relevant information are included in daily reports which are issued to the Managing Director. Records of all incidents, inspections and reports are maintained through an electronic filing system.

All environmental monitoring records will be maintained in a water and soil quality database and will be available upon request to the NT EPA.

An annual report is also prepared which details and reviews annual water usage, waste generation and energy use across the farm.

8.6.2 External

Non-compliances with the EPL will be reported by completing a Non-Compliance Notification via the NT EPA website within 24 hours of the event. The non-compliance notification will include:

- Date and time on non-compliance
- When the non-compliance was detected and by whom
- Nature of non-compliance
- The actual and potential causes and contributing factors to the non-compliance
- The risk of environmental harm as a result of the non-compliance
- Actions taken to mitigate environmental harm as a result of the non-compliance
- Corrective actions to prevent re-occurrence
- If no action was taken, explanation why; and
- Date when investigation report will be submitted to the NT EPA.

An Annual return will be submitted to the NT EPA on the anniversary date of the EPL to summarise the activities and outcomes of the previous 12 months. Additionally, a Monitoring Report will be prepared and submitted with the Annual Return that includes a trend analysis of the water quality monitoring data and an assessment of any environmental impacts from operations.

9 EMERGENCY RESPONSE PLAN

Emergency response planning includes responses to environmental emergencies, and operational actions that cause an environmental incident. The Emergency Response Plan (ERP) provides detailed information regarding the types of environmental emergencies that could be experienced at the Project as well as specific procedures for flood events, cyclone and sever weather. The ERP also outlines the roles and responsibilities of the Emergency Response Team in responding to environmental emergencies.

Table 9-1 lists the potential emergency events and relevant responses, applicable to the operation of the Project.

Table 9-1. Emergency events and responses

Emergency event	Relevant response
Medical	Preparation • Site-based staff trained in first aid • First aid equipment maintained on site In the event of a medical emergency: • First aid to be administered by trained first aid personnel. • If required call emergency services (000) for assistance.
Bushfire	Preparation • Ensure firebreaks surrounding perimeter of the facility is adequately cleared all year round in accordance with the Bushfires Management Act 2016. • If hazard reduction burns are identified as necessary on site, a burn permit is to be applied for through the local Lambells Lagoon Volunteer Bushfire Brigade (M: 0414 576 363 Email: llvbfb11@gmail.com). • Ensure no remnant materials, that could cause a fire hazard, are built up on the site. • If smoke is visible in the vicinity of the Project, utilise the North Australian Fire Information (NAFI) website as a first response capacity to track the bushfire. In the event of a fire • If required call external Lambells Lagoon Volunteer Bushfire Brigade (M: 0414 576 363) or emergency services (000) for assistance. • Arrange for safe removal of personnel and contractors from any dangerous situation. • If able to be conducted safely, apply appropriate firefighting equipment to fire source (Ensure that water or water-based suppression is not applied to Class E (electrical) fires until de-energised). • Secure the area and do not allow any disturbance to the Project area • Ensure all hazards identified and managed / isolated prior to entry. • Allow only designated personnel into the Project area.
Fire / explosion on site	
Cyclone	Preparation • All rubbish and other materials that could be projectiles in the event of tropical cyclone conditions to be removed, stored or tied down as appropriate. Cyclone watch • Secure or remove all unfixed items • Check to ensure all fuel tanks are full (for vehicles, equipment and generators) (if applicable). • Check to ensure equipment/ machinery stored in the open are secured. Cyclone warning • Ensure all portable equipment/ machinery and related items are tied down, and when advised, vacate the Project area and move off site as advised by the Site Manager or Northern Territory Emergency Services.

Emergency event	Relevant response
Flood event	Preparation • Secure / store any loose materials or equipment that has the potential to cause harm or damage in a safe location. • Park any vehicles/ equipment to be left at the facilities, under solid shelter. • Secure all external doors and windows (if applicable). • Disconnect all electrical items, external radio aerials and computer equipment (if applicable). • Listen to announcements on ABC Local Radio 105.7FM for weather updates. Unexpected / during • Personnel on site to move to any fastened structure or vehicle on site. • Move all people away from windows and shut windows. • Shut doors and shelter in the strongest part of the structure. • Stay inside. • Monitor all directions from staff/ emergency services. After • Listen to your portable radio for Warning updates. • Check for damaged windows, walls, or roof. Temporarily cover with plastic sheeting and nailed on wooden strips (if applicable). • For emergency assistance, contact your local emergency services call **000.** • If you don't need help, check, and if necessary, help your neighbours. Don't go sightseeing.
Severe weather	
Fuel or chemical spill	In the event of a spill of a contaminating material, the spill response procedure is to be implemented as per the subsequent section below.
Unauthorised discharge	In the event of an unauthorised discharge in accordance with the EPL, the NT EPA will be notified with a Section 14 pollution incident report. All reasonable attempts will be made to control, contain, clean-up and dispose of the material. An incident investigation will occur to prevent future reoccurrence and conduct environmental monitoring to mitigate prolonged potential risk to the environment.
Disease outbreak	In the event of a disease outbreak resulting in crocodile mortalities and large-scale quantities of biological wastes, the disease is to be immediately diagnosed through the Berrimah Veterinary Laboratory and measures taken according to the farm biosecurity plan.

General emergency response preparedness is undertaken through the following actions:

- Ensure that all personnel including management have received a site induction that specifically covers emergency response procedures
- The Farm Manager and ERT regularly liaise with staff to ensure that they are competent in responding to emergencies
- Conduct regular inspections on all emergency response equipment and ensure that all equipment is in good working order
- Undertake emergency drills to ensure all employees and contractors can be accounted for, assess response to the drill and provide learnings and continual improvements.
- Following an emergency event, undertake an incident debrief and provide all staff with training into improved emergency response procedures or actions.

9.1 Spill response procedure

All spills will be addressed under the following procedure:

- **Assess** the spill by determining:
  - The type of spill
  - Location of the spill
  - Source of the spill, and whether it can be isolated

- The requirements to address the spill – i.e. personal protective equipment, volume of spill control materials, etc.

- **Severity** of the spill as per **Table 9-2** and **Table 9-3**.

Table 9-2. Assessing the severity of the spill

Type	Potential Consequence
Minor	Reversible and localised impact on the environment. OR Environmental impact requires a programmed commitment of time and/or money to remediate, OR would take less than 2 years to recover naturally.
Moderate	Significant but reversible, OR irreversible and localised, impact on the environment. OR Environmental impact requires a programmed commitment of moderate time and/or money to remediate, OR would take 2-10 years to recover naturally.
Major / severe	Significant AND irreversible impact on the environment. OR Environmental impact requires emergency commitment of significant time and/or money to remediate, OR would take more than 10 years to recover naturally.

In terms of volume, the following can be used as a guideline for determining severity.

Table 9-3. Volume of spill to determine severity

Minor	<100 L to inland waters/land
Moderate	100 – 1,500 L to inland waters/land
Major / sever	>1,500 L to inland waters/land

- **Secure** the spill – if safe to do so, the spill should be immediately secured, by eliminating the source, barricading the area to prevent personnel from accessing the area unnecessarily.
- **Control** the spill – by constructing an earthen bund, or by deploying suitable absorbent spill kit materials (i.e. absorbent booms, absorbent pads, granular absorbents, disposable bags and ties).
- **Dispose** of the contaminated material – which will be determined by the nature and extent of the spill. Advice will be sought from Litchfield Council and the relevant authorities (i.e. the NT EPA) to determine the appropriate disposal method for the contaminated material. Used absorbent material including granular absorbents, boom and pads shall be put into disposable bags, tied and placed in regular waste bins. Bags will be clearly labelled and transported to a licenced waste disposal facility as soon as possible.
- **Report** the spill – Any spill within the Project construction area is to be reported to the Project Manager as soon as possible (and within 24 hours). Lambells Lagoon Crocodile Farm Project Manager will be responsible for reporting the spill to the NT EPA that are of a moderate or major severity level.

9.2 Incident reporting

The Farm Manager is the contact person for all emergencies and environmental incidents. All incidents which cause or have the potential to cause environmental pollution will be reported to the NT Environmental

Protection Authority (NT EPA) as soon as possible after the event, and in any case within 24 hours, as required under Section 14 of the NT *WMPC Act*.

The details of the designated contact persons for emergencies and environmental incidents are included in Table 9-4. This includes contacts for reporting pollution incidents (including non-urgent problems such as dust/noise) and contacts for provision of advice.

Table 9-4. Emergency contact details

Entity	Contact Details
NT EPA Pollution Hotline / Pollution reporting	Level 1 Arnhemica House, 16 Parap Road, Parap NT 0820 Pollution Hotline: 1800 064 567 pollution@nt.gov.au
NT Police / Fire	131 444 / 000
PRI Group Managing Director	Michael Burns PO Box 3942, Darwin NT 0801 P: 08 8988 1491 M: 0407 638 300 E: mick@biznt.com
Farm Manager	Michael Burns
DEPWS - Works on waterway, fauna sightings, vegetation clearing	Level 1, Goyder Centre, 25 Chung Wah Terrace, Palmerston NT 0830 08 8924 4218 (general services) 08 8999 4455 (water resources general enquiries)
EcOz Environmental Consultants	70 Cavenagh Street, Darwin NT, 0801 08 8981 1100 ecoz@ecoz.com.au

10 CONSULTATION AND COMMUNICATION PLAN

10.1 Stakeholder and community engagement

Consultation with stakeholders is undertaken directly through written (letters, emails) or verbal communication (meetings, phone calls) as required. Relevant stakeholders for the Project are outlined in Table 10-1.

Table 10-1. Relevant stakeholders

Stakeholder	Relationship
NT Government	
NT EPA	Issuer and regulator of the EPL and its compliance
DEPWS	Water Resources - Groundwater extraction regulation. Parks and Wildlife - Issuer and regulator of wildlife permits and permit access into Black Jungle CN for monitoring a downstream surface water location.
Industry	
Crocodile Farmers Association NT	Crocodile Farmers Industry body for NT
Lambells Lagoon Operations	
Employees	Workforce
Contractors	
Surrounding land users	
Darwin Fruit Farms	Neighbouring stakeholders
Darwin Plant Wholesalers	
Koolpinyah Station (PPL1147)	
Volunteer Fire Brigade Station	

10.2 Complaint management

For any complaints received regarding the operations of the farm or associated activities, a register of complaints will be kept that records:

- Date and time the complaint was reported
- Method by which complaint was made (i.e. telephone, letter, meeting, etc.)
- Person to whom the complaint was made
- Name, address, contact telephone number of complainant/s
- Details of complaint, including; nature of complaint, date and time of event giving rise to the complaint, prevailing weather conditions at the time if relevant to the complaint,
- Action taken in response to the complaint, including follow up contract with the complainant
- Any monitoring to confirm the complaint has been satisfactorily resolved

- If no action was taken, the reason for no action being taken.

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APPENDIX A BASELINE SOIL QUALITY RESULTS

ES2002110	Date Sampled	23/01/2020	Preferred Levels* for crop/plant growth (NSW DPI, 2004)	NEPM TABLE 1-A 2013 (SOIL) - HIL A (Residential) Guideline Limit	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Physio-chemistry	Units	LOR			ES2002110001	ES2002110002	ES2002110003	ES2002110004	ES2002110005	ES2002110006	ES2002110007	ES2002110008	ES2002110009	ES2002110010	ES2002110011	ES2002110012	ES2002110013
pH Value	pH Unit	0.1	-	-	7	7.5	6.5	6.9	7.1	6.7	6.5	6.1	6.7	5.6	6.4	6.9	6.7
Sodium Adsorption Ratio	-	0.01	-	-	0.21	0.2	0.12	0.1	0.12	0.17	0.24	0.2	0.06	0.16	0.16	0.15	0.18
Electrical Conductivity @ 25°C	µS/cm	1	-	-	29	45	22	31	36	18	25	15	24	12	22	30	30
Moisture Content	%	1	-	-	17.2	14	13.6	14.4	16.2	12	16.8	10.2	11.2	10.7	14.5	15.6	15.4
Color (Munsell)	-		-	-	Black (10YR 2/1)	Black (10YR 2/1)	Very Dark Gray (10YR 3/1)	Black (10YR 2/1)	Very Dark Gray (7.5YR 3/1)	Dark Brown (10YR 3/3)	Very Dark Brown (7.5YR 2.5/2)	Very Dark Gray (10YR 3/1)	Very Dark Grayish Brown (10YR 3/2)	Very Dark Gray (10YR 3/1)	Very Dark Brown (7.5YR 2.5/3)	Very Dark Brown (7.5YR 2.5/3)	Very Dark Brown (7.5YR 2.5/3)
Emerson Class Number	-		-	-	3	3	3	3	3	3	7	3	3	3	3	3	3
Texture	-		-	-	Clay Loam	Loam	Clay Loam	Loam	Sandy Clay Loam	Sandy Loam	Clay Loam	Clayey Sand	Clayey Sand	Loamy Sand	Clay Loam	Clay Loam	Clay Loam
Exchangeable Cations on Alkaline Soils																	
Cation Exchange Capacity	meq/100g	0.2	-	-	-	2.7	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Calcium	meq/100g	0.2	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Magnesium	meq/100g	0.2	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Potassium	meq/100g	0.2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Sodium	meq/100g	0.2	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Sodium Percent	%	0.2	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Cations																	
Cation Exchange Capacity	meq/100g	0.1	-	-	7.1	-	4.4	6.6	7.4	2.2	4.2	1.3	3.7	0.5	3	6.5	5.1
Exchangeable Calcium	meq/100g	0.1	-	-	4.5	-	3	4.2	5.5	1.6	2.5	0.9	2.7	0.2	2	4.1	3.2
Exchangeable Magnesium	meq/100g	0.1	-	-	1.8	-	0.8	1.7	1.4	0.4	1.1	0.2	0.7	0.2	0.7	1.7	1.3
Exchangeable Potassium	meq/100g	0.1	-	-	0.8	-	0.5	0.7	0.5	0.2	0.6	0.1	0.2	<0.1	0.3	0.6	0.6
Exchangeable Sodium	meq/100g	0.1	-	-	0	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium Percent	%	0.1	-	-	0.3	-	0.3	0.2	0.2	0.7	0.5	0.8	0.3	2.5	0.5	0.3	0.3

ES2002110	Date Sampled	23/01/2020	Preferred Levels* for crop/plant growth (NSW DPI, 2004)	NEPM TABLE 1-A 2013 (SOIL) - HIL A (Residential) Guideline Limit	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Physio-chemistry	Units	LOR			ES2002110001	ES2002110002	ES2002110003	ES2002110004	ES2002110005	ES2002110006	ES2002110007	ES2002110008	ES2002110009	ES2002110010	ES2002110011	ES2002110012	ES2002110013
Total Metals																	
Arsenic	mg/kg	5	<20	100	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	mg/kg	1		20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	2		-	11	49	18	36	42	25	11	54	25	27	14	16	14
Copper	mg/kg	5	2 - 50	6000	5	<5	<5	<5	<5	<5	7	<5	<5	<5	5	9	6
Lead	mg/kg	5	<35	300	7	7	5	6	7	5	9	5	5	<5	7	7	6
Nickel	mg/kg	2	1 - 20	400	2	<2	<2	<2	<2	<2	2	<2	<2	<2	<2	<2	<2
Zinc	mg/kg	5		7400	29	24	15	21	20	8	<5	<5	6	<5	<5	17	12
Mercury	mg/kg	0.1		40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nutrients																	
Nitrite + Nitrate as N (Sol.)	mg/kg	0.1		-	1.2	1.4	1.9	1.7	1.7	0.8	1.5	0.6	0.8	0.6	1.9	1.1	2.5
Total Kjeldahl Nitrogen as N	mg/kg	20		-	980	880	790	860	920	390	1310	850	520	580	800	930	760
Total Nitrogen as N	mg/kg	20	>10	-	980	880	790	860	920	390	1310	850	520	580	800	930	760
Total Phosphorus as P	mg/kg	2	20 - 30	-	**301**	**334**	**325**	**411**	**314**	**153**	**345**	**181**	**210**	**128**	**238**	**500**	**303**
Phosphate Sorption Capacity	mg P sorbed/kg	250		-	1610	1150	1030	1020	1350	562	1710	476	1010	862	1130	1280	1220
Phosphate Sorption Index	mgkg-1/log10ugL-1	1		-	51	27	43	35	50	26	67	45	40	58	66	41	46

APPENDIX B BASELINE SURFACE WATER QUALITY RESULTS

Analyte	Units	LOR	*ANZG 2000 Prot. Aquatic Ecosystems - Freshwater 95% protection*	*ANZG 2000 Prot. Aquatic Ecosystems Tropical - Freshwater Lakes & Reservoirs*	SW01	SW02	SW03	SW04
Field Parameters								
pH	pH		-	6.0 - 8.0	**5.64**	**5.52**	**5.83**	**5.62**
Temperature	oC		-	-	27.2	27	27.3	26.9
Electrical Conductivity (EC)	µS/cm		-	-	17.4	15.2	19.1	24.1
Total Dissolved Solids (TDS)	mg/L		-	-	12.7	11	14	18
Salinity	ppt		-	-	0.01	0.01	0.01	0.01
Dissolved Oxygen (DO)	%sat		-	90 - 120	**84**	94	**83**	**87**
Turbidity	NTU		-	-	29	47	24	14.3
Dissolved Metals								
Arsenic	mg/L	0.001	-	-	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0002	-	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-	-	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0014	-	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001	0.0034	-	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.011	-	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005
Mercury	mg/L	0.0001	0.0006	-	<0.0001	<0.0001	<0.0001	<0.0001
Nutrients								
Ammonia as N	mg/L	0.01	0.9	0.01	<0.01	<0.01	**0.02**	<0.01
Nitrite as N	mg/L	0.01	-	-	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	0.7	-	0.04	0.02	<0.01	0.02
Nitrite + Nitrate as N	mg/L	0.01	-	0.01	**0.04**	**0.02**	<0.01	**0.02**
Total Kjeldahl Nitrogen as N	mg/L	0.1	-	-	0.2	0.2	0.5	0.2
Total Nitrogen as N	mg/L	0.1	-	0.35	0.2	0.2	**0.5**	0.2
Total Phosphorus as P	mg/L	0.01	-	0.01	**0.09**	<0.01	**0.06**	**0.12**
Reactive Phosphorus as P	mg/L	0.01	-	0.005	**0.05**	<0.01	**0.04**	**0.08**
Major Anions								
Bicarbonate Alkalinity as CaCO3	mg/L	1	-	-	4	2	5	8
Carbonate Alkalinity as CaCO3	mg/L	1	-	-	<1	<1	<1	<1
Hydroxide Alkalinity as CaCO3	mg/L	1	-	-	<1	<1	<1	<1
Total Alkalinity as CaCO3	mg/L	1	-	-	4	2	5	8
Sulfate as SO4	mg/L	1	-	-	<1	<1	<1	<1
Chloride	mg/L	1	-	-	<1	<1	<1	<1
Dissolved Major Cations								
Calcium	mg/L	1	-	-	<1	<1	<1	1
Magnesium	mg/L	1	-	-	<1	<1	<1	<1
Potassium	mg/L	1	-	-	1	<1	2	2

Analyte	Units	LOR	*ANZG 2000 Prot. Aquatic Ecosystems - Freshwater 95% protection*	*ANZG 2000 Prot. Aquatic Ecosystems Tropical - Freshwater Lakes & Reservoirs*	SW01	SW02	SW03	SW04
Sodium	mg/L	1	-	-	<1	<1	<1	<1
Bacteriological								
Escherichia coli	CFU/100mL	1	-	-	~3000	~3000	~1100	9000
Faecal Coliforms	CFU/100mL	1	-	-	~3000	~3000	~1100	9000
Enterococci	CFU/100mL	1	-	-	23000	3200	7800	2100
Other Parameters								
Oil & Grease	mg/L	5	-	-	5	8	<5	<5
Biochemical Oxygen Demand	mg/L	2	-	-	<2	<2	3	<2

APPENDIX C BASELINE GROUNDWATER QUALITY RESULTS

Analyte	Units	LOR	ANZG Primary Industries (2000) (WATER) - Long-term trigger values (LTV) - Irrigation and General Use	ADWG (2011) (WATER) - Health & Aesthetic	DEC (2004) Effluent by irrigation, NSW: LOW STRENGTH (mg/L)	RN030418	RN024671	RN036485	RN029096	RN029097	RN030413	RN029097	RN029098	RN029096	RN036485
Field Parameters	Date					23-01-20	23-01-20	27/02/2020	27/02/2020	27/02/2020	09-07-20	09-07-20	09-07-20	09-07-20	09-07-20
Ph	Ph		6 - 8.5			7.36	6.98	7.4	7.53	7.55	7.25	7.49	5.63	7.5	7.75
Electrical Conductivity (EC)	µS/cm					337	380	249	291	302	266	275	76.2	317	198
Salinity (SAL)	ppt					0.16	0.18	0.12	0.14	0.14	0.12	0.13	0.03	0.15	0.09
Turbidity	NTU					0.39	21.5	1.1	1.4	4.5	0.29	4.5	5.7	0	0.4
Dissolved Oxygen (DO)	%sat					32.1	42	74.6	56.8	50.6	18	81.3	90.4	96.2	96.3
Temperature	oC					31.1	31.2	29.8	29.7	30.3	31	30.4	29.4	30.6	29.6
Total Dissolved Solids dried at 180 ± 5 °C															
Total Dissolved Solids @180°C	mg/L	10	-	600	<600	188	217	114	167	174	145	150	65	170	122
Major Anions															
Bicarbonate Alkalinity as CaCO3	mg/L	1	-	-		163	174	119	136	130	124	119	15	137	86
Carbonate Alkalinity as CaCO3	mg/L	1	-	-		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Hydroxide Alkalinity as CaCO3	mg/L	1	-	-		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Alkalinity as CaCO3	mg/L	1	-	-		163	174	119	136	130	124	119	15	137	86
Sulfate as SO4 - Turbidimetric	mg/L	1	-	250		<1	<1	<1	<1	1	<1	<1	<1	<1	<1
Chloride	mg/L	1	25	250		3	5	2	8	13	1	11	7	12	3
Dissolved Major Cations															
Calcium	mg/L	1	-	-		32	36	23	26	23	22	20	2	24	15
Magnesium	mg/L	1	-	-		22	25	15	17	16	14	15	4	18	11
Potassium	mg/L	1	-	-		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	mg/L	1	115	180		3	3	3	5	8	3	7	3	7	3
SAR and Hardness Calculations															
Sodium Adsorption Ratio	-	0.01	-	-		0.1	0.09	0.12	0.19	0.31	0.12	0.29	0.28	0.26	0.14
Dissolved Metals															
Arsenic	mg/L	0.001	0.1	0.01		0.002	0.002	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.01	0.002		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.1	0.05		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.2	1		0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	<0.001
Lead	mg/L	0.001	2	0.01		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.2	0.02		<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001
Zinc	mg/L	0.005	2	3		<0.005	0.009	<0.005	<0.005	<0.005	<0.005	0.005	0.01	<0.005	<0.005
Mercury	mg/L	0.0001	0.002	0.001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analyte	Units	LOR	ANZG Primary Industries (2000) (WATER) - Long-term trigger values (LTV) - Irrigation and General Use	ADWG (2011) (WATER) - Health & Aesthetic	DEC (2004) Effluent by irrigation, NSW: LOW STRENGTH (mg/L)	RN030418	RN024671	RN036485	RN029096	RN029097	RN030413	RN029097	RN029098	RN029096	RN036485
Nutrients															
Ammonia as N	mg/L	0.01	-	0.41		0.14	0.04	<0.01	<0.01	0.03	0.05	0.07	0.09	0.17	0.01
Nitrite as N	mg/L	0.01	-	3		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	-	50		0.82	0.17	2.05	1.49	1.67	2.74	1.88	3.55	1.3	2.6
Nitrite + Nitrate as N	mg/L	0.01	-	-		0.82	0.17	2.05	1.49	1.67	2.74	1.88	3.55	1.3	2.6
Total Kjeldahl Nitrogen as N	mg/L	0.1	-	-		0.2	<0.1	0.3	0.2	0.2	0.5	0.3	0.5	0.2	0.6
Total Nitrogen as N	mg/L	0.1	5	-	<50	1	0.2	2.4	1.7	1.9	3.2	2.2	4	1.5	3.2
Total Phosphorus as P	mg/L	0.01	0.05	-	<10	0.01	0.03	0.11	0.11	0.19	0.03	0.04	<0.01	0.04	0.04
Reactive Phosphorus as P	mg/L	0.01	-	-		0.02	0.02	0.02	0.02	0.02	0.02	0.01	<0.01	0.01	0.02
Oil and Grease (O&G)															
Oil & Grease	mg/L	5	-	-		<5	10	<5	<5	<5					
Biochemical Oxygen Demand (BOD)															
Biochemical Oxygen Demand	mg/L	2	-	-	<40	<2	<2	<2	2	<2	<2	<2	<2	<2	<2
Bacteriological															
Escherichia coli	CFU/100mL	1	-	-		**~3**	<1	~<1	~<1	~<1	~<1	<1	<1	<1	<1
Faecal Coliforms	CFU/100mL	1	-	-		~3	<1	~<1	~<1	~<1	~<1	<1	<1	<1	<1
Enterococci	CFU/100mL	1	-	-		120	<1	~5	~2	~1	<1	<1	~2	<1	<1

APPENDIX D IRRIGATION MANAGEMET PLAN

Irrigation Management Plan

Lambells Lagoon Crocodile Farm

PRI Farming Pty Ltd



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DOCUMENT CONTROL RECORD

Job	EZ19153
Document ID	194919-45
Author(s)	Emma Lewis, Adele Faraone

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	Suzanne Barber	Ray Hall	PRI Farming	11/11/20
2	Suzanne Barber	Ray Hall	PRI Farming & NT EPA	24/03/21
3	Suzanne Barber	Suzanne Barber	PRI Farming	01/11/2021

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Acronyms

ANZECC	Australian and New Zealand Environment and Conservation Council
BoM	Bureau of Meteorology
DEC	Department of Environment and Conservation (NSW)
DENR	Department of Environment and Natural Resources (Northern Territory) – now DEPaWS
DHAC	Darwin Harbour Advisory Community
DEPaWS	Department of Environment, Parks and Water Security – formerly DENR
DITT	Department of Industry, Tourism and Trade – formerly DPIR
DOEE	Department of the Environment and Energy (Commonwealth)
EC	Electrical Conductivity
ECi	Electrical Conductivity (irrigation)
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act (1999)* (Commonwealth)
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plan
ESP	Exchange Sodium Percentage
GDE	Groundwater Dependent Ecosystem
GEL	Groundwater Extraction Licence
LCA	Land capability assessment
LTV	Long-term trigger values
IMP	Irrigation Management Plan
NSW	New South Wales
NTEPA	Northern Territory Environmental Protection Authority
NT	Northern Territory
SOCS	Site of Conservation Significance

1 INTRODUCTION

1.1 Background

PRI Farming Pty Ltd (PRI) propose to operate the Lambells Lagoon Crocodile Farm (LLCF) for commercial production of saltwater crocodiles (*Crocodylus porosus*) for meat and skin products. The site is located in the Lambells Lagoon area on Section 1611 and 1688 Hundred of Guy, at the end of Alphatonia Road, 5.5 km north of the Arnhem Highway.

LLCF is currently being constructed and subsequently operated in two stages. Stage one encompasses the Incubation, hatchery and auxiliary infrastructure. Stage two encompasses the grow-out pens, finishing pens and auxiliary infrastructure.

1.2 Purpose and scope

PRI recognise the importance of finding a solution to manage wastewater produced on site and prevent the discharge of untreated wastewater off-site. As a wastewater management strategy, PRI propose to utilise irrigation practices to dispose of the wastewater from Stage one onto suitable crops.

This Irrigation Management Plan (IMP) has been developed to illustrate the management and reuse of wastewater by PRI at LLCF through irrigation application during both stage one and two operations. This plan is a requirement as part of the Environmental Protection Licence (EPL) application (amendment to EPL320).

2 WASTEWATER QUALITY

As there is no operational wastewater quality data for LLCF, anticipated effluent quality has been derived from monitoring undertaken at other existing farms. As the Stage one effluent will be generated directly from the hatchery and will undergo a solids screening process prior to irrigation, the effluent quality will differ from Stage 2 (growers and finishers) and the combined operations (hatchery, growers and finishers) undertaken at the other farms. Therefore, for the purpose of assessing irrigation requirements, effluent quality has been derived from sampling undertaken directly from the hatchery at three existing crocodile farms and limited sampling undertaken from hatchery effluent post solids screening at Lagoon Crocodile Farm (as part of a wastewater treatment trial). Effluent from the growers and finishers has been taken from Janamba Crocodile farm and used to provide an estimate of predicted effluent quality for LLCF (Table 2-1).

The anticipated effluent quality for irrigation and the effluent strength when assessed against the *Environmental Guidelines – use of effluent by irrigation (DEC 2004)* is detailed in Table 2-1. The anticipated wastewater concentration for Stage one-hatchery is classified as "medium" strength due to the high nutrient concentration. Stage 2 – growers and finishers and the combined wastewater (whole of farm effluent) is classed as "low" strength.

Table 2-1. Classification of effluent based on DEC 2004 criteria

Analyte	**Irrigation water quality – stage 1**	**Irrigation water quality – stage 2 (wet season / dry season)**	**Combined wastewater streams -**	**Strength (average concentration mg/L)**		
				Low	**Medium**	**High**
Total Nitrogen	100	6 / 13	18	<50	50-100	>100
Total Phosphorus	13	0.7 / 4	4	<10	10-20	>20
Biological oxygen demand (BOD)	<2	ND	7	<40	40-1500	>1500
Total dissolved solids (TDS)	470	153	267	<600	600-1000	>1000
Metals	see Section 3.4			Concentrations > 5 times the long-term trigger value (see Section 3.4) must be considered high strength		
Grease and oil	<5			Concentrations > 1500mg/L must be considered high strength		
Effluent strength	Medium strength	Low strength	Low strength			

3 IRRIGATION SUITABILITY ASSESSMENT

This section assesses all of the factors that need to be taken into consideration under the New South Wales (NSW) *Environmental Guidelines – use of effluent by irrigation (DEC 2004)* (NSW guideline).

3.1 Organic content

Organic material is present in many effluent waste streams and when applied at a suitable rate, can assist in the physical and chemical health of soils. Normally, organic material concentrations are low enough to prohibit any short-term detrimental effects on soil and vegetation characteristics. However, if soil is continually overloaded with organic material this can result in the blocking of soil pores, favour anaerobic soil microbes and lead to a slimy bacterial scum crust on the soil (DEC 2004).

The average maximum daily organic material loading was calculated from the irrigation rate and the BOD (mg/L) concentration of the applied effluent. The NSW guideline suggests that an average loading rate of 1,500 kg/ha/month can be taken as the maximum organic loading for most soils.

The median BOD content of the wastewater for irrigation is estimated at 100 mg/L. This value was used as a conservative approach until site specific data can be determined. The minimum irrigation area required based on organic loading can be estimated as follows:

A = CQ / (1,000 x Lc)

Where:

A = irrigation area (h)

C = concentration of BOD^5 (mg/L)

Q = average effluent flow rate (kL/month)

Lc = critical loading rate of constituent (kg/ha/month)

For LLCF Stage 1:

A = 100 mg/L x 3,000 kL / month / (1,000 x 1,500 kg/ha/month)

A = 0.2 hectares

The above calculation indicates that a minimum area of 0.2 ha is required to manage the organic content of LLCF wastewater in Stage 1.

For LLCF Stage 2:

A = 100 mg/L x 37,950 kL / month / (1,000 x 1,500 kg/ha/month)

A = 2.53 hectares

The above calculation indicates that a minimum area of 2.53 ha is required to manage the organic content of LLCF wastewater in Stage 2.

3.2 Suspended solids

The Total Suspended Solids (TSS) concentration is expected to be < 100 mg/L post solids screening. There is no water quality limit or concentration of concern for TSS in the NSW guidelines for irrigation.

Recommendations for concentrations of suspended solids to avoid clogging in localised (drip) irrigation systems are available from Ayers and Wescot (1985). The recommendations are based on the degree of restriction of use:

- <50 mg/L = no restriction
- 50-100 mg/L = slight to moderate restriction
- >100 mg/L = severe restriction

The anticipated low levels of suspended solids are not expected to present a problem in regards to the irrigation system getting clogged or the coating of leaf surfaces. In conjunction with solids treatment, an appropriately sized nozzle will be used to prevent potential clogging.

3.3 pH

The NSW guideline suggests effluent with a pH between 5.0 and 8.5 is generally acceptable for use in irrigation. If the effluent is very acidic (pH less than 5), or very alkaline (pH greater than 8.5), the wastewater may need to be neutralised before being used for irrigation as soil pH affects the availability of nutrients and other elements to plants. The pH of the irrigation water is expected to be 7.5 – 8.0.

3.4 Metals

ANZECC (2000) Guidelines, Volume 3, Section 9.2.5 identify the maximum concentrations of metals in irrigation waters considered acceptable for continuous use. The current concentration of metals in the wastewater is shown below (Table 3-1) along with the long-term trigger value (LTV) and short-term trigger value (STV) guidelines adapted from the Guidelines. The majority of metal levels in the groundwater and similar wastewaters are all below the detectable limit and are therefore well below the LTV.

Table 3-1. Summary of irrigation water long-term trigger value (LTV) and short-term trigger value (STV) guidelines for heavy metals and metalloids

Metal	LTV in irrigation water (mg/L)	STV in irrigation water (mg/L)	Project wastewater quality
As	0.1	2.0	<0.001
Cd	0.01	0.05	<0.0001
Cr(VI)	0.1	1	<0.001
Cu	0.2	5	0.03
Pb	2	5	<0.001
Hg	0.002	0.002	<0.0001
Ni	0.2	2	<0.001
Zn	2	5	0.05

3.5 Mineral salts and specific ions

The EC and concentration of salts and specific ions (sodium, chloride, alkalinity etc) in the wastewater are relatively low (see Table 3-2). The aim is to protect soil structure and downstream surface and groundwater, and to not exceed the salt tolerance of pasture grasses.

Table 3-2. Salt and ion concentrations in irrigation water

Ca	Mg	Na	K	SO4	Chloride	Alkalinity
mg/L	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
40	23	15	6	5	26	224

3.6 Oil and grease

The levels of oil and grease in the wastewater are currently below detection limits. These low levels will not present problems in regards to clogging irrigation systems or coating leaf surfaces of irrigated crops.

3.7 Pathogens

The concentration of *E.coli* and other pathogens in the wastewater for irrigation is expected to be high. Bacterial movement through soils is extremely limited and the harsh sunlight and climatic conditions typical of Australia rapidly diminish viable populations of bacteria. The irrigation area is off-limits to the public, therefore any pathogens in the wastewater are not expected to cause any harm to human receptors. Irrigation application is to be managed appropriately to avoid potentially harmful runoff. Chlorination of the wastewater to assist in pathogen removal can be introduced if required.

3.8 Salinity & sodicity

3.8.1 Salinity

Salinity is the term for the presence of soluble salts in soils or water. Salinity is a land-use issue when the concentrations of salt adversely affect plant growth, therefore salt content can affect the ability to reuse water for irrigation.

In order to assess the suitability of a water sources and soil for irrigation the following need to be considered;

- The quality of the irrigation water.
- Characteristics of the soil being irrigated.
- Salt tolerance of the crop to be grown.

EC is a measure of the total soluble salts in water. Some general irrigation electrical conductivity (ECi) ratings for wastewater are shown in Table 3-3. The anticipated average ECi of LLCF wastewater to be used for irrigation is 0.5 dS/m, which is considered low for irrigation according to ANZECC (2000).

Table 3-3. Salinity ratings for water (ANZECC 2000)

ECi (dS/m)	Water salinity rating
<0.65	Low
0.65-1.3	Moderate
1.3-2.9	High
2.9-5.2	Very high
>5.2	Extremely high

3.8.2 Sodicity

Sodicity is a term for the high concentrations of sodium ions relative to other cations in the exchangeable and / or soluble form in soil or water. Sodic soils have a range of adverse properties including poor soil structure and stability; surface crusting; poor aggregation; increased runoff and erosion; poor seedling emergence and slow water infiltration. Soil sampling was undertaken in the proposed irrigation area and the results of sampling identified that the exchange sodium percentage (ESP) was less than 1%. Soils with an ESP less than 6% are considered non-sodic, an ESP between 6 and 15% are considered sodic, and an ESP greater than 16% is considered strongly sodic.

Irrigation water with a high sodium concentration can result in the degradation of soil structure. The potential for excess sodium effecting soils is commonly assessed using sodium adsorption ratio (SAR). The SAR is used to calculate projected potential of sodium accumulation in soil, which is the end product of continual use of sodic water.

The SAR in LLCF wastewater for irrigation is expected to be 0.5 which is not considered an issue, as outlined in Table 3-4.

Table 3-4. Sodicity classes for irrigation water (Mills 2001)

SAR	Sodicity class
<3	No sodium problem
3-6	Low sodium, few problems except with sodium sensitive crops
6-8	Medium sodium, increasing problems
8-14	High sodium, not generally recommended
>14	Very high sodium - unsuitable

3.8.3 Relationship between salinity and sodicity

Based on the low salinity rating of the proposed irrigation site soil and the low SAR of the irrigation water, it is not expected that the irrigation will have an impact on the soil structure. When plotted on the EC/SAR relationship graph detailed in the ANZECC 2000 guidelines, the levels fall within the “stable soil structure” category (Figure 3-1).

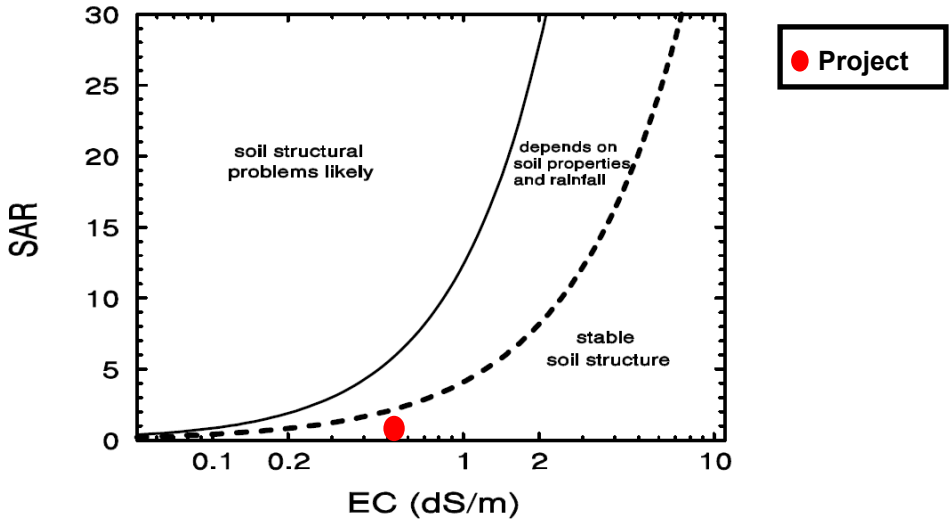


Figure 3-1. Relationship between SAR and EC for irrigation water for prediction of soil structure stability

Based on the relationship between SAR and EC for irrigation water being within the stable soil structure region and the water quality being of very low EC, salinity is not expected to be an issue for irrigation and salinity modelling is not required in this case.

4 MODELLING OF EFFLUENT REUSE

The Model for Effluent Disposal using Land Irrigation (MEDLI) is a program for designing effluent reuse schemes. The model addresses many factors impacting on effluent irrigation, such as the quality and quantity of effluent, climate, storage, irrigation frequency and amount, nitrogen, phosphorus and salt components and plant growth. The MEDLI program was used on LLCF wastewater to assess the viability of irrigation as a method of wastewater management.

The model has been updated from the initial MEDLI model provided in the CEMP in August 2020, with more accurate data including water quality and refined water demand data from other crocodile farms within the Northern Territory, site specific soil data from LLCF and appropriate methods and rates of irrigation. As the construction of Marpu is staged (i.e Stage 1 and Stage 2), the MEDLI modelling has been developed to reflect this.

4.1 Stage 1

The MEDLI program was used to inform design requirements for the effluent land irrigation scheme for Stage 1 of the LLCF. In this instance, Stage 1 refers to the development and operation of the hatchery components of the farming operations.

4.1.1 Input data

Climate

The quantity of effluent and current quality outlined in the sections above was used in the MEDLI assessment. A 60-year climate file for LLCF area was obtained from the SILO database (a climate database managed by the Queensland Department of Environment and Science) to input rainfall and evaporation data. The model was run using climate data from 1950 to 2019, to account for recent impacts of climate change that may affect the model outputs.

Inflow

The effluent inflow was set at 100 m^3 a day based on predicted water use once the hatchery is at peak capacity (early operational months may produce significantly less effluent). Inflow volumes were only set for March to December to coincide with the current programmed Stage one operational period. By December it is anticipated that Stage two will come online, which includes a full-scale wastewater management system and the Stage one irrigation activities will no longer be required. PRI have since decided that stage 1 and stage 2 wastewater will remain separate, this stage 1 no longer a temporary irrigation area.

Storage

A 6x6x3 m open concrete storage tank was used in the scenario to represent the proposed storage and step screen solids removal tank. The tank is uncovered and therefore model parameters allowed for rainfall infiltration and evaporation over the exposed surface area.

Soil

Soil samples were collected from LLCF area on 10 July 2020 and sent a laboratory specialising in MEDLI analysis suites (see Appendix A). The analyses undertaken directly related to the required MEDLI inputs and allowed for site specific soil information to be incorporated into the model.

Crop selection

The default planting parameters for Forage Sorghum Crop were used in the model as they are representative of the crop selection for the proposed irrigation area. The default crop also has a maximum crop coefficient of 0.8, and according to the NT *Guidelines for Land Capability Assessment for On-site Wastewater Management* (DOH, 2014), a crop factor of 0.8-1.0 would be appropriate for irrigation design purposes, based on the generally high year-round daytime temperatures in the NT.

Irrigation method

The irrigation method modelled was a centre pivot system over varying irrigation areas to determine the minimum irrigation area required. The irrigation was applied on a daily frequency at a rate of 5 mm per day.

A "dry-run" was also modelled for both irrigation areas, where the irrigation inputs were removed, in order to determine the natural conditions and deep drainage rates for the area without any irrigation inputs.

4.1.2 Modelling results

The results of the water and nutrient balances modelled by MEDLI are outlined in Table 4-1 to

Table 4-3 respectively. Based on the nutrient balance, a minimum irrigation area of 15 ha is recommended to manage the nutrient loading of the wastewater, therefore the outputs of the 15 ha irrigation area scenario have been provided. The full MEDLI report is included in 0.

Table 4-1. Land water balance

	Unit	With irrigation	Dry-run
Rain	mm/year	1544	1544
Irrigation	mm/year	203	0
Soil evaporation	mm/year	489	601
Transpiration	mm/year	461	0
Rain runoff	mm/year	41	114
Irrigation runoff	mm/year	0	0
Deep drainage	mm/year	758	829

Table 4-2. Pond system water balance

	Unit	Value
Rain	m3/year	51.47
Inflow	m3/year	30524
Evaporation	m3/year	75
Overflow	m3/year	22
Irrigation	m3/year	30479
Effluent reuse (proportion of inflow + net rain gain irrigated)	Fraction	1
Probability of at least 90% reuse	Fraction	1

Table 4-3. Land nutrient balance

	Unit	N balance	P balance
Irrigation (effluent load added)	kg/ha/year	161	26
Denitrification	kg/ha/year	0.12	-
Irrigation runoff	kg/ha/year	0	0
Plant uptake	kg/ha/year	140	19
Leached	kg/ha/year	24	0.07

The MEDLI results indicate that the proposed irrigation scheme is sufficient to manage the daily effluent volumes produced without creating any irrigation runoff or significant increases to the deep drainage. The proposed concrete tank is sufficient in size to store the wastewater without causing significant overflows and ensuring 100% reuse of the effluent produced (through irrigation).

The application rate of nutrients is slightly higher than the predicted plant uptake rates which results in some leaching of nitrogen. The predicted average nitrate concentration of the deep drainage based on current soil concentrations and effluent irrigation, is 3.2 mg/L which is still considered low. The concentration of nutrients in the wastewater is to be monitored to ensure that if concentrations increase significantly above the predicted values, the irrigation area is adjusted accordingly, or alternative treatment methods are assessed.

4.2 Stage 2

The MEDLI program was used to inform design requirements for the effluent land irrigation scheme for Stage 2 of the LLCF. In this instance, Stage 2 refers to the development and operation of the grower and finisher components of the farming operations.

4.2.1 Input data- general

The following inputs were used for the Stage 2 MEDLI model:

Climate

A 60-year climate file for LLCF area was obtained from the SILO database to input rainfall and evaporation data. The model was run using climate data from 1958 to 2019, to account for recent impacts of climate change that may affect the model outputs.

Soil type

Soil samples were collected from LLCF area on 10 July 2020 and sent a laboratory specialising in MEDLI analysis suites. The analyses undertaken directly related to the required MEDLI inputs and allowed for site specific soil information to be incorporated into the model.

Crop type

The default planting parameters for Forage Sorghum Crop were used in the model as they are representative of the crop selection for the proposed irrigation area. The default crop also has a maximum crop coefficient of 0.8, and according to the NT *Guidelines for Land Capability Assessment for On-site Wastewater Management* (DOH, 2014), a crop factor of 0.8-1.0 would be appropriate for irrigation design purposes, based on the generally high year-round daytime temperatures in the NT.

Irrigation method

The irrigation method modelled was a centre pivot system with irrigation triggered when the soil water deficit (SWD) reaches 5mm. The irrigation was applied at a depth of 5mm at each irrigation event, until the SWD is reached. Irrigation cannot occur when a rainfall event occurs and rainfall reaches a total of 10mm per event (likely during most of the wet season) to prevent over saturation of the soil. The model was run using different irrigation sizes in order to determine the best outcome for the water and nutrient balance.

A "dry-run" was also modelled for the irrigation area, where the irrigation inputs were removed, in order to determine the natural conditions and deep drainage rates for the area without any irrigation inputs.

The model was set to turn-off irrigation when rainfall reaches a total of 10mm (likely during most of the wet season) to prevent over saturation of the soil.

4.2.2 Input data- effluent volumes and quality

Since the initial MEDLI modelling was completed, a number of inputs relating to effluent volumes and quality have been updated for the LLCF. The following assumptions were made by PRI Farming, in determining the final effluent quality and volumes in the model:

- The feeding programs of the grower and finisher pens will be the same as the Janamba Crocodile Farm in the Northern Territory, whereby water usage is reduced by half in the wet season, due to the change in crocodile behaviour that occurs when there is increased rainfall and semi cooler temperatures from December to March.
- Allowance was made in the wet season months (December to March) for rainfall inputs into the pens. PRI Farming Pty Ltd have advised that the pens are to be constructed with a shade cloth roofing, shedding 70% of rainfall away from the pens. The volume inputs were derived from data from BoM and the impact a low permeability shade cloth, which allows for 30% of rainfall to enter the pens during the months of December to March.
- During the drier months (i.e April to Nov), the forecast water use for the stage 2 component of the crocodile farm is 1,265kL/day (as provided by PRI Farming Pty Ltd, based on extrapolation of data from Janamba Crocodile Farm).
- Effluent quality (i.e. nutrient concentrations) will be similar to that produced from the grower and finisher pens at Janamba Crocodile Farm (as provided by PRI Farming Pty Ltd).

The effluent quality is based on the estimated combined effluent quality prior to any treatment. The actual wastewater quality to be irrigated would be lower in nutrients following primary treatment. However, this will not make a difference to the model outputs because the limiting factor at the LLCF is water volumes not nutrient concentrations.

4.2.3 Modelling results

The results of the water and nutrient balances modelled by MEDLI are outlined in Table 4-4 to Table 4-6, respectively. Based on the nutrient balance, a minimum irrigation area of 100 ha is recommended to manage the nutrient loading of the wastewater, therefore the outputs of the 100 ha irrigation area scenario have been provided.

Table 4-4. Land water balance

	Unit	60ML	Dry-run
Rain	mm/year	1544	1544
Irrigation	mm/year	391.23	0

Soil evaporation	mm/year	626.59	570.95
Transpiration	mm/year	510.78	24.88
Rain runoff	mm/year	29.40	86.11
Irrigation runoff	mm/year	0.00	0.00
Deep drainage	mm/year	769.60	861.89

Table 4-5. Pond system water balance

	Unit	60ML
Rain	m3/year	33,814
Inflow	m3/year	394,710
Evaporation	m3/year	35,045
Overflow	m3/year	2224
Irrigation	m3/year	391,226
Effluent reuse (proportion of inflow + net rain gain irrigated)	Fraction	0.99
Probability of at least 90% reuse	Fraction	0.98

Table 4-6. Land nutrient balance

	Unit	N balance	P balance
		60ML	
Irrigation (effluent load added)	kg/ha/year	33.58	7.89
Denitrification	kg/ha/year	0.00422	-
Irrigation runoff	kg/ha/year	0.00	0.00
Plant uptake	kg/ha/year	34.16	5.60
Leached	kg/ha/year	0.22	0.04

4.2.4 Discussion

Irrigation area

The MEDLI results indicate that the proposed irrigation schemes provided are sufficient to manage the daily effluent volumes produced without creating any irrigation runoff or significant increases to the deep drainage.

The application rate of nutrients is slightly higher than the predicted plant uptake rates which results in some leaching of phosphorous. The predicted average phosphorous concentration of the deep drainage based on current soil concentrations and effluent irrigation is considered low.

The concentration of nutrients in the wastewater is to be monitored to ensure that if concentrations increase significantly above the predicted values, the irrigation area is adjusted, or alternative treatment methods are reviewed.

A large WWS and land irrigation area is required for wetter than average wet seasons. During the drier seasons (i.e May to September), higher volumes of water are likely to be required to be applied to smaller areas of the irrigation area, to maintain crop growth. This may require a rotational program to be implemented to avoid nutrient accumulation in those areas.

Wet weather storage

The MEDLI results indicate that 60 ML of WWS capacity should be large enough to minimise uncontrolled release of effluent, excepting during extreme weather events. Assuming the effluent volumes entering the system align with those used in the modelling, the results indicate that overflow events may occur at a rate of 0.18 events/year, or 1.8 events every ten years.

Increasing the WWS size to 80 ML or 100 ML in the model, reduces the overflow events down to less than one every ten years. However, the model results indicate there would still be some overflow during extreme weather events. Whilst there is sufficient land availability to construct large storages, the cost and feasibility of managing such storages may be limiting. Assuming the treated effluent will contain very low concentrations of nutrients, which would be further diluted by rainfall in the storage, it is considered that there is minimal environmental benefit to be achieved by constructing zero discharge storages.

The modelling of different reuse scenarios indicates that reuse of effluent could further reduce the frequency and volume of overflows from the WWS. Treatment and reuse are an option that can be further investigated by PRI Farming as the farm is developed and site-specific effluent data become available. However, while there is uncertainty about the levels of reuse that can be achieved, it is recommended that the design criteria for WWS capacity are based on the worst-case scenario of zero reuse.

If the actual effluent volumes or quality are found to be higher than predicted, then the staging of the development and large available land area allows for additional irrigation areas and/or storages to be added progressively as the farm reached its 5 year operational capacity to achieve the water quality objectives established in the EPL.

4.3 Summary and recommendations

It is imperative to LLCF that the results of the modelling and ultimate decision on sizing of the WWS both take into consideration environmental factors and operational requirements. The results of the MEDLI model and its outputs in both models reflect the information made available at the time of modelling and do include a number of assumptions and limitations.

The staged nature of the development provides an opportunity to add WWS capacity over time in response to actual conditions experienced during operations. The following recommendations are made for future improvements to the model and ultimate design of the LLCF, to ensure that the WWS and irrigation area are appropriate.

- Sampling of LLCF effluent volumes and quality in the Stage 1 and Stage 2 pens and effluent storages should be undertaken to verify model inputs. These results can be adopted in later re-runs of the MEDLI to reflect site specific conditions (as currently all data used within the MEDLI model are from Lagoon and Janamba Crocodile Farms).
- PRI Farming Pty Ltd to actively monitor the water levels, inputs and outputs of the WWS over the course of increasing operations of LLCF over the next 5 years (particularly during the wet season months of December to March) to determine whether the WWS can hold the volumes of water required.

5 IRRIGATION AND CROP MANAGEMENT

5.1 Irrigation infrastructure

Stage 1

The Pierce C600 centre pivot system has been selected to be used as the irrigation mechanism for wastewater disposal over the proposed crop irrigation area. The system is a self-propelled system that rotates around a fixed central point. The system is a remote irrigation management product that uses the Global System for Mobile Communications (GSM) technology to monitor and manage the irrigation system. The technology allows for remote access to the current end pressure, speed percentage, angle, endgun, total hours running and total hours with water. This system will be fitted with a Zenner Flanged meter attached to the water extraction pump and is for loaded water, i.e. agriculture, wastewater treatment plants or sewage works. The meter enables readings to be recorded with each extraction.

The benefits of using a centre pivot system are:

- Irrigation water is applied gently to reduce the risk of puddling or surface runoff.
- Water coverage is evenly distributed over the irrigation area selected.
- The system continuously moves over the crops.
- An alignment control valve is attached to stop irrigation if the system faults, with a sensor shutting down the water at the same time.

To achieve a minimum 15 ha area, one pivot system has been installed half reach to each achieve an 8 ha span. The control panel features forward and reverse controls, variable application rates, GPS monitoring and the ability to stop in a set position as well as an SMS alert system. The sprinkler system is comprised of nylon goosenecks, flexible drops, 10spi regulators and I-Wob sprinklers. The pivot system will rest on a heavy duty concrete pivot pad.

Irrigation will commence at a rate of 5mm/day as calculated by the site water balance and as recommended by the Australian Standard for *On-site domestic wastewater management* (AS/NZS 1547:2012) for drip or spray irrigation. The irrigation rate will be monitored alongside soil moisture levels to ensure appropriate application rates to avoid runoff.

The proposed irrigation areas for Stage one area outlined on Figure 5-1.

Stage 2

An in-line drip system has been selected to be used as the irrigation mechanism for wastewater disposal over the proposed 100 ha crop irrigation area. The construction of the irrigation infrastructure will be progressively staged in 20 ha intervals.

Similarly to the centre pivot system above, irrigation will commence at a rate of 5mm/day as calculated by the site water balance and as recommended by the Australian Standard for *On-site domestic wastewater management* (AS/NZS 1547:2012) for drip or spray irrigation. The irrigation rate will be monitored alongside soil moisture levels to ensure appropriate application rates to avoid runoff.

The proposed irrigation areas for Stage two are outlined on Figure 5-2.

5.2 Irrigation management

PRI recognise the importance of finding a solution to wastewater management and preventing discharge of untreated wastewater offsite which has the potential to impact the receiving environment. Sustainable wastewater management involves the selection of suitable irrigation infrastructure to the water and nutrient requirements of the crops, while also preventing oversaturation resulting in uncontrolled run off, damaging of the soil and unsustainable crops.

A procedure regarding monitoring and the reuse of wastewater via land irrigation has been developed to ensure the activities are managed appropriately (see Appendix D).

5.2.1 Runoff control

LLCF will control and manage runoff of effluent by:

- Using a spray/drip irrigation system, that applies the irrigation water at a low rate.
- Apply the effluent water over an area large enough to absorb the capacity of water.
- Daily visual inspections of irrigation area for evidence of potential runoff (also mist/overspray and odour).
- Only apply effluent at the rate identified applicable to each season (i.e. dry season and wet season).
- Buffer zone of 50 m around the irrigation area, to prevent impact on sensitive receptors and neighbouring properties.

During the wet season (November to April) rainfall in the area increases, resulting in the soils becoming saturated and the wastewater no longer can infiltrate at the same rate as the dry season, leading to runoff. Irrigation will not be undertaken during rain events and will only recommence once soil moisture conditions allow as per the procedures in Appendix D.

5.2.2 Storage contingencies

Stage 1

The outcomes of the MEDLI water balance indicate that 100 m^3 of storage is required to prevent overflows and irrigation runoff. Where this storage requirement cannot be achieved in one tank (i.e. the concrete tank modelled), additional storage tanks will be kept on site with emergency overflow valves fitted to direct water as required.

In the event of infrastructure maintenance or breakdown, water ingress into the hatchery will cease until repairs can be undertaken. As the generation of wastewater will be interrupted, this will reduce reliance on storages to accommodate additional wastewater flows during the maintenance process. Likewise, in the event of large monsoonal events that may hinder irrigation activities, water inputs can be managed to try and reduce the volume of wastewater generated during this period.

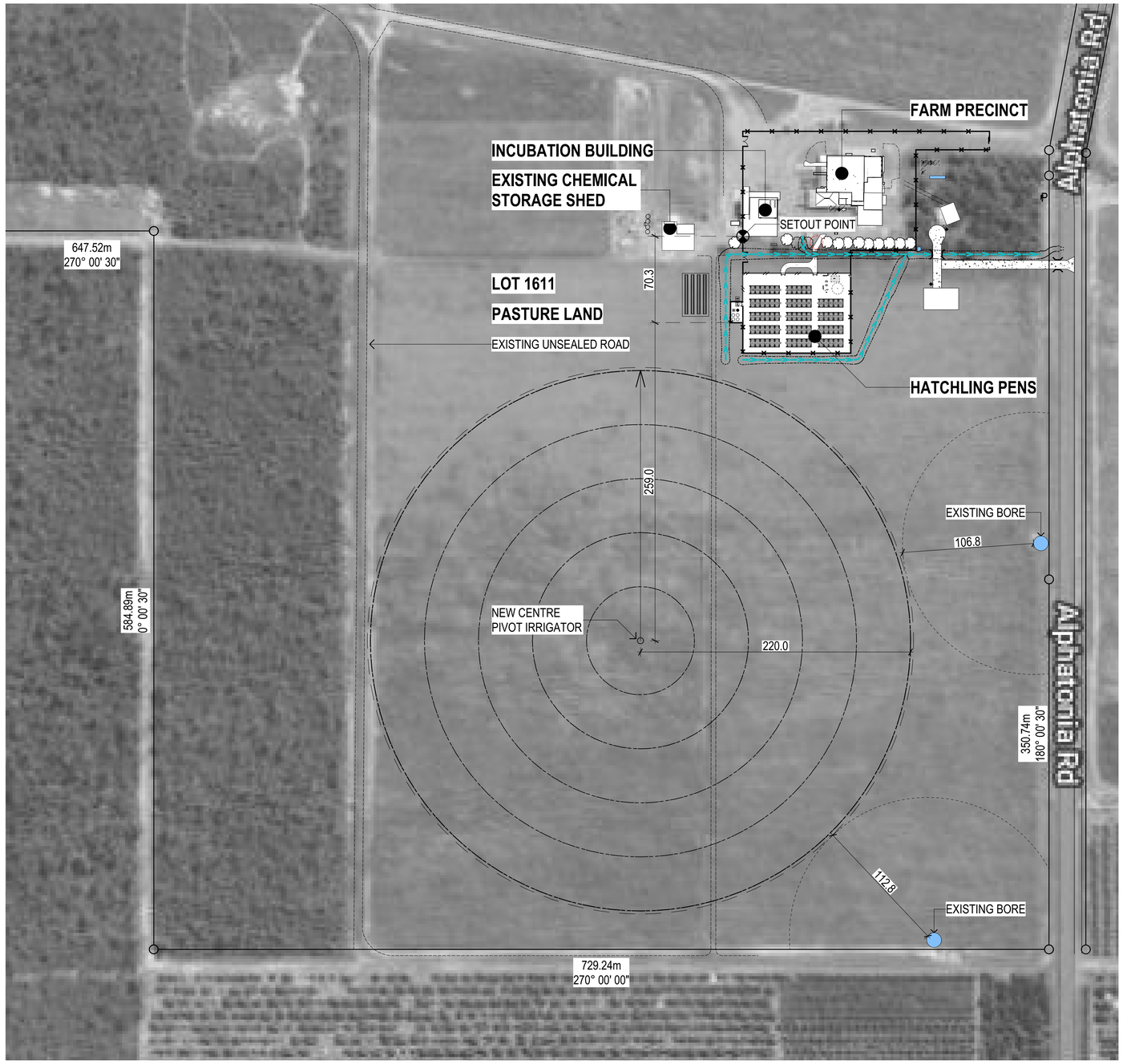
Stage 2

The outcomes of the MEDLI modelling for Stage indicate that a 60ML dam is sufficient cater for the volume of water proposed to be used at Marpu when in full operation. The design of the dam will incorporate a sump, to cater for the times when there is only a small volume of water available for irrigation purposes. Additional WWS can be assessed in the future if the need arises.

5.3 Crop management

The irrigation area is to be managed by a specialist agricultural technician, who will be responsible for the harvesting when required. The crops proposed to be used in Stages 1 irrigation area is Mariner Rhodes grass and Stage 2 irrigation area is African Mahogany plantation. The crops will be inspected regularly to monitor their growth as well as plant health to determine any visual impacts of nutrient supply.

Crops will be harvested regularly to encourage growth and nutrient uptake and will then be processed for stockfeed.



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STAGE 1 IRRIGATION PLAN

SCALE @ A1 - 1:2000

0 50 100 150 200 250m

SPECIFICATIONS:

- 600 MICRON WEDGE WIRE JOHNSON SIEVE BED SCREEN.
- 5ml PER m^2 IRRIGATION RATE.
- 16ha (220M RADIUS) CENTRE PIVOT IRRIGATOR.
- 8ha TRIAL AREA WITH CAPACITY TO INCREASE TO 16HA.
- 110kL DAILY EXPECTED FLOW AT MAX CAPACITY.
- 4 X 25m^3 STORAGE TANKS FOR EMERGENCY REDUNDANCY.
- 9800L CAPACITY IN PUMP STATIONS.

NOTE:

- ALL DIMENSIONS TO BE CHECK ON SITE AND CONFIRM LOCATION WITH SUPERINTENDENT. CENTRE PIVOT IRRIGATION AND EXISTING BORES ARE INDICATIVELY DRAWN.
- SETOUT POINT STARTS FROM EDGE OF CONCRETE HARDSTAND OF THE INCUBATION BUILDING.

KEY:

- STORMWATER SWALE DRAIN. REFER TO CIVIL ENGINEER'S FOR DETAILS.
- EXISTING UNSEALED TRACKS.
- PERIMETER OF CENTRE PIVOT IRRIGATOR.
- CONCENTRIC IRRIGATION LINES.
- DASHED LINES DENOTES CLEARANCE DISTANCES BETWEEN EXISTING BORES AND IRRIGATION AREA.
- FLOW DIRECTION OF IRRIGATION.

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REV	DESCRIPTION	DATE	INIT.
00	ISSUE FOR CONSTRUCTION	01/04/2021	DV

AMENDMENTS

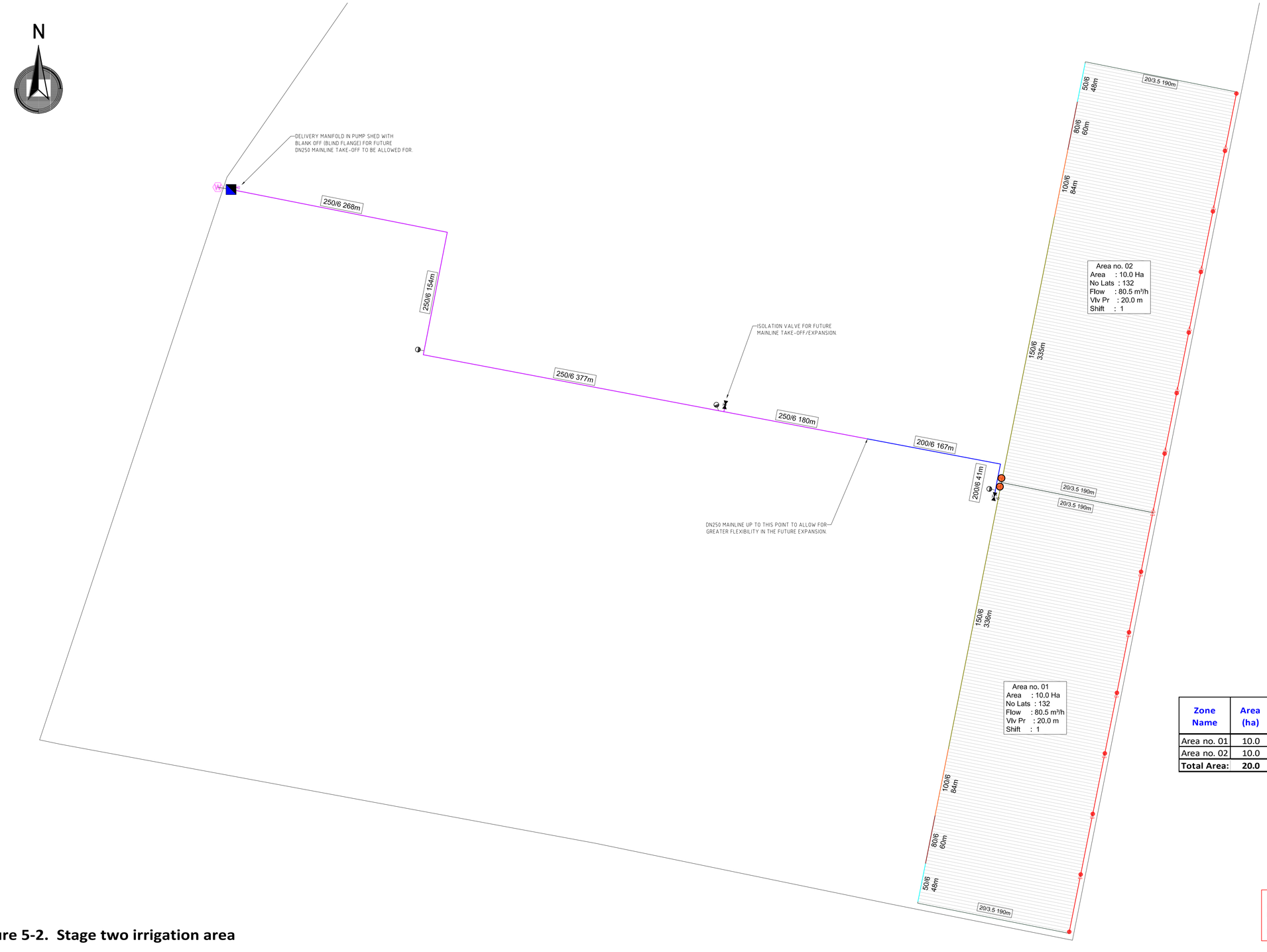
PROJECT: CROCODILE FARMING PROJECT
CLIENT: SITZLER
ADDRESS: SEC 1611 (255) ALPHATONIA ROAD, HUMPTY DOO NT 0836

DRAWING: **Figure 5-1. Stage one irrigation area**

PROJECT DATE:	SCALE:	DESIGNED/DRAWN:	CHECKED:	SHEET SIZE:
OCT 2020	AS SHOWN	DV	PW	A1

SITZLER DRAWING No:	SHEET No:	REVISION:
A-SW-012	012 of 11	00

C:\DPY\01\01\1 2021 - BA2665 - STAGE 1 IRRIGATION PLAN_DP



IRRIGATION DATA TABLE

Description	Units	Initial 20 ha	Final 200 ha
Crop		Mahogany Tree	
Irrigation Area (Net)	ha	20.0	200.0
Rows/Beds Spacing	Mtr.	4.0	4.0
Plants Spacing	Mtr.	2.0	2.0
Irrigation System		In-line Drip	In-line Drip
Emitter Type		Uniram 20010 AS	Uniram 20010 AS
Minimum Emitter Pressure	Mtr.	13.0	13.0
Emitter Discharge	L/H	1.60	1.60
Emitter Spacing	Mtr.	0.50	0.50
Laterals Average Spacing	Mtr.	4.0	4.0
No. of Laterals per Row/Bed	No.	1	1
Application Rate	mm/h	0.80	0.80
Max. Daily Consumption	mm/day	4.0	4.0
Irrigation Cycle	Days	1	1
Duration of one Operation	Hrs.	5.0	5.0
Number of Operations	No.	1	4
Max. Daily Operation Duration	Hrs.	5.0	20.0
Available Daily Duration	Hrs.	24	24
Mainline Flexibility		Medium/Maximum	
Max Number of Laterals per Flush Tap	No.	20 Laterals Per Manifold & Tap	
Pump Duty (Excludes Backflush Requirements)		**Initial 20 ha**	**Final 200 ha**
Maximum Discharge Required	m3/h	161.0	414.0
Maximum Discharge Required	lps	44.7	115.0
Required Pressure at Water Source	Mtr.	38.0	55.0
Required Pressure After Filtration	Mtr.	26.0	43.0
Assumed Filter Station RL:	Mtr.	0.0	0.0
Assumed Lowest Water RL:	Mtr.	-2.0	-2.0

Allowances For Calculation of Total Dynamic Head:			
Suction Line	Mtr.	3.0	3.0
Filtration - (Disk)	Mtr.	7.0	7.0
Miscellaneous/Headworks	Mtr.	2.0	2.0
Field Valve Assembly	Mtr.	4.0	4.0

Allowances in Calculation of Total Dynamic Head Required (TDH) - Final 200 ha

TDH For Final Pump Duty (m)	Critical (Furthest) Valve Pressure Required (m)	Total Mainline loss (m)	Total Mainline Distance (m)	Elevation (m)	Valve Assy Loss (m)	Headworks Losses (m)
55.0	22.0	11.0	2200.0	6.0	4.0	12.0
	Loss Allowed/100m=	0.5				

Zone Name	Area (ha)	Valve Size	Flow (m3/h)	Reg Pressure (m)	Min Pressure (m)	Max Pressure (m)	Mean Flow (lph)	Flow Var. (%)
Area no. 01	10.0	100mm	80.5	20.0	13.2	20.0	1.6	0.0
Area no. 02	10.0	100mm	80.5	20.0	13.2	20.0	1.6	0.0
Total Area:	**20.0**	**(ha)**						

NOTE: **SYSTEM DESIGNED FLAT**
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Figure 5-2. Stage two irrigation area

- Uniram 20010 AS 1.6 lph @ 0.5m
- 50mm PVC Class 6
- Collect Manif - 50mm PVC Class 6
- 80mm PVC Class 6
- 100mm PVC Class 6
- 150mm PVC Class 6
- 200mm PVC Class 6
- 250mm PVC Class 6
- Suction/Delivery Manifold
- Valve Take Off - TBD

DIAL BEFORE YOU DIG www.1100.com.au The Essential First Step

- 100mm Valve Assy
- 50mm Air Valve Assy (AV50-xx)
- 50mm Threaded AV-10 Vacuum Breaker
- 50mm Collection Manifold (CF50-01)
- 150mm Purge Valve Assy (PV150-xx)
- Pump / Disc Filter Station
- Isolation Valve - Line Sized
- Water Supply

CERTIFIED IRRIGATION DESIGNER — IRRIGATION AUSTRALIA — ADM2570 — AGRICULTURAL DRIP MICRO

NOTES:
1. ALL NOTES SHALL BE READ IN CONJUNCTION WITH THE CONTRACT SPECIFICATIONS, DESIGN DRAWINGS, TECHNICAL SPECIFICATIONS AND OTHER RELEVANT STANDARDS. PRECEDENCE IS GIVEN TO SPECIFICATIONS AND STANDARDS, THEN DRAWINGS, THEN NOTES.
2. THE PLANS ARE A SCHEMATIC REPRESENTATION OF THE DESIGNED IRRIGATION SYSTEM.
3. RETAIN AND PROTECT ALL EXISTING SERVICES. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO LOCATE AND IDENTIFY ALL SERVICES PRIOR TO COMMENCEMENT OF WORK AND PROTECT ALL DURING WORK. PRIOR TO COMMENCEMENT OF WORK THE CONTRACTOR SHALL PERFORM A 'DIAL BEFORE YOU DIG' ENQUIRY. IT IS NOT GUARANTEED THAT ALL SERVICES HAVE BEEN SHOWN ON THE DRAWING.
4. ALL CONTROL CABLE CROSSING HARDSTAND AREAS TO BE INSTALLED WITHIN CONDUIT.

0 25.0 50.0 100.0 150.0 200.0
ORIGINAL SCALE @ A1 : 1:2500

ISSUED FOR CONSTRUCTION

REVISION	DATE	REVISION DESCRIPTION	BY
D	14/09/21	ISSUE FOR CONSTRUCTION	GV
C	21/07/21	REVISED AND APPROVED ISSUE FOR TENDER	GV
B	21/06/21	APPROVED ISSUE FOR TENDER	GV
A	17/06/21	PRELIMINARY ISSUE FOR REVIEW	GV

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NETWORKS DESIGN • SERVICE • PROJECTS

Project:	Description:
Mahogany's Anzac Parade	Stage 1
Client:	System: / Location:
Water Dynamics	Irrigation / Lambells Lagoon NT

Sheet:	Design by:	Drawn:	Checked by:	Size:	Scale:	Date:	Rev:	Job No:	Org No.
1 of 1	GV	GV	KK	A1	1:2500	17/06/2021	D	0621002p1	01

6 MONITORING AND REPORTING

6.1 Daily monitoring

Monitoring of the irrigation area will be undertaken as per the procedures included in Appendix D.

Irrigation activities will only be conducted during work hours when the system can be monitored at all times.

6.2 Compliance water and soil monitoring

Monitoring and reporting for irrigation activities will be conducted in accordance with the EPL application and LLCF Environmental Management Plan. Water sampling includes the sampling of groundwater, surface water and wastewater to be irrigated, and soil sampling is a standardised regime aligned with the NSW Guideline *Use of Effluent by Irrigation* (DEC 2004).

6.3 Assessment of performance indicators

Annual nutrient balance calculations should be undertaken and compared with the soil monitoring results to assess the sustainability of the wastewater irrigation system. If the wastewater is managed so that the nitrogen and phosphorous input and output levels remain consistent, the overall soil nutrient concentrations should remain consistent.

The key parameters of soil should be graphed and compared annually, to identify any nutrient application issues or irrigation practices that may need to be altered.

Key parameters:

- Soil nitrogen
- Available phosphorus
- Salinity
- Sodicity.

6.4 Reporting

All routine wastewater and soil monitoring data along with incident/investigation monitoring data will be recorded in a water and soil quality database, and to be available upon request to the NT EPA.

6.4.1 Internal reporting

Details of environmental incidents, non-conformances or other relevant information are included in daily reports which are issued to the Farm Manager. Records of all incidents, inspections and reports are maintained through an electronic filing system.

All environmental monitoring records will be maintained in a water and soil quality database.

An annual report is also prepared which details and reviews annual water usage, waste generation (all streams) and energy use across the farm.

6.4.2 External reporting

All non-compliances of the EPL will be reported by PRI by completing a Non-Conformance Notification via the NT EPA website as soon as practicable after becoming aware of the non-conformance (and within 24 hours of the event), as per Section 14 of the *Waste Management and Pollution Control Act 1998 (NT)*.

Reporting will be undertaken in accordance with the EPL. An annual report will be submitted to the NT EPA on the anniversary data of the EPL which summaries the activities and outcomes of the previous 12 months of operation. Additionally, a monitoring report will be prepared and submitted in conjunction with the Annual report, which will include a trend analysis of the water quality monitoring data and an assessment of any environmental impacts from LLCF operations.

7 REFERENCES

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000), Australian and New Zealand Guidelines for fresh and marine water quality, Volume 3, Primary industries – rationale and background information, Agriculture and Resource Management Council of Australia and New Zealand.

Cameron A.G. and Lemcke B. (2008). *Agnote No. E29: Guinea Grass.* Department of Regional Development, Primary Industry, Fisheries and Resources, Northern Territory Government.

Department of Environment Conservation (DEC) (2004), *Use of Effluent by Irrigation; Environmental Guidelines*, Department of Environment and Conservation (DEC), New South Wales Government, Sydney.

Department of Land Resource Management (LRM), *Soils of the Northern Territory factsheet*, LRM, Northern Territory Government, Darwin.

Hausler P., O'Gara F. and Price T. (2002) *Agnote No. C32: Growing Grain Sorghum in the Northern Territory.* Department of Primary Industry, Fisheries and Mines, Northern Territory Government.

Mills, B (2001), *DPI&F Notes: Interpreting water analysis for crop and pasture* (revised 2004), The State of Queensland Department of Primary Industry and Fisheries.

APPENDIX A SOIL SAMPLING RESULTS

ES2002110	Date Sampled	23/01/2020	Preferred Levels* for crop/plant growth (NSW DPI, 2004)	NEPM TABLE 1-A 2013 (SOIL) - HIL A (Residential) Guideline Limit	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Physio-chemistry	Units	LOR			ES2002110001	ES2002110002	ES2002110003	ES2002110004	ES2002110005	ES2002110006	ES2002110007	ES2002110008	ES2002110009	ES2002110010	ES2002110011	ES2002110012	ES2002110013
pH Value	pH Unit	0.1	-	-	7	7.5	6.5	6.9	7.1	6.7	6.5	6.1	6.7	5.6	6.4	6.9	6.7
Sodium Adsorption Ratio	-	0.01	-	-	0.21	0.2	0.12	0.1	0.12	0.17	0.24	0.2	0.06	0.16	0.16	0.15	0.18
Electrical Conductivity @ 25°C	µS/cm	1	-	-	29	45	22	31	36	18	25	15	24	12	22	30	30
Moisture Content	%	1	-	-	17.2	14	13.6	14.4	16.2	12	16.8	10.2	11.2	10.7	14.5	15.6	15.4
Color (Munsell)	-		-	-	Black (10YR 2/1)	Black (10YR 2/1)	Very Dark Gray (10YR 3/1)	Black (10YR 2/1)	Very Dark Gray (7.5YR 3/1)	Dark Brown (10YR 3/3)	Very Dark Brown (7.5YR 2.5/2)	Very Dark Gray (10YR 3/1)	Very Dark Grayish Brown (10YR 3/2)	Very Dark Gray (10YR 3/1)	Very Dark Brown (7.5YR 2.5/3)	Very Dark Brown (7.5YR 2.5/3)	Very Dark Brown (7.5YR 2.5/3)
Emerson Class Number	-		-	-	3	3	3	3	3	3	7	3	3	3	3	3	3
Texture	-		-	-	Clay Loam	Loam	Clay Loam	Loam	Sandy Clay Loam	Sandy Loam	Clay Loam	Clayey Sand	Clayey Sand	Loamy Sand	Clay Loam	Clay Loam	Clay Loam
Exchangeable Cations on Alkaline Soils																	
Cation Exchange Capacity	meq/100g	0.2	-	-	-	2.7	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Calcium	meq/100g	0.2	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Magnesium	meq/100g	0.2	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Potassium	meq/100g	0.2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Sodium	meq/100g	0.2	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Sodium Percent	%	0.2	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Cations																	
Cation Exchange Capacity	meq/100g	0.1	-	-	7.1	-	4.4	6.6	7.4	2.2	4.2	1.3	3.7	0.5	3	6.5	5.1
Exchangeable Calcium	meq/100g	0.1	-	-	4.5	-	3	4.2	5.5	1.6	2.5	0.9	2.7	0.2	2	4.1	3.2
Exchangeable Magnesium	meq/100g	0.1	-	-	1.8	-	0.8	1.7	1.4	0.4	1.1	0.2	0.7	0.2	0.7	1.7	1.3
Exchangeable Potassium	meq/100g	0.1	-	-	0.8	-	0.5	0.7	0.5	0.2	0.6	0.1	0.2	<0.1	0.3	0.6	0.6
Exchangeable Sodium	meq/100g	0.1	-	-	0	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium Percent	%	0.1	-	-	0.3	-	0.3	0.2	0.2	0.7	0.5	0.8	0.3	2.5	0.5	0.3	0.3
Total Metals																	
Arsenic	mg/kg	5	<20	100	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	mg/kg	1		20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

ES2002110	Date Sampled	23/01/2020	Preferred Levels* for crop/plant growth (NSW DPI, 2004)	NEPM TABLE 1-A 2013 (SOIL) - HIL A (Residential) Guideline Limit	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Physio-chemistry	Units	LOR			ES2002110001	ES2002110002	ES2002110003	ES2002110004	ES2002110005	ES2002110006	ES2002110007	ES2002110008	ES2002110009	ES2002110010	ES2002110011	ES2002110012	ES2002110013
Chromium	mg/kg	2		-	11	49	18	36	42	25	11	54	25	27	14	16	14
Copper	mg/kg	5	2 - 50	6000	5	<5	<5	<5	<5	<5	7	<5	<5	<5	5	9	6
Lead	mg/kg	5	<35	300	7	7	5	6	7	5	9	5	5	<5	7	7	6
Nickel	mg/kg	2	1 - 20	400	2	<2	<2	<2	<2	<2	2	<2	<2	<2	<2	<2	<2
Zinc	mg/kg	5		7400	29	24	15	21	20	8	<5	<5	6	<5	<5	17	12
Mercury	mg/kg	0.1		40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nutrients																	
Nitrite + Nitrate as N (Sol.)	mg/kg	0.1		-	1.2	1.4	1.9	1.7	1.7	0.8	1.5	0.6	0.8	0.6	1.9	1.1	2.5
Total Kjeldahl Nitrogen as N	mg/kg	20		-	980	880	790	860	920	390	1310	850	520	580	800	930	760
Total Nitrogen as N	mg/kg	20	>10	-	980	880	790	860	920	390	1310	850	520	580	800	930	760
Total Phosphorus as P	mg/kg	2	20 - 30	-	**301**	**334**	**325**	**411**	**314**	**153**	**345**	**181**	**210**	**128**	**238**	**500**	**303**
Phosphate Sorption Capacity	mg P sorbed/kg	250		-	1610	1150	1030	1020	1350	562	1710	476	1010	862	1130	1280	1220
Phosphate Sorption Index	mgkg-1/log10ugL-1	1		-	51	27	43	35	50	26	67	45	40	58	66	41	46

Queensland Government

Department of Environment and Science - Chemistry Centre

Soil Analysis Report

Job No: 20-0715
Report ID: 20-0715-F-V1

Sample No	Customer's ID	Description	Method / Component / Units / Depth (m)	S_PSA Total %	S_AQ4_EL pH -	S_AQ4_EL EC dS/m	S_AQ4_AA Cl mg/kg	S_AQ4_AA NO3-N mg/kg	S_COLWELL P mg/kg	* S_PBI PBI col	* S_PBI PBI unadj	S_WALKLEY OC %	S_KJ_AA TKN %	S_KJ_AA TKP %	S_ADM_105 ADMC %	S_PSA Coarse sand %	S_PSA Fine sand %	S_PSA Silt %	S_PSA Clay %	S_03_BAR 1/3 Bar %	S_15_BAR 15 Bar %
20-0715-0001	S1-A	MEDLI Soil sampling for EZ191	0.30-0.50	105.8	6.39	0.02	<20	<1	16	112	109	0.85	0.038	<0.013	<1.5	32.3	49.5	8.7	15.3	12.9	6.7
20-0715-0002	S1-B	MEDLI Soil sampling for EZ191	1.20-1.40	100.3	5.57	<0.01	<20	<1	3	137	137	0.49	0.017	<0.013	2.2	23.9	31.8	8.9	35.6	21.2	13.4
20-0715-0003	S2-A	MEDLI Soil sampling for EZ191	0.30-0.50	104.6	5.97	0.02	<20	<1	15	94	91	1.06	0.049	0.013	<1.5	30.2	51.9	7.3	15.1	12.2	6.5
20-0715-0004	S2-B	MEDLI Soil sampling for EZ191	1.30-1.50	102.9	5.59	<0.01	<20	<1	3	120	119	0.35	0.017	<0.013	<1.5	27.9	42.3	5.9	26.8	15.7	9.7
20-0715-0005	S3-A	MEDLI Soil sampling for EZ191	0.10-0.30	101.0	6.17	0.03	<20	3	36	59	53	0.80	0.059	0.022	<1.5	27.5	57.8	2.6	13.2	9.8	6.4
20-0715-0006	S3-B	MEDLI Soil sampling for EZ191	0.50-0.70	100.7	6.21	0.02	<20	1	13	96	94	0.54	0.030	<0.013	1.6	30.6	45.9	7.6	16.6	16.2	9.4
20-0715-0007	S4-B	MEDLI Soil sampling for EZ191	0.20-0.40	102.0	6.03	0.02	<20	<1	55	77	67	1.11	0.065	0.027	<1.5	22.9	61.7	4.2	13.2	11.6	6.4
20-0715-0008	S4-A	MEDLI Soil sampling for EZ191	0.90-1.10	103.9	5.98	<0.01	<20	<1	11	137	135	0.46	0.023	<0.013	1.5	26.0	51.9	5.9	20.0	15.0	8.2

Name : Angus McElnea
Title : Team Leader Soil and Plant

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Number: 5072

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The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

APPENDIX B STAGE 1 MEDLI OUTPUTS

1 MEDLI SUMMARY: STAGE ONE

The Model for Effluent Disposal using Land Irrigation (MEDLI) is a program for designing effluent reuse schemes. The model addresses many factors impacting on effluent irrigation, such as the quality and quantity of effluent, climate, storage, irrigation frequency and amount, nitrogen, phosphorus and salt components and plant growth. The MEDLI program was used on the LLCF wastewater to assess the viability of irrigation as a method of wastewater management.

1.1 Input data

1.1.1 Climate

The quantity of effluent and current quality outlined in the sections above was used in the MEDLI assessment. A 60-year climate file for the Project area was obtained from the SILO database (a climate database managed by the Queensland Department of Environment and Science) to input rainfall and evaporation data. The model was run using climate data from 1950 to 2019, to account for recent impacts of climate change that may affect the model outputs.

1.1.2 Inflow

The effluent inflow was set at 100m^3 a day based on predicted water use once the hatchery is at peak capacity (early operational months may produce significantly less effluent). Inflow volumes were only set for March to December to coincide with the current programmed Stage one operational period. By December it is anticipated that Stage two will come online, which includes a full-scale wastewater management system and the Stage one irrigation activities will no longer be required.

1.1.3 Storage

A 6x6x3m open concrete storage tank was used in the scenario to represent the proposed storage and step screen solids removal tank. The tank is uncovered and therefore model parameters allowed for rainfall infiltration and evaporation over the exposed surface area.

1.1.4 Soil

Soil samples were collected from the Project area on 10 July 2020 and sent a laboratory specialising in MEDLI analysis suites. The analyses undertaken directly related to the required MEDLI inputs and allowed for site specific soil information to be incorporated into the model.

1.1.5 Crop selection

The default planting parameters for Forage Sorghum Crop were used in the model as they are representative of the crop selection for the proposed irrigation area. The default crop also has a maximum crop coefficient of 0.8, and according to the NT *Guidelines for Land Capability Assessment for On-site Wastewater Management* (DOH, 2014), a crop factor of 0.8-1.0 would be appropriate for irrigation design purposes, based on the generally high year-round daytime temperatures in the NT.

1.1.6 Irrigation method

The irrigation method modelled was a centre pivot system over varying irrigation areas to determine the minimum irrigation area required. The irrigation was applied on a daily frequency at a rate of 5 mm per day.

A “dry-run” was also modelled for both irrigation areas, where the irrigation inputs were removed, in order to determine the natural conditions and deep drainage rates for the area without any irrigation inputs.

1.2 Modelling results

The results of the water and nutrient balances modelled by MEDLI are outlined in Table 1-1 to Table 1-3 respectively. Based on the nutrient balance, a minimum irrigation area of 15 ha is recommended to manage the nutrient loading of the wastewater, therefore the outputs of the 15 ha irrigation area scenario have been provided.

Table 1-1. Land water balance

	Unit	With irrigation	Dry-run
Rain	mm/year	1544	1544
Irrigation	mm/year	203	0
Soil evaporation	mm/year	489	601
Transpiration	mm/year	461	0
Rain runoff	mm/year	41	114
Irrigation runoff	mm/year	0	0
Deep drainage	mm/year	758	829

Table 1-2. Pond system water balance

	Unit	Value
Rain	m3/year	51.47
Inflow	m3/year	30524
Evaporation	m3/year	75
Overflow	m3/year	22
Irrigation	m3/year	30479
Effluent reuse (proportion of inflow + net rain gain irrigated)	Fraction	1
Probability of at least 90% reuse	Fraction	1

Table 1-3. Land nutrient balance

	Unit	N balance	P balance
Irrigation (effluent load added)	kg/ha/year	161	26
Denitrification	kg/ha/year	0.12	-
Irrigation runoff	kg/ha/year	0	0
Plant uptake	kg/ha/year	140	19
Leached	kg/ha/year	24	0.07

The MEDLI results indicate that the proposed irrigation scheme is sufficient to manage the daily effluent volumes produced without creating any irrigation runoff or significant increases to the deep drainage. The proposed concrete tank is sufficient in size to store the wastewater without causing significant overflows and ensuring 100% reuse of the effluent produced (through irrigation).

The application rate of nutrients is slightly higher than the predicted plant uptake rates which results in some leaching of nitrogen. The predicted average nitrate concentration of the deep drainage based on current soil

concentrations and effluent irrigation, is 3.2mg/L which is still considered low. The concentration of nutrients in the wastewater is to be monitored to ensure that if concentrations increase significantly above the predicted values, the irrigation area is adjusted accordingly or alternative treatment methods are reviewed.

MEDLI REPORT - FULL RUN

Enterprise: **Stage 1 Hatchery**

Description:
Lambells Lagoon

Client: **PRI Farming Pty Ltd**

MEDLI User: ECOZ\emma.lewis

Scenario Details:

DESCRIPTION

Climate Data: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days

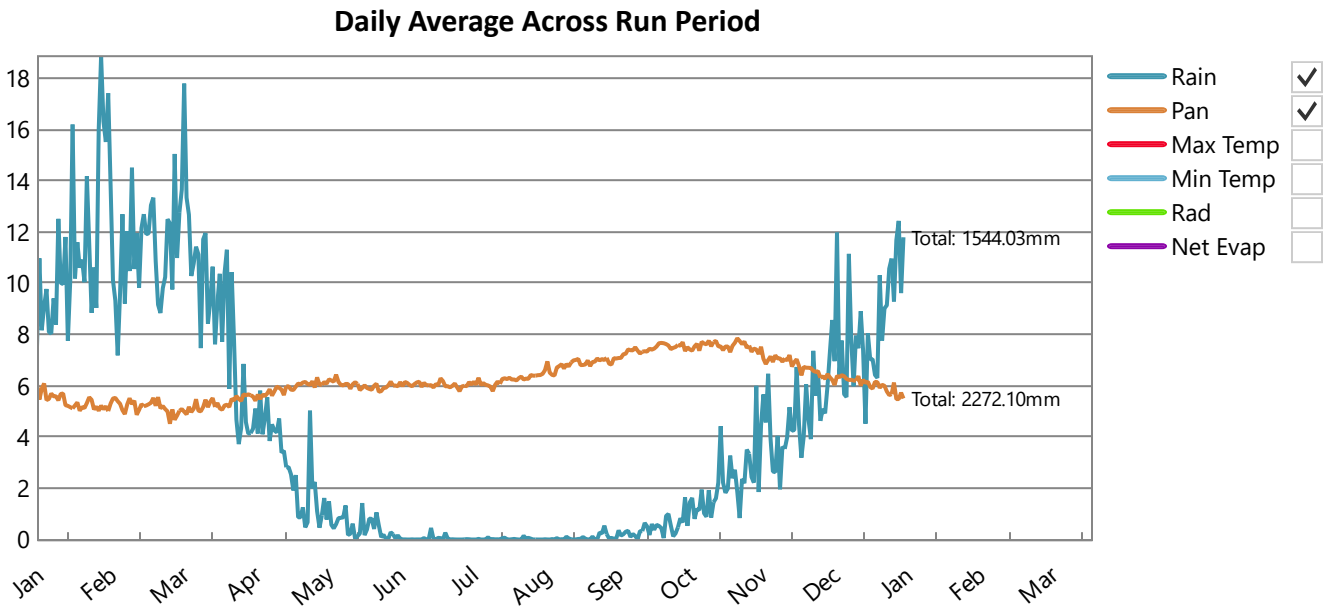
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	1108	1521	2163
Pan Evaporation (mm/year)	2100	2273	2448

Climate Data:

Chart Table

Monthly Daily

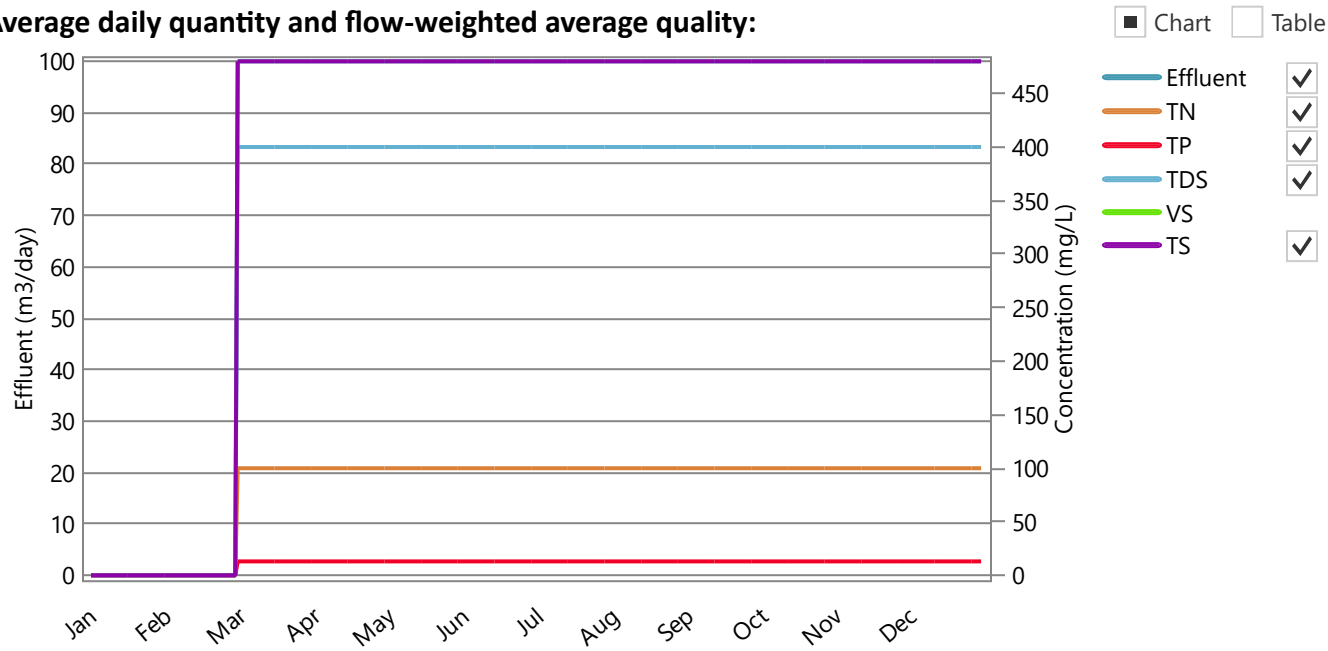


DESCRIPTION

Effluent type: Lambells Lagoon Hatchery

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: **30524.19 m3/year** or 83.57 m3/day (Min-Max: 0.00 - 100.00)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

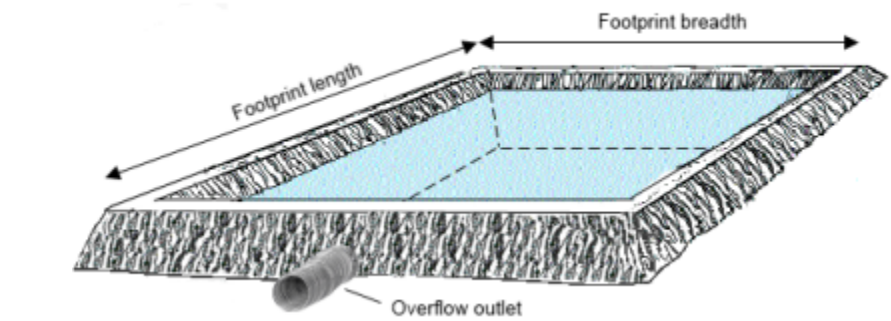
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	100.00 (0.00 - 100.00)	3052.42 (3050.00 - 3060.00)
Total Phosphorus	13.00 (0.00 - 13.00)	396.81 (396.50 - 397.80)
Total Dissolved Salts	400.00 (0.00 - 400.00)	12209.68 (12200.00 - 12240.00)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	480.00 (0.00 - 480.00)	14651.61 (14640.00 - 14688.00)

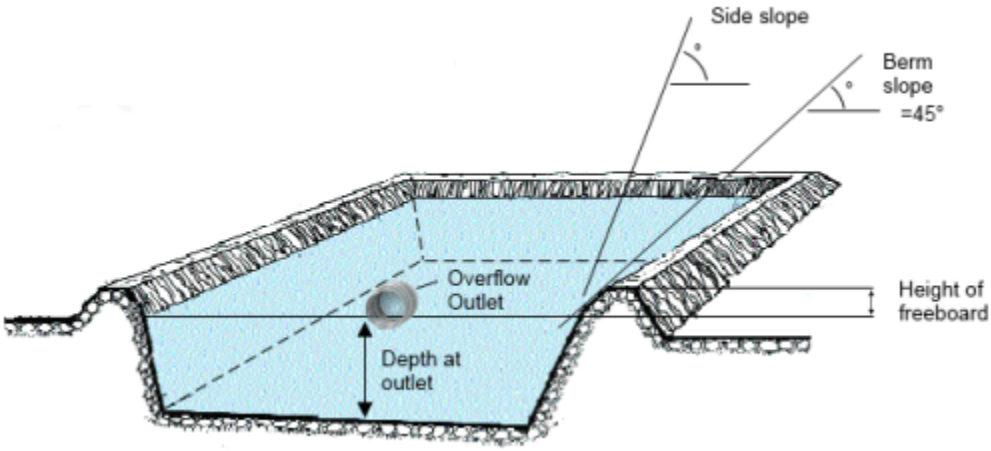
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (m3)	100.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	3.00
Maximum water surface area (m2)	33.33
Pond footprint length (m)	5.77
Pond footprint width (m)	5.77
Pond catchment area (m2)	33.33
Average active volume (m3)	1.02





Irrigation pump limits:

Minimum pump rate limit (ML/day)	0.00
Maximum pump rate per area limit (ML/day/ha)	1.00

Shandying water:

Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

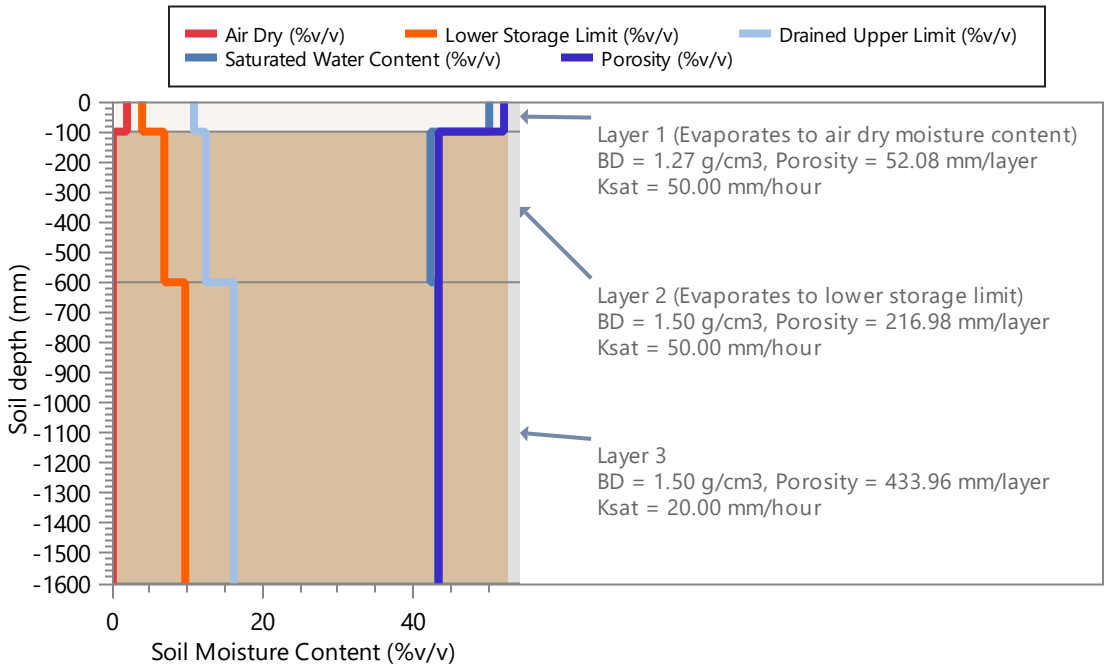
DESCRIPTION

Land: Stage 1 irrigation

Area (ha): 15.00

Soil Type: Lambells, 1600.00 mm defined profile depth

Profile Porosity (mm)	703.02
Profile saturation water content (mm)	694.60
Profile drained upper limit (or field capacity) (mm)	235.10
Profile lower storage limit (or permanent wilting point) (mm)	136.05
Profile available water capacity (mm)	99.05
Profile limiting saturated hydraulic conductivity (mm/hour)	20.00
Surface saturated hydraulic conductivity (mm/hour)	50.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Forage Sorghum Crop

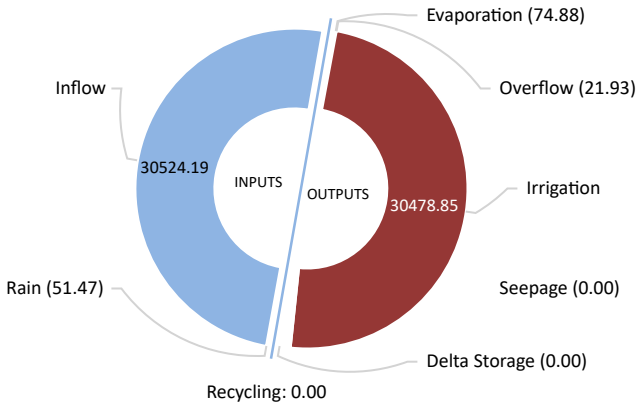
Average monthly cover (fraction) (minimum - maximum)	0.32 (0.00 - 0.67)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Maximum potential root depth in defined soil profile (mm)	1600.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **100 m3**

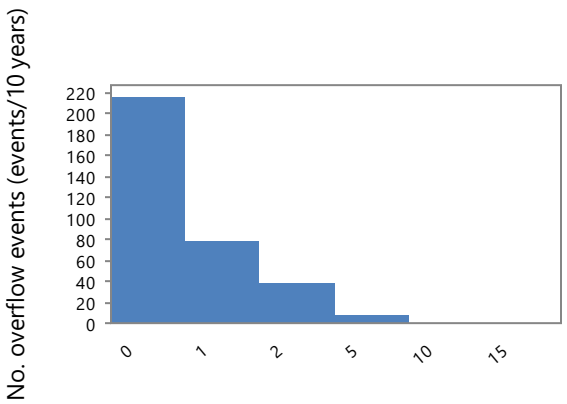
Pond System Water Balance (m3/year)



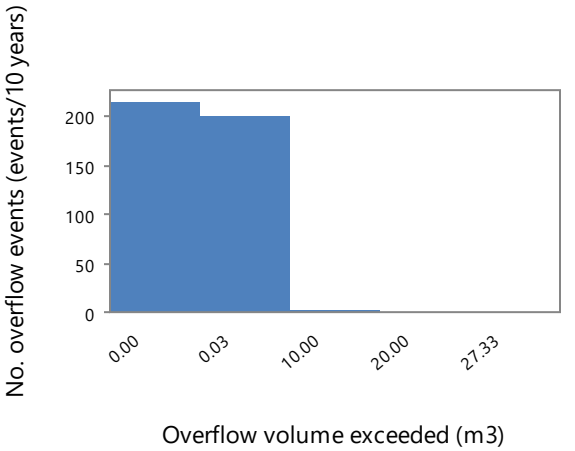
Name	Value
Rain	51.47
Inflow	30524.19
Recycling	0.00
Evaporation	74.88
Overflow	21.93
Irrigation	30478.85
Seepage	0.00
Delta Storage	0.00

Overflow Diagnostics

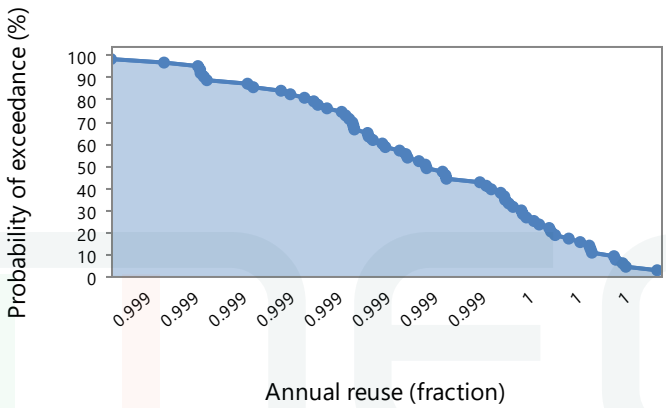
Volume of overflow (m3/year)	21.93
No. days pond overflows (days/year)	38.85
Average duration of overflow (days)	1.81
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% reuse (fraction)	1.00



Export plot



Export plot



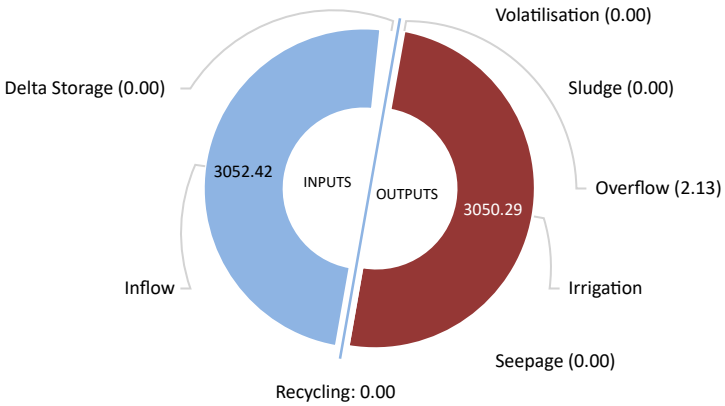
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

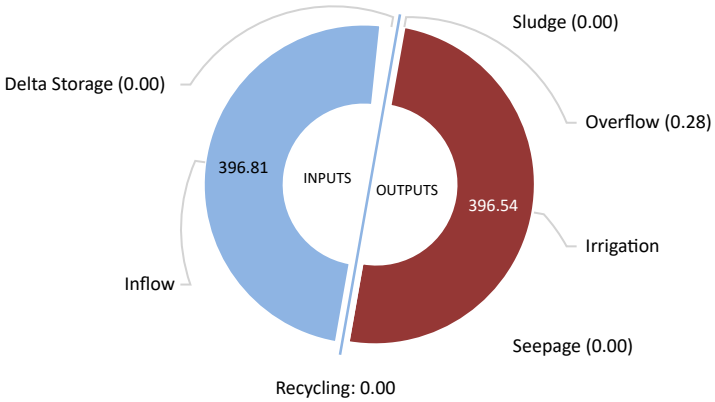
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



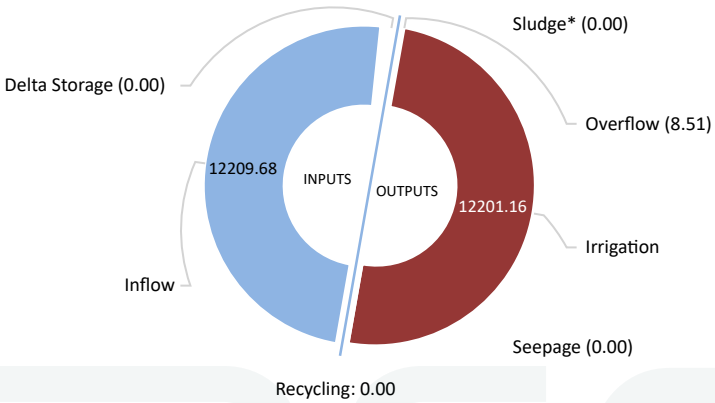
Name	Value
Inflow	3052.42
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	2.13
Irrigation	3050.29
Seepage	0.00
Delta Storage	0.00

Phosphorus Balance (kg/year)



Name	Value
Inflow	396.81
Recycling	0.00
Sludge	0.00
Overflow	0.28
Irrigation	396.54
Seepage	0.00
Delta Storage	0.00

Salt Balance (kg/year)



Name	Value
Inflow	12209.68
Recycling	0.00
Sludge*	0.00
Overflow	8.51
Irrigation	12201.16
Seepage	0.00
Delta Storage	0.00

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	0.10
Average phosphorus concentration of pond liquid (mg/L)	0.01
Average salinity of pond liquid (dS/m)	0.00

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	99.63
Final phosphorus concentration of pond liquid (mg/L)	12.95
Final salinity of pond liquid (dS/m)	0.62

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	30478.85
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	30478.85
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	100.08
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	79.26
Average phosphorus concentration of irrigation water (mg/L)	13.01
Average salinity of irrigation water (dS/m)	0.63

Irrigation Diagnostics:

Proportion Days Irrigation Turned Off (fraction)	0.16
Proportion of Days irrigation occurs (fraction)	0.84

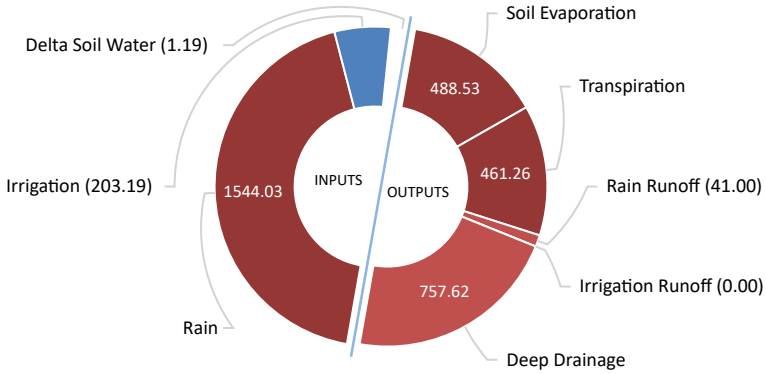
PERFORMANCE

Land Performance - Soil Water

Paddock: Stage 1 irrigation, 15 ha
Soil Type: Lambells, 99.05 mm PAWC at maximum root depth

Land Water Balance (mm/year):

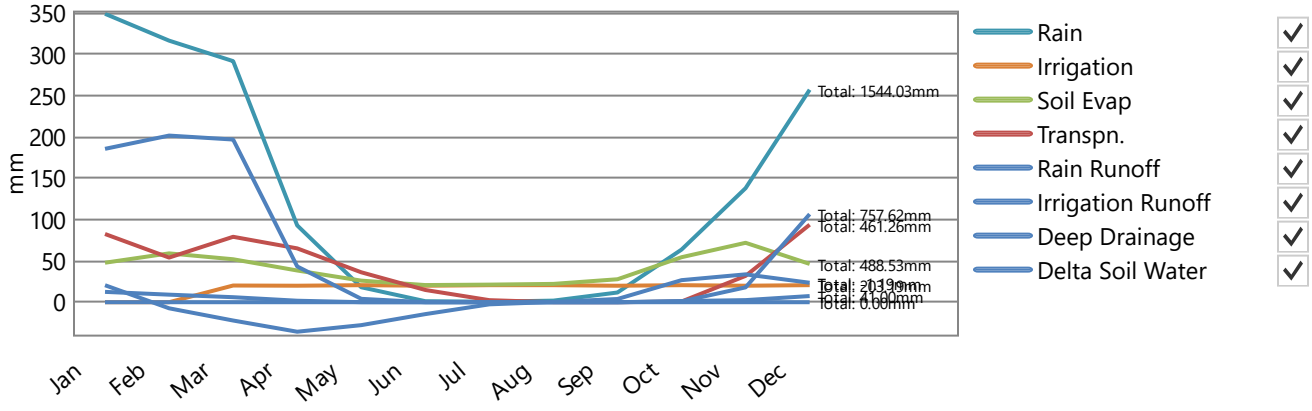
mm/year % Total inputs



Name	Value
Rain	1544.03
Irrigation	203.19
Soil Evaporation	488.53
Transpiration	461.26
Rain Runoff	41.00
Irrigation Runoff	0.00
Deep Drainage	757.62
Delta Soil Water	-1.19

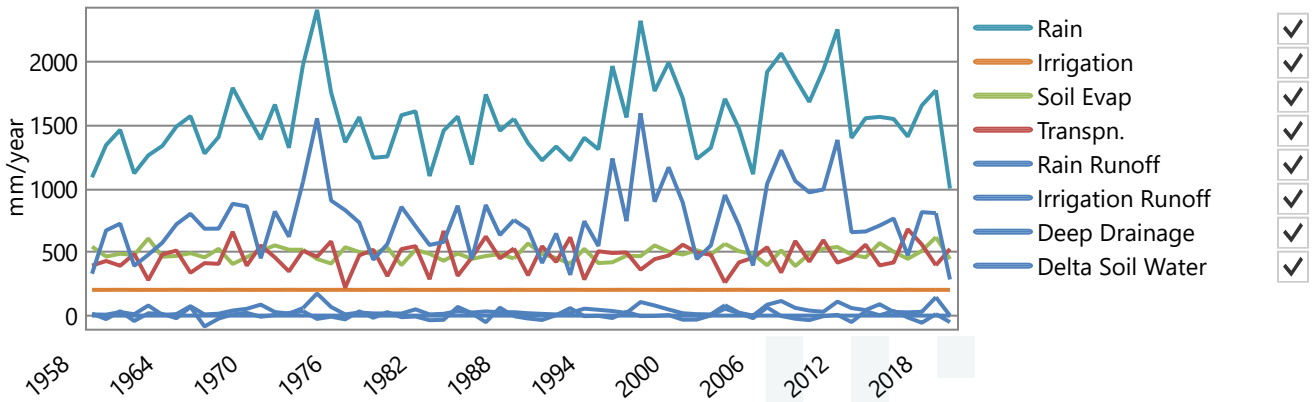
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



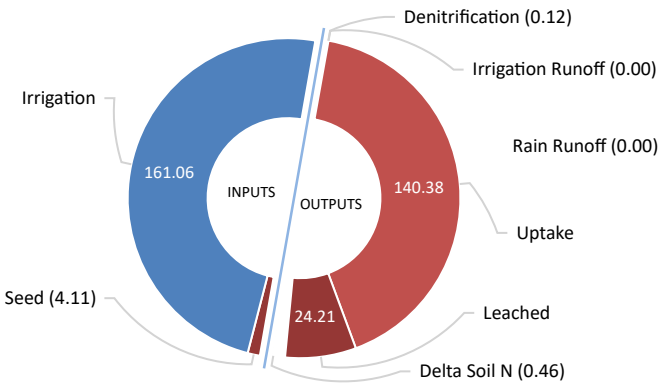
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Stage 1 irrigation, 15 ha **Soil Type**: Lambells

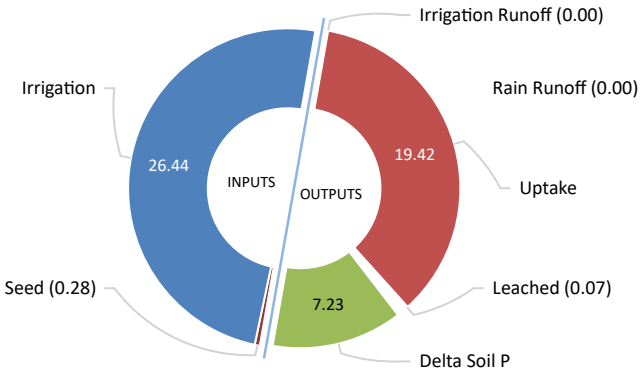
Irrigation ammonium volatilisation losses (kg/ha/year): 42.30
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.80

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	4.11
Irrigation	161.06
Denitrification	0.12
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	140.38
Leached	24.21
Delta Soil N	0.46

Land Phosphorus Balance (kg/ha/year)



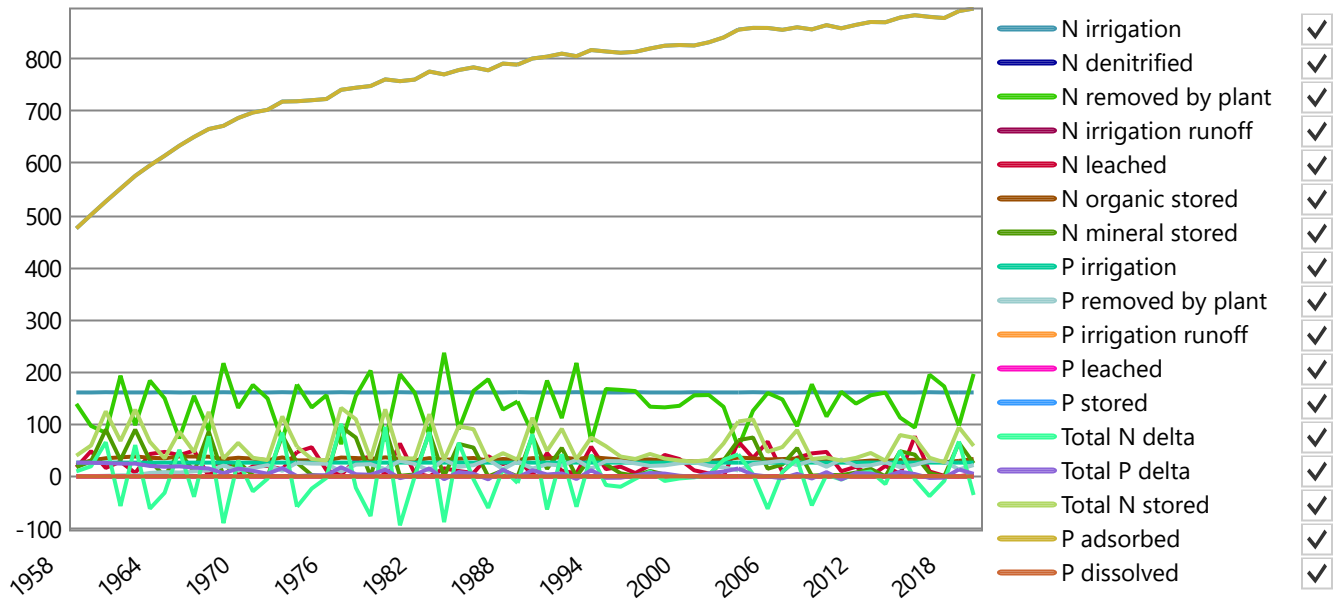
Name	Value
Seed	0.28
Irrigation	26.44
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	19.42
Leached	0.07
Delta Soil P	7.23

PERFORMANCE

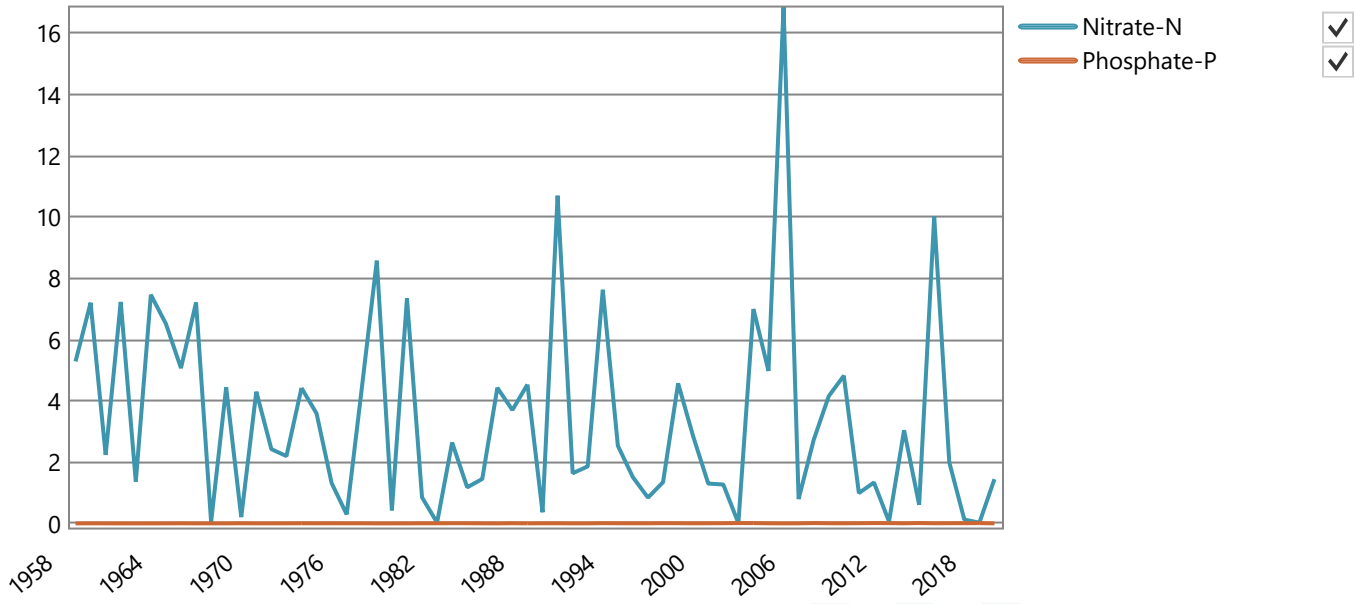
Land Performance - Soil Nutrient

Paddock: Stage 1 irrigation, 15 ha **Soil Type**: Lambells

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Stage 1 irrigation, 15 ha **Soil Type**: Lambells

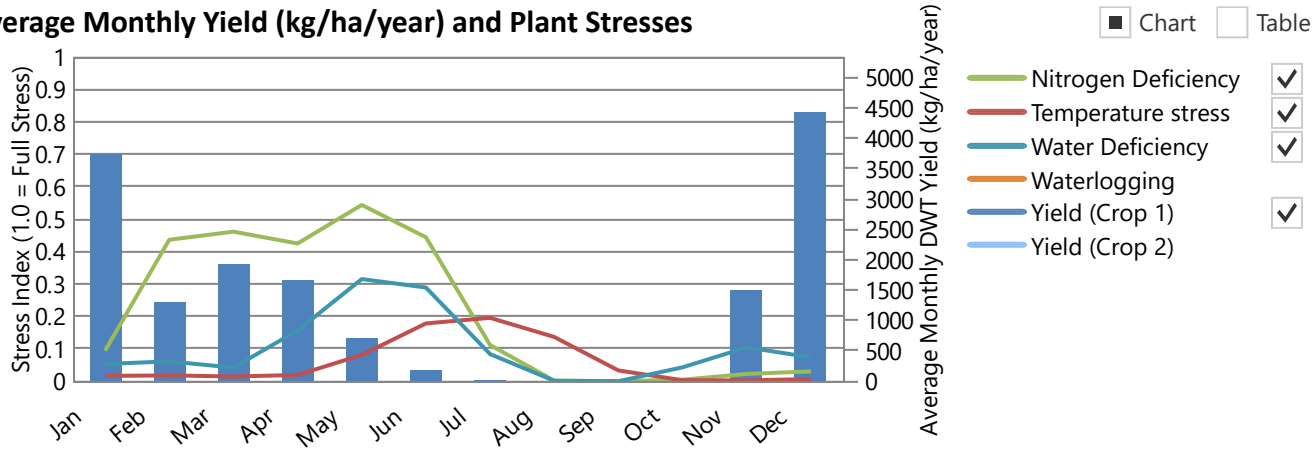
Plant: Continuous Forage Sorghum Crop

Average annual shoot dry matter yield (kg/ha/year)	15615.19 (4693.68 - 26433.23)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.32 (0.00 - 0.67)
Average monthly root depth (mm) (minimum - maximum)	680.52 (0.00 - 1312.90)

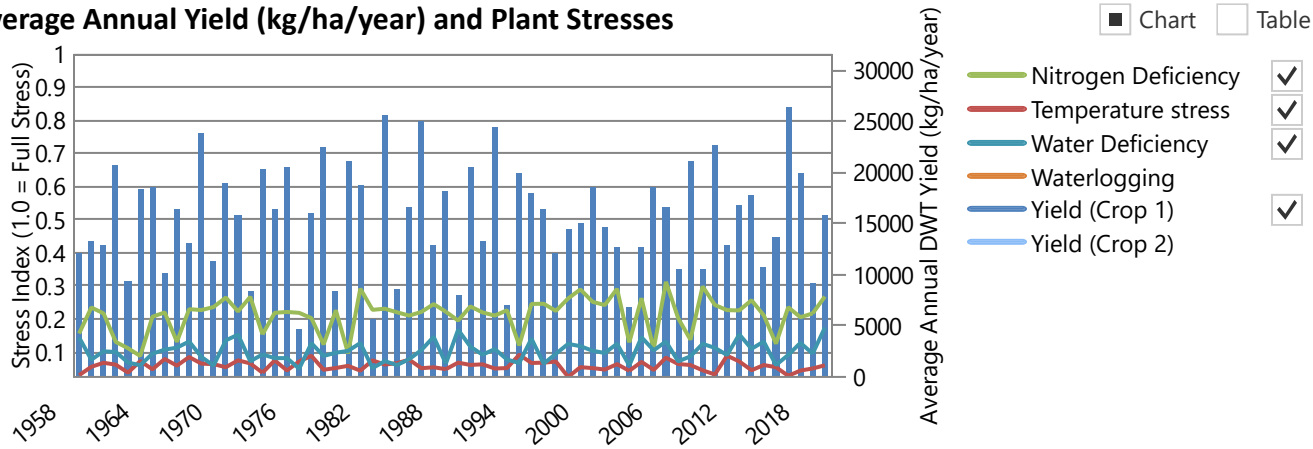
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	140.38 (55.56 - 237.05)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	19.42 (0.40 - 32.54)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.001 (0.000 - 0.003)

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 2.10 (normal), 1.00 (forced by crop death due to nitrogen stress (0.45), water stress (0.55))

No. days without crop/year (days/year): 141.45 due to water stress (141.45)

PERFORMANCE

Land Performance

Paddock: Stage 1 irrigation, 15 ha **Soil Type**: Lambells

Plant: Continuous Forage Sorghum Crop

Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11
No. years assumed for leaching to reach steady-state (years)	10.00

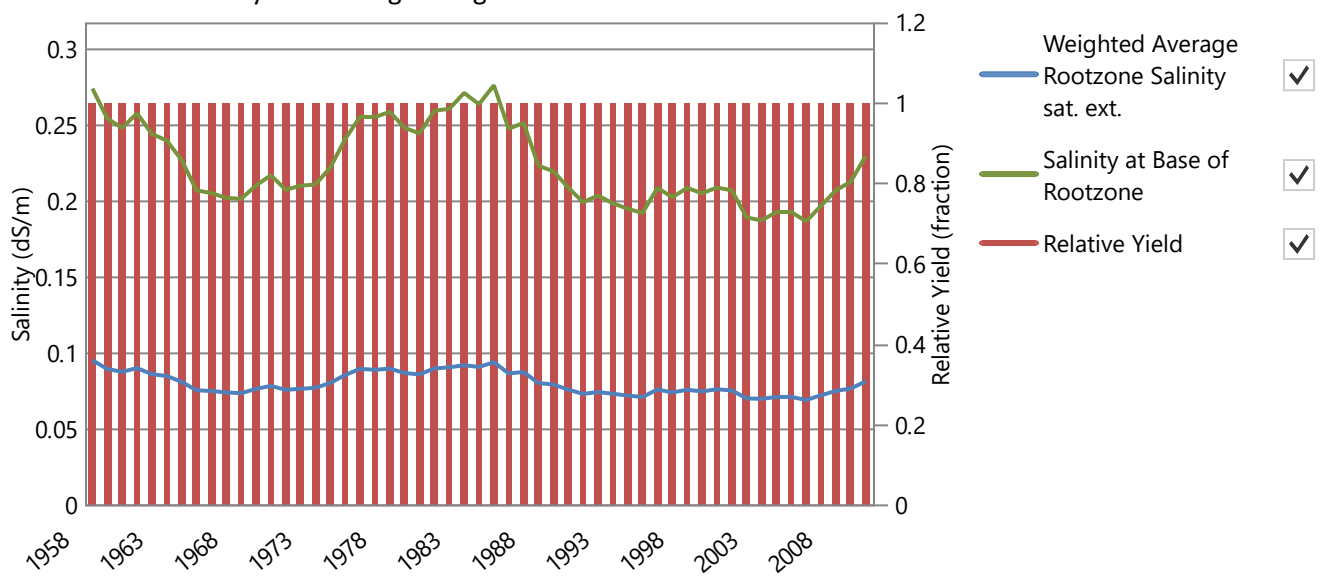
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.10
Salt added by rainfall (kg/ha/year)	288.58
Average annual effluent salt added & leached at steady state (kg/ha/year)	1101.99
Average leaching fraction based on 10 year running averages (fraction)	0.57
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.08
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.22
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



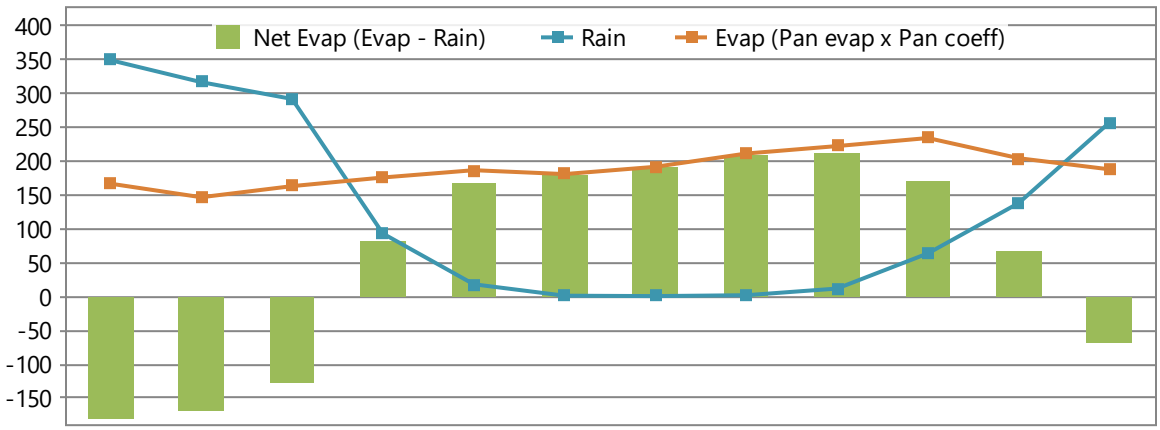
DIAGNOSTICS

Sustainability Diagnostics: Stage 1 Hatchery

Averaged Historical Climate Data Used in Simulation (mm)

Location: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Evap	166.8	146.7	163.1	175.9	186.7	180.9	191.7	211.3	222.3	234.2	204.4	188.0	2272.1
Net Evap	-182.6	-170.1	-128.9	82.9	168.6	179.7	191.1	209.4	210.6	170.5	66.3	-69.4	728.1
Net Evap/day	-5.9	-6.0	-4.2	2.8	5.4	6.0	6.2	6.8	7.0	5.5	2.2	-2.2	2.0

DIAGNOSTICS

Sustainability Diagnostics: Stage 1 Hatchery

Pond System: 1 facultative, aerobic or storage pond

Lambells Lagoon Hatchery - 30524.19 m3/year or 83.57 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 305.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	100.00 (0.00 - 100.00)	3052.42 (3050.00 - 3060.00)
Total Phosphorus	13.00 (0.00 - 13.00)	396.81 (396.50 - 397.80)
Total Dissolved Salts	400.00 (0.00 - 400.00)	12209.68 (12200.00 - 12240.00)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	480.00 (0.00 - 480.00)	14651.61 (14640.00 - 14688.00)

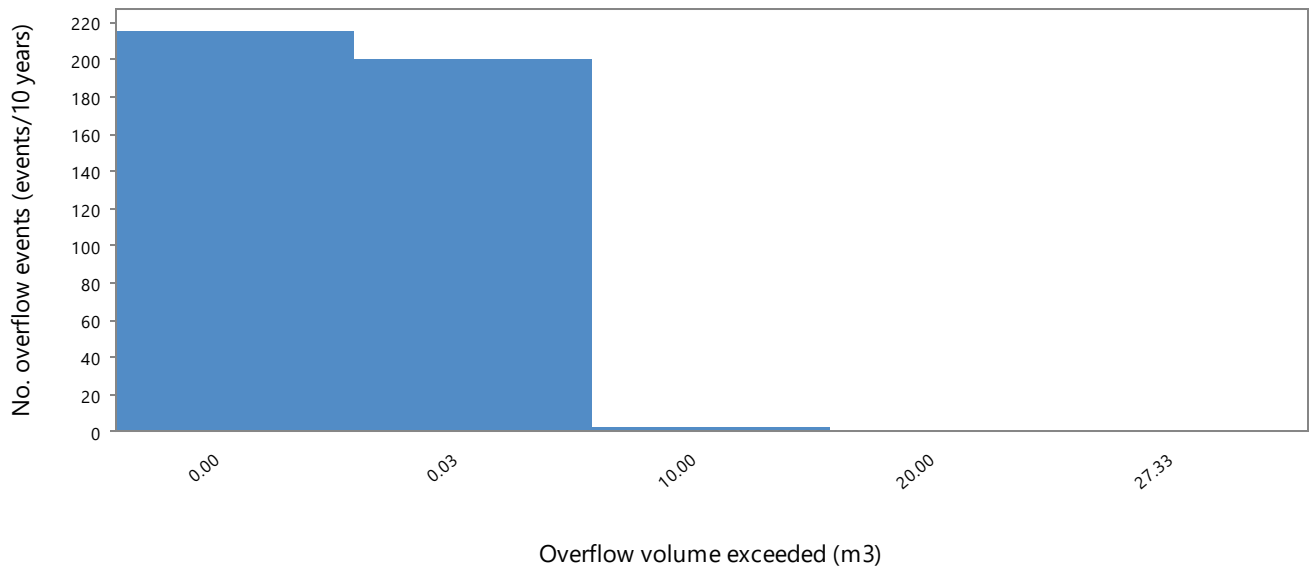
Last pond (Wet weather store): 100.00 m3

Theoretical hydraulic retention time (days)	1.20
Average volume of overflow (m3/year)	21.93
No. overflow events per year exceeding threshold* of 0.03 m3 (no./year)	20.03
Average duration of overflow (days)	1.81
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	0.00
Salinity of last pond on final day of simulation (dS/m)	0.62
Ammonia loss from pond system water area (kg/m2/year)	0.00

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: Stage 1 Hatchery

Irrigation Information

Irrigation: 15 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	30478.85	2031.92
Total nitrogen applied (kg)	2415.83	161.06
Total phosphorus applied (kg)	396.54	26.44
Total salts applied (kg)	12201.16	813.41

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is turned off (fraction)	0.16
Proportion of Days irrigation occurs (fraction)	0.84

DIAGNOSTICS

Sustainability Diagnostics: Stage 1 Hatchery

Paddock Land: Stage 1 irrigation: 15 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate a fixed amount of 5.00 mm each day
Irrigation window from 1/3 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Lambells, 99.05 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Irrigation	0.0	0.0	20.2	20.0	20.6	20.0	20.6	20.6	20.0	20.6	20.0	20.6	203.2
Soil Evap	47.8	59.2	52.0	38.4	26.1	20.8	21.3	22.2	27.8	54.5	72.0	46.4	488.5
Transpn.	82.6	54.0	79.2	65.2	36.2	14.8	2.5	0.0	0.0	0.8	31.9	93.9	461.3
Rain Runoff	12.5	9.2	6.1	1.8	0.0	0.0	0.0	0.0	0.0	1.4	2.5	7.5	41.0
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	185.8	201.8	197.0	43.3	4.1	0.0	0.0	0.0	0.0	1.0	18.0	106.7	757.6
Delta	20.6	-7.4	-22.2	-35.7	-27.8	-14.4	-2.6	0.3	3.9	26.7	33.7	23.6	-1.2

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	161.06
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	140.38
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.12
Average annual soil nitrogen leached (kg/ha/year)	24.21
Average annual nitrate-N loading to groundwater (kg/ha/year)	24.21
Soil organic-N kg/ha (Initial - Final)	6.41 - 33.38
	23.77 - 25.15
Average nitrate-N concentration of deep drainage (mg/L)	3.20
Max. annual nitrate-N concentration of deep drainage (mg/L)	16.87

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	26.44
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	19.42
Average annual soil phosphorus leached (kg/ha/year)	0.07
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.01
Adsorbed phosphorus (kg/ha) (Initial - Final)	449.15 - 897.11
Average phosphate-P concentration in rootzone (mg/L)	0.04
Average phosphate-P concentration of deep drainage (mg/L)	0.01
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.02
Design soil profile storage life based on average infiltrated water phosphorus concn. of 1.55 mg/L (years)	144.49

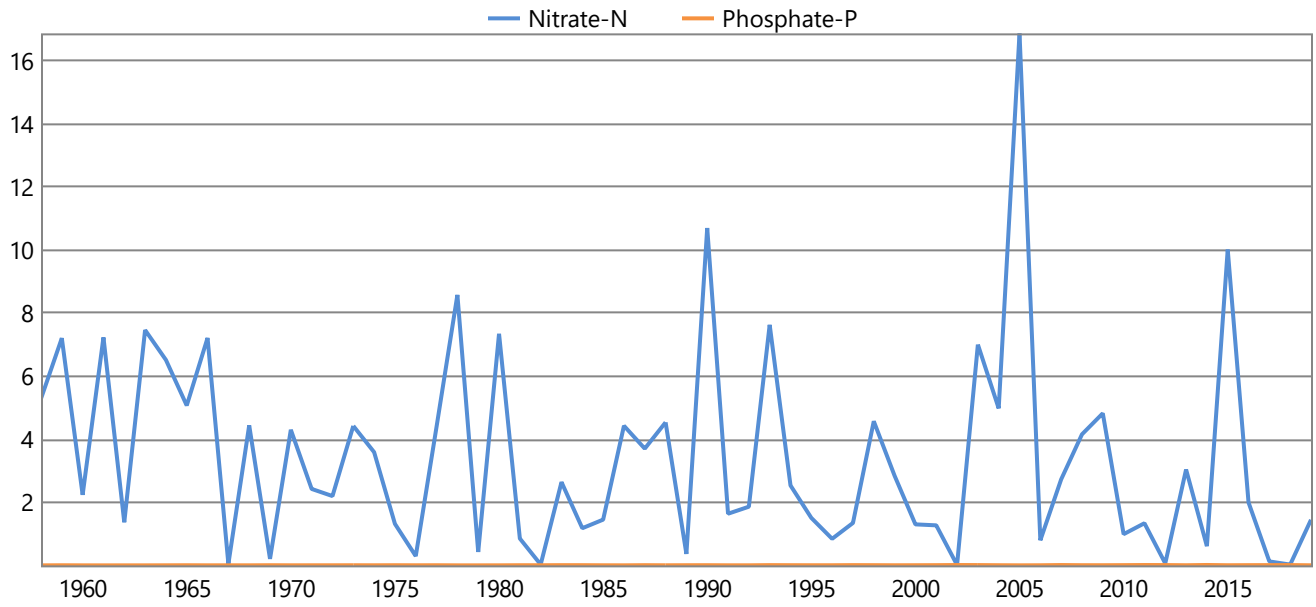
DIAGNOSTICS

Sustainability Diagnostics: Stage 1 Hatchery

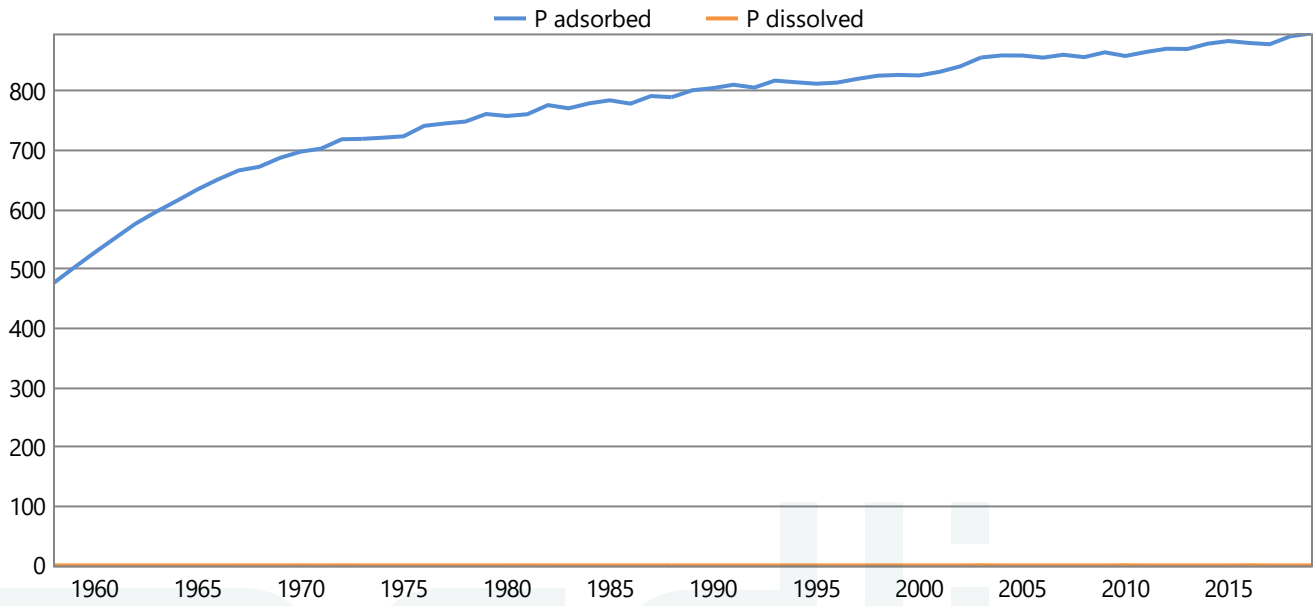
Paddock Land: Stage 1 irrigation: 15 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: Stage 1 Hatchery

Paddock Plant Performance: Stage 1 irrigation: 15 ha

Average Plant Performance (Minimum - Maximum): Continuous Forage Sorghum Crop

Average annual shoot dry matter yield (kg/ha/year)	15615.19 (4693.68 - 26433.23)
Average monthly plant (green) cover (fraction)	0.32 (0.00 - 0.67)
Average monthly crop factor (fraction)	0.26 (0.00 - 0.53)
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Average monthly root depth (mm)	680.52 (0.00 - 1312.90)
Average number of normal harvests per year (no./year)	2.10 (1.00 - 3.00)
Average number of normal harvests for last five years only (no./year)	2.20
Average number of crop deaths per year (no./year)	1.00 (1.00 - 1.00)
Average number of crop deaths for last five years only (no./year)	1.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.21 (0.09 - 0.31)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.20 (0.07 - 0.33)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.10 (0.00 - 0.31)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	141.45

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts
All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.10
Salt added by rainfall (kg/ha/year)	288.58
Average annual effluent salt added & leached at steady state (kg/ha/year)	1101.99
Average leaching fraction based on 10 year running averages (fraction)	0.57
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.08
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.22
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

APPENDIX C STAGE 2 MEDLI OUTPUTS

1.1 MEDLI Summary: Stage 2 Lambells Lagoon Crocodile Farm (LLCF)

The Model for Effluent Disposal using Land Irrigation (MEDLI) is a program for designing effluent reuse schemes. The model addresses many factors impacting on effluent irrigation, such as the quality and quantity of effluent, climate, storage, irrigation frequency and amount, nitrogen, phosphorus and salt components and plant growth. The MEDLI program was used to inform design requirements for the effluent land irrigation scheme for Stage 2 of the LLCF. In this instance, Stage 2 refers to the development and operation of the grower and finisher components of the farming operations (i.e. it excludes the hatchery operations effluent stream which was covered in Stage 1).

The model has been updated from the initial MEDLI model provided in the CEMP in August 2020, with more accurate data including water quality and refined water demand data from other crocodile farms within the Northern Territory, site specific soil data from LLCF and appropriate methods and rates of irrigation. The model was run with different effluent reuse assumptions (0%, 25%, 50% and 75%) and is summarised in the following sections.

Overall, the wet weather storage (WWS) volume has reduced from the volume and area provided for the entire farm in the CEMP (submitted to the NT EPA in August 2020), due to the changes in inputs, as provided by PRI Farming Pty Ltd. See the 'effluent assessment' section below for information regarding the changes in inputs.

1.2 General model inputs

The following inputs were used for the MEDLI model:

Climate: A 60-year climate file for the Project area (Lambells Lagoon) was obtained from the SILO database (a climate database managed by the Queensland Department of Environment and Science) to input rainfall and evaporation data. The model was run using climate data from 1958 to 2019, to account for recent impacts of climate change that may affect the model outputs.

Soil type: Soil samples were collected from the Project area on 10 July 2020 and sent a laboratory specialising in MEDLI analysis suites. The analyses undertaken directly related to the required MEDLI inputs and allowed for site specific soil information to be incorporated into the model.

Crop type: The default planting parameters for Forage Sorghum Crop were used in the model as they are representative of the crop selection for the proposed irrigation area. The default crop also has a maximum crop coefficient of 0.8, and according to the NT *Guidelines for Land Capability Assessment for On-site Wastewater Management* (DOH, 2014), a crop factor of 0.8-1.0 would be appropriate for irrigation design purposes, based on the generally high year-round daytime temperatures in the NT.

Irrigation method: The irrigation method modelled was a centre pivot system with irrigation triggered when the soil water deficit (SWD) reaches 5mm. The irrigation was applied at a depth of 5mm at each irrigation event, until the SWD is reached. Irrigation cannot occur when a rainfall event occurs and rainfall reaches a total of 10mm per event (likely during most of the wet season) to prevent over saturation of the soil. The model was run using different irrigation sizes in order to determine the best outcome for the water and nutrient balance.

A "dry-run" was also modelled for the irrigation area, where the irrigation inputs were removed, in order to determine the natural conditions and deep drainage rates for the area without any irrigation inputs.

The model was set to turn-off irrigation when rainfall reaches a total of 10mm (likely during most of the wet season) to prevent over saturation of the soil. In reality, with high evaporation rates, it is possible that irrigation

may still occur on days that experience minor rainfall events provided conditions in a site-specific Irrigation Management Plan are adhered to.

1.2.1 Assumptions and limitations

Assumptions and limitations to the general inputs in the MEDLI model include:

- Future weather will behave like past weather as supplied in the historical data (i.e from 1958 to 2019). This model does not account for the uncertainty regarding future climate conditions.
- Data obtained for the rainfall and evaporation at the site, is assumed to be as close as possible to the site as the site does not have its own weather station (SILO data obtained for Lambells Lagoon).
- Data provided by PRI Farming Pty Ltd is accurate and reflects project operating conditions.
- A SWD rate of 5mm was adopted based on general conditions of the tropics in the absence of SWD data from the site.
- 10mm of rainfall was adopted as a conservative measure to ensure the impact of rainfall on soil saturation is reflective of site conditions in the wet season when irrigation may occur.

1.3 Effluent volumes and quality

Effluent volumes and water quality data were obtained from PRI Farming Pty Ltd. The effluent volumes and water quality used in the modelling are summarised in Table 1-1 and Table 1-2.

The following assumptions were made by PRI Farming Pty Ltd in determining these inputs:

- The feeding programs of the grower and finisher pens will be the same as at the Janamba Crocodile Farm in the Northern Territory, whereby water usage is reduced by half in the wet season, due to the change in crocodile behaviour that occurs when there is increased rainfall and semi cooler temperatures from December to March.
- Allowance was made in the wet season months (December to March) for rainfall inputs into the pens. PRI Farming Pty Ltd have advised that the pens are to be constructed with a shade cloth roofing, shedding 70% of rainfall away from the pens. The volume inputs were derived from data from BoM and the impact a low permeability shade cloth, which allows for 30% of rainfall to enter the pens during the months of December to March. See Table 1-1 for input volumes
- During the drier months (i.e April to Nov), the forecast water use for the stage 2 component of the crocodile farm is 1,265kL/day (as provided by PRI Farming Pty Ltd, based on extrapolation of data from Janamba Crocodile Farm).
- Effluent quality (i.e. nutrient concentrations) will be similar to that produced from the grower and finisher pens at Janamba Crocodile Farm (as provided by PRI Farming Pty Ltd).

The effluent quality is based on the estimated combined effluent quality prior to any treatment. The actual wastewater quality to be irrigated would be lower in nutrients following primary treatment. However, this will not make a difference to the model outputs because the limiting factor at the LLCF site is water volumes not nutrient concentrations.

Table 1-1. Daily effluent volumes per month (m^3)
(data obtained from PRI Farming Pty Ltd and BoM)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inflow	632.5	632.5	632.5	1265	1265	1265	1265	1265	1265	1265	1265	632.5
*Rainfall**	107.7	102	62.7	0	0	0	0	0	0	0	0	37.2
Total	740.2	734.5	695.2	1265	1265	1265	1265	1265	1265	1265	1265	669.7

**Rainfall inputs accounts for 70% reduction in rainfall volume entering the pens daily per month, based on low permeability shade cloth, as advised by PRI Farming Pty Ltd.*

Table 1-2. Effluent quality entering pens
(data obtained from PRI Farming Pty Ltd)

Contaminant	Wet Season (Oct – Apr) Concentration (mg/L)	Dry Season (May – Sep) Concentration (mg/L)
Total nitrogen	6	13
Total phosphorus	0.7	4
Total dissolved salts	153	153
Total solids	500	500

1.3.1 Assumptions and limitations

Several assumptions include

- The volume of daily influent has been provided by PRI Farming Pty Ltd based on data from Janamba Crocodile Farm, however day to day operations may include less or more influent in response to system operations and requirements.
- Data provided by PRI Farming Pty Ltd is accurate and reflects project conditions. Currently, water quality data has been obtained from the Janamba Crocodile Farm and not site-specific data.
- Rainfall inputs into the pens may vary due to varying climatic conditions (i.e. prolonged drier or wetter periods may be experienced) and quality of low permeability shade cloth.
- Reuse in MEDLI is defined as the daily recycling volume, which adopts the minimum inflow volume as the maximum upper limit to determine reuse volumes. In this case, the lowest inflow volume is 669.7kL/day, therefore 25%, 50% and 75% reuse scenarios were based off this value.

1.4 Modelling results

Various different scenarios were modelled to determine the storage and irrigation area combinations required to minimise release of nutrients to the environment by effluent overflow, or as a result of runoff or seepage from the irrigation areas. The design criteria adopted for the MEDLI model is to achieve as close as possible to zero overflow from the WWS.

The MEDLI model was run for four scenarios with different reuse assumptions (0%, 25%, 50% and 75%). WWS, irrigation area, overflow volumes and duration derived for each scenario are documented in Table 1-3.

Table 1-3. WWS performance

% reuse for farm	WWS volume (ML)	Irrigation area (ha)	No. of overflow events (events/year)	Average duration of overflow (days)	Overflow volume (m3/year)
0%	60	100	0.18	12.73	2224.32
	80	100	0.08	14.60	1283.22
	100	100	0.06	8.25	568.04
25% (reuse = 168m^3/day)	60	100	0.06	14.25	757.29
	80	85	0.10	6.50	553.73
50% (reuse = 335m^3/day)	50	85	0.06	12.00	483.21
	60	100	0.03	9.50	260.53
75% (reuse = 502.5m^3/day)	60	100	No overflow	No overflow	No overflow

The most conservative WWS requirements from Table 1-3 (i.e calculated by the MEDLI model with 0% reuse) are further analysed in the below section. Whilst the LLCF will be aiming for a high level of water efficiency and reuse, the worst-case scenario is modelled here for the purpose of demonstrating the feasibility of a sustainable effluent reuse scheme at the site. MEDLI outputs for reuse scenarios can be provided upon request.

Table 1-4. Land water balance

	Unit	100ML	80ML	60ML	Dry-run
Rain	mm/year	1544	1544	1544	1544
Irrigation	mm/year	390.55	391.05	391.23	0
Soil evaporation	mm/year	623.68	621.74	626.59	570.95
Transpiration	mm/year	507.91	512.00	510.78	24.88
Rain runoff	mm/year	30.50	26.69	29.40	86.11
Irrigation runoff	mm/year	0.00	0.00	0.00	0.00
Deep drainage	mm/year	773.60	772.75	769.60	861.89

Table1-5. Pond system water balance

	Unit	100ML	80ML	60ML
Rain	m3/year	55,237	44,552	33,814
Inflow	m3/year	394,710	394,710	394,710
Evaporation	m3/year	58,795	46,901	35,045
Overflow	m3/year	568	1283	2224
Irrigation	m3/year	390,551	391,047	391,226
Effluent reuse (proportion of inflow + net rain gain irrigated)	Fraction	1.00	1.00	0.99
Probability of at least 90% reuse	Fraction	1.00	1.00	0.98

Table 1-6. Land nutrient balance

	Unit	N balance	P balance	N balance	P balance	N balance	P balance
		100ML		80ML		60ML	
Irrigation (effluent load added)	kg/ha/year	33.66	7.90	33.63	7.89	33.58	7.89
Denitrification	kg/ha/year	0.003	-	0.00414	-	0.00422	-
Irrigation runoff	kg/ha/year	0.00	0.00	0.00	0.00	0.00	0.00
Plant uptake	kg/ha/year	34.26	5.62	34.22	5.60	34.16	5.60
Leached	kg/ha/year	0.20	0.04	0.21	0.04	0.22	0.04

1.5 Discussion

The implications of the model results for irrigation area sizing and WWS volumes are summarised below.

1.5.1 Irrigation area

The MEDLI results indicate that the proposed irrigation schemes provided are sufficient to manage the daily effluent volumes produced without creating any irrigation runoff or significant increases to the deep drainage.

The application rate of nutrients is slightly higher than the predicted plant uptake rates which results in some leaching of phosphorous. The predicted average phosphorous concentration of the deep drainage based on current soil concentrations and effluent irrigation is considered low.

The concentration of nutrients in the wastewater is to be monitored to ensure that if concentrations increase significantly above the predicted values, the irrigation area is adjusted, or alternative treatment methods are reviewed.

A large WWS and land irrigation area is required for wetter than average wet seasons. During the drier seasons (i.e May to September), higher volumes of water are likely to be required to be applied to smaller areas of the irrigation area, to maintain crop growth. This may require a rotational program to be implemented to avoid nutrient accumulation in those areas.

1.5.2 Wet weather storage

The MEDLI results indicate that 60 ML of WWS capacity should be large enough to minimise uncontrolled release of effluent, excepting during extreme weather events. Assuming the effluent volumes entering the system align with those used in the modelling, the results indicate that overflow events may occur at a rate of 0.18 events/year, or 1.8 events every ten years.

Increasing the WWS size to 80 ML or 100 ML in the model, reduces the overflow events down to less than one every ten years. However, the model results indicate there would still be some overflow during extreme weather events. Whilst there is sufficient land availability to construct large storages, the cost and feasibility of managing such storages may be limiting. Assuming the treated effluent will contain very low concentrations of nutrients, which would be further diluted by rainfall in the storage, it is considered that there is minimal environmental benefit to be achieved by constructing zero discharge storages.

The modelling of different reuse scenarios indicates that reuse of effluent could further reduce the frequency and volume of overflows from the WWS. Treatment and reuse are an option that can be further investigated by PRI Farming as the farm is developed and site-specific effluent data become available. However, while there is uncertainty about the levels of reuse that can be achieved, it is recommended that the design criteria for WWS capacity are based on the worst-case scenario of zero reuse.

If the actual effluent volumes or quality are found to be higher than predicted, then the staging of the development and large available land area allows for additional irrigation areas and/or storages to be added progressively to achieve the water quality objectives established in the EPL.

1.6 Summary and recommendations

It is imperative to the project that the results of the modelling and ultimate decision on sizing of the WWS both take into consideration environmental factors and operational requirements. The results of this model and its outputs are a reflection of the information made available at the time of modelling and do include a number of assumptions and limitations.

The staged nature of the development provides an opportunity to add WWS capacity over time in response to actual conditions experienced during operations. The following recommendations are made for future improvements to the model and ultimate design of the LLCF, in order to ensure that the WWS and irrigation area are appropriate.

- Once operational, sampling of effluent volumes and quality in the Stage 2 pens and effluent storages should be undertaken to verify model inputs. These results can be adopted in later re-runs of the MEDLI to reflect site specific conditions (as currently all data used within the MEDLI model are from Janamba Crocodile Farm).
- PRI Farming Pty Ltd to actively monitor the size of the WWS over the course of increasing operations of LLCF over the next 5 years (particularly during the wet season months of December to March) to determine whether the WWS can hold the volumes of water required without negatively impacting the identified receiving environments.

Attachment A. MEDLI Report: Dry-run scenario

MEDLI REPORT - FULL RUN

Enterprise: **MARPU - Lambells Lagoon Crocodile Farm**

Description:
Marpu Stage 2 irrigation and storage modelling

Client: **PRI Farming Pty Ltd**

MEDLI User: ECOZ\adele.faraone

Scenario Details:
Updated inflows = dry run

DESCRIPTION

Climate Data: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days

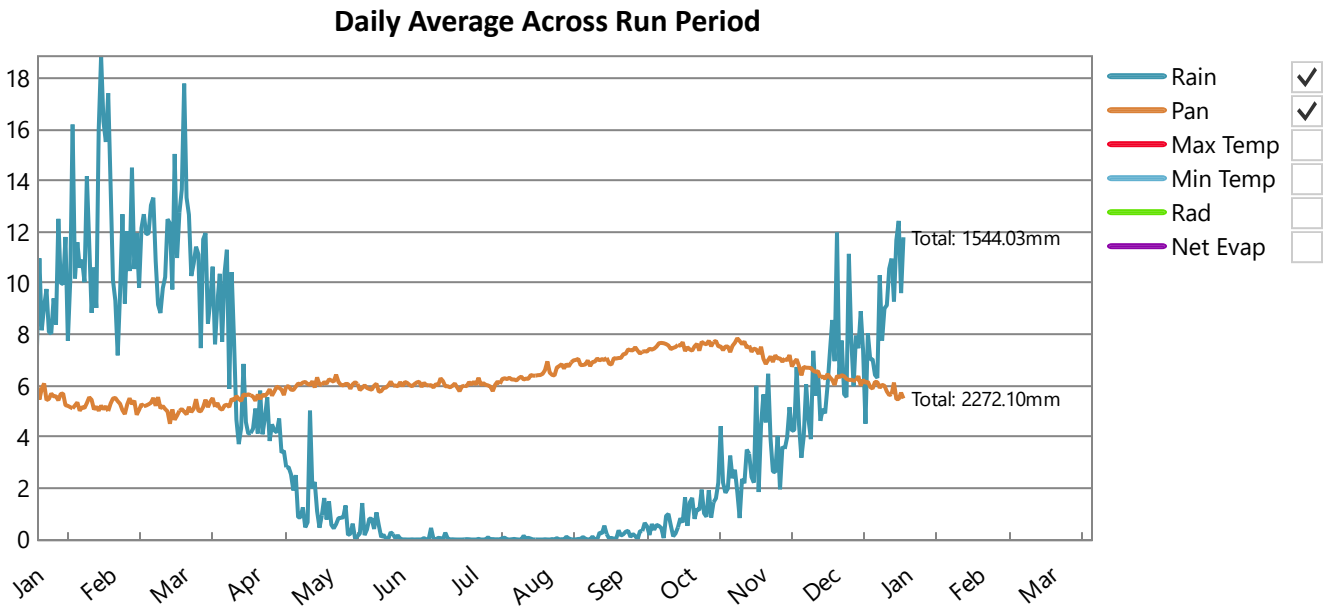
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	1108	1521	2163
Pan Evaporation (mm/year)	2100	2273	2448

Climate Data:

Chart Table

Monthly Daily

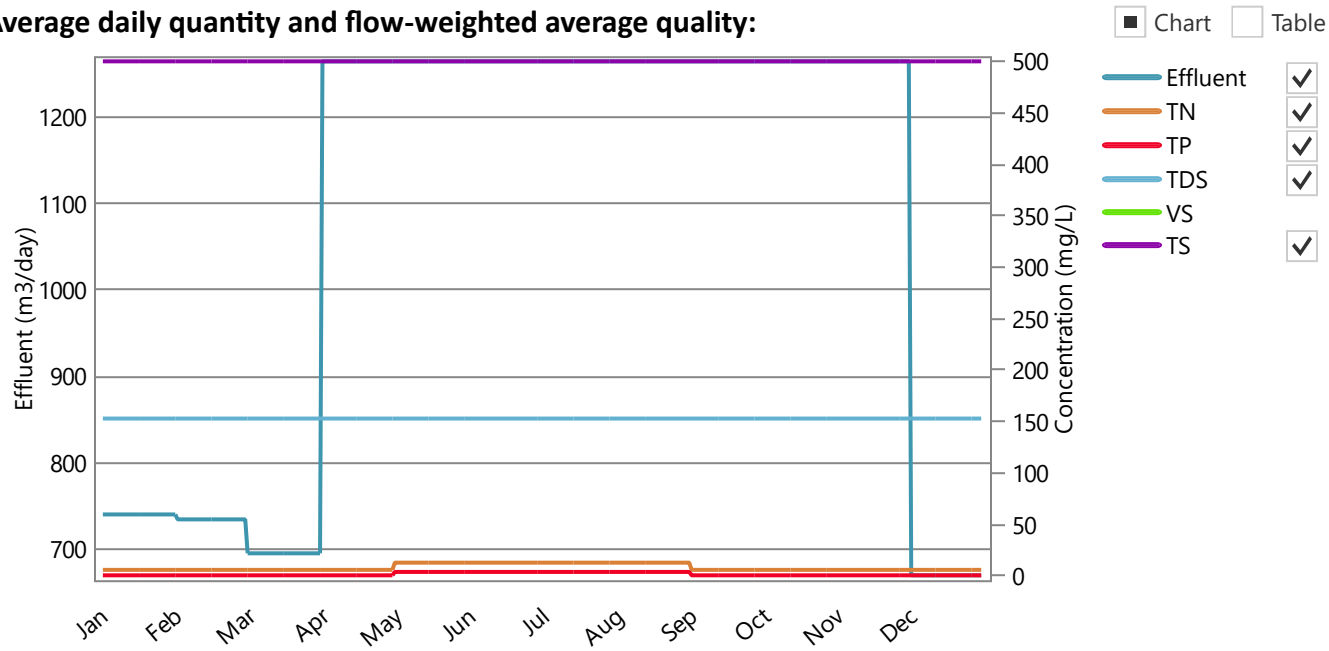


DESCRIPTION

Effluent type: New Generic System

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 394710.92 m3/year or 1080.68 m3/day (Min-Max: 669.70 - 1265.00)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

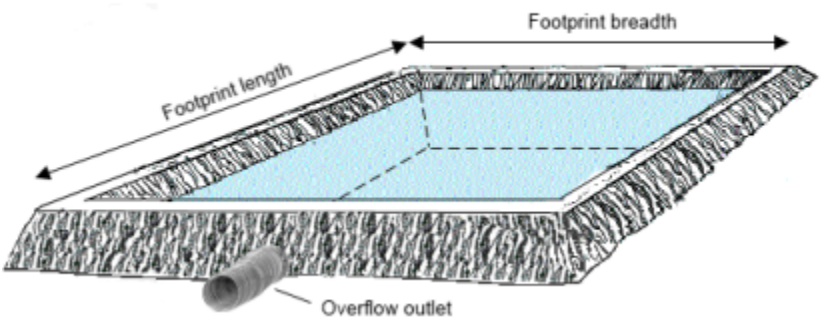
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	8.76 (6.00 - 13.00)	3457.43 (3456.46 - 3460.48)
Total Phosphorus	2.00 (0.70 - 4.00)	789.76 (789.65 - 790.12)
Total Dissolved Salts	153.00 (153.00 - 153.00)	60390.77 (60365.98 - 60468.45)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	500.00 (500.00 - 500.00)	197355.46 (197274.45 - 197609.30)

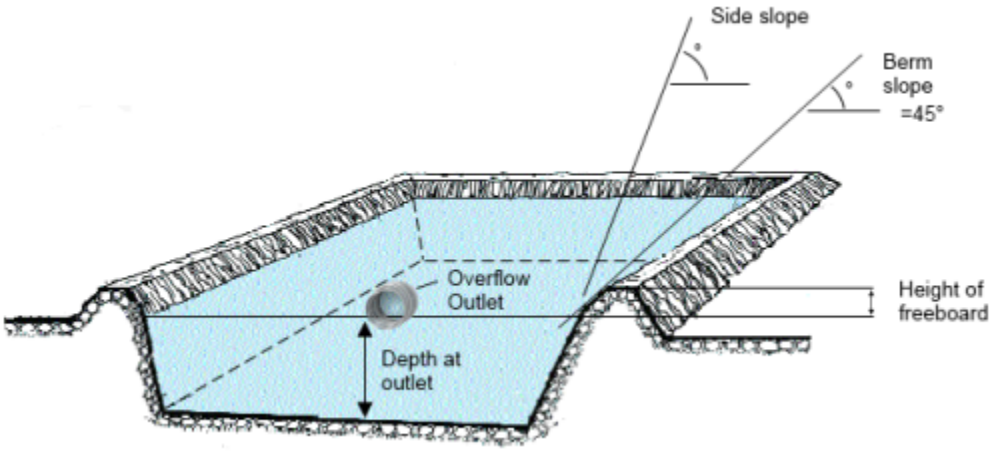
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (m3)	60000.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	3.00
Maximum water surface area (m2)	20908.21
Pond footprint length (m)	207.69
Pond footprint width (m)	105.45
Pond catchment area (m2)	21900.00
Average active volume (m3)	59897.74





Irrigation pump limits:

Minimum pump rate per area limit (ML/day/ha)	0.00
Maximum pump rate per area limit (ML/day/ha)	1.00

Shandying water:

Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

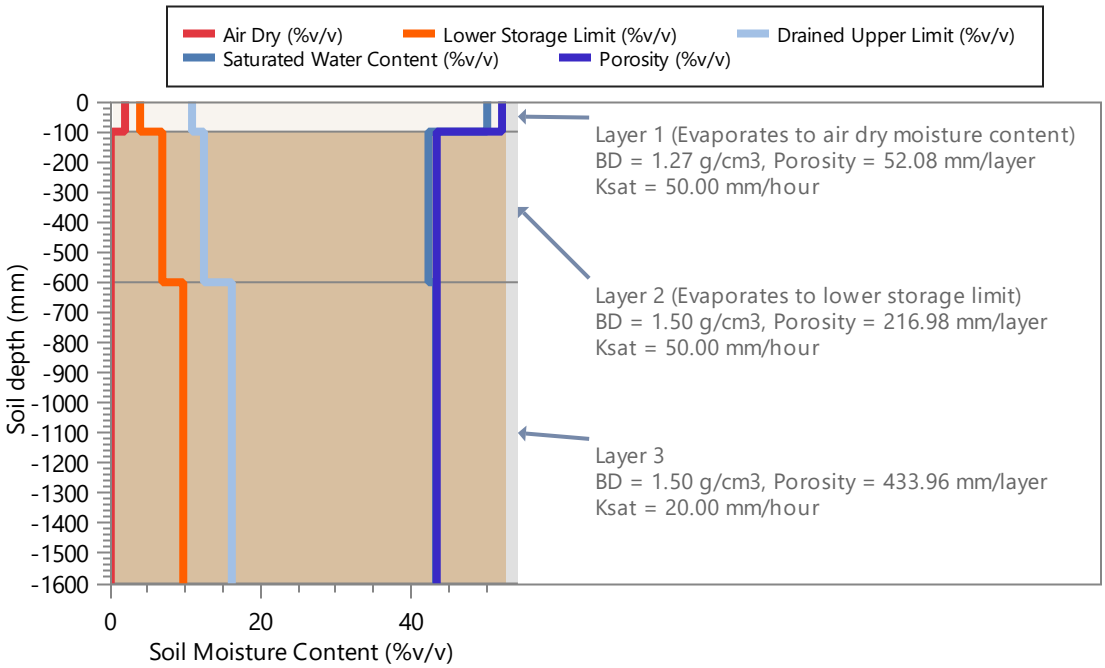
DESCRIPTION

Land: Stage 2 irrigation

Area (ha): 100.00

Soil Type: Lambells, 1600.00 mm defined profile depth

Profile Porosity (mm)	703.02
Profile saturation water content (mm)	694.60
Profile drained upper limit (or field capacity) (mm)	235.10
Profile lower storage limit (or permanent wilting point) (mm)	136.05
Profile available water capacity (mm)	99.05
Profile limiting saturated hydraulic conductivity (mm/hour)	20.00
Surface saturated hydraulic conductivity (mm/hour)	50.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Forage Sorghum Pasture

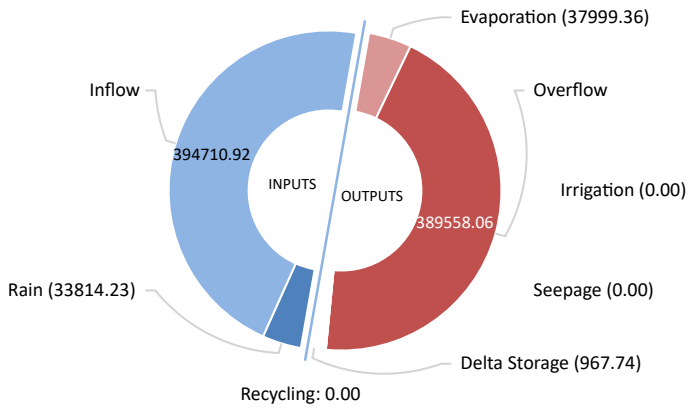
Average monthly cover (fraction) (minimum - maximum)	0.02 (0.00 - 0.04)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Maximum potential root depth in defined soil profile (mm)	1548.13
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **60000 m3**

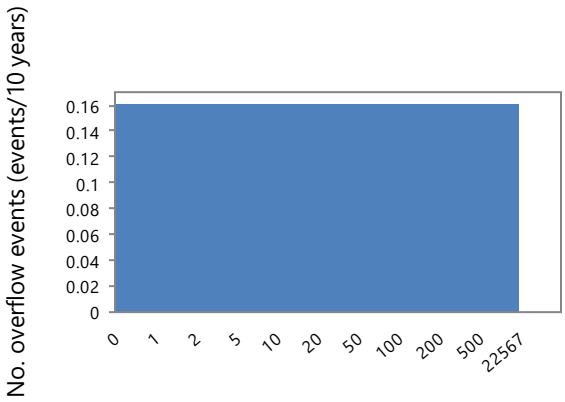
Pond System Water Balance (m3/year)



Name	Value
Rain	33814.23
Inflow	394710.92
Recycling	0.00
Evaporation	37999.36
Overflow	389558.06
Irrigation	0.00
Seepage	0.00
Delta Storage	967.74

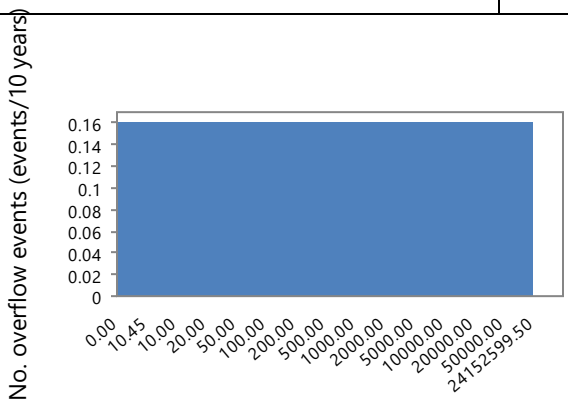
Overflow Diagnostics

Volume of overflow (m3/year)	389558.06
No. days pond overflows (days/year)	363.98
Average duration of overflow (days)	22567.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.00
Probability of at least 90% reuse (fraction)	0.00



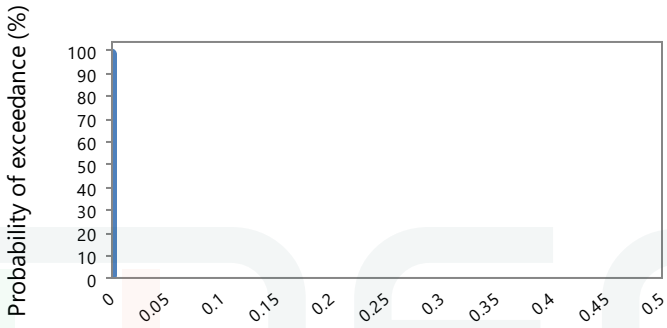
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

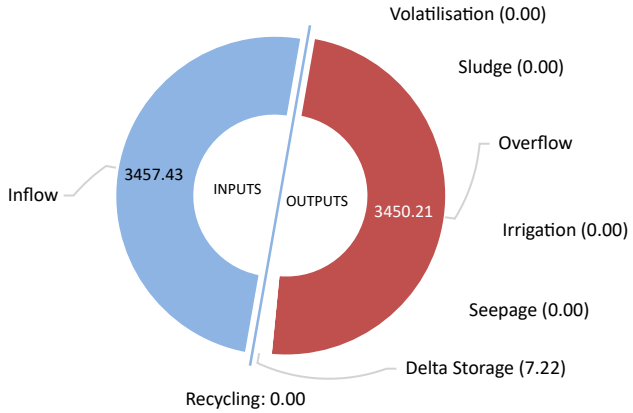
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

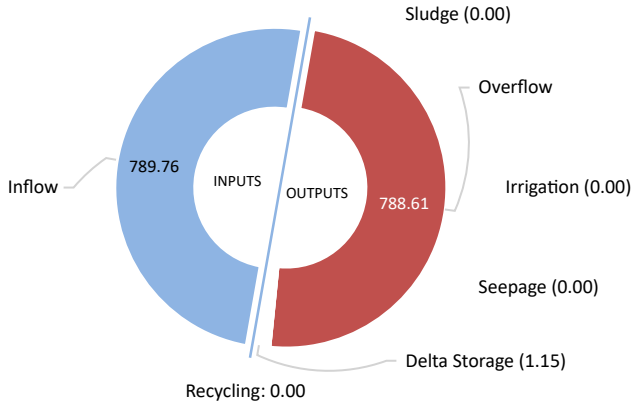
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



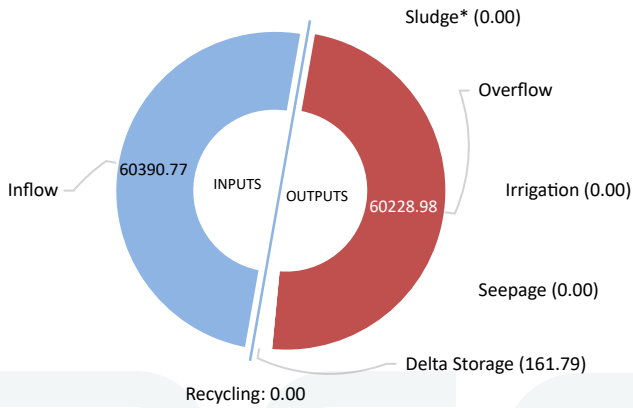
Name	Value
Inflow	3457.43
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	3450.21
Irrigation	0.00
Seepage	0.00
Delta Storage	7.22

Phosphorus Balance (kg/year)



Name	Value
Inflow	789.76
Recycling	0.00
Sludge	0.00
Overflow	788.61
Irrigation	0.00
Seepage	0.00
Delta Storage	1.15

Salt Balance (kg/year)



Name	Value
Inflow	60390.77
Recycling	0.00
Sludge*	0.00
Overflow	60228.98
Irrigation	0.00
Seepage	0.00
Delta Storage	161.79

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	8.66
Average phosphorus concentration of pond liquid (mg/L)	1.94
Average salinity of pond liquid (dS/m)	0.24

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	7.46
Final phosphorus concentration of pond liquid (mg/L)	1.19
Final salinity of pond liquid (dS/m)	0.26

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	0.00
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	0.00
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	0.00
Average phosphorus concentration of irrigation water (mg/L)	0.00
Average salinity of irrigation water (dS/m)	0.00

Irrigation Diagnostics (No effluent irrigation occurred!):

Proportion Days Irrigation Turned Off (fraction)	1.00 (Hence no irrigation!)
Proportion of Days irrigation occurs (fraction)	0.00

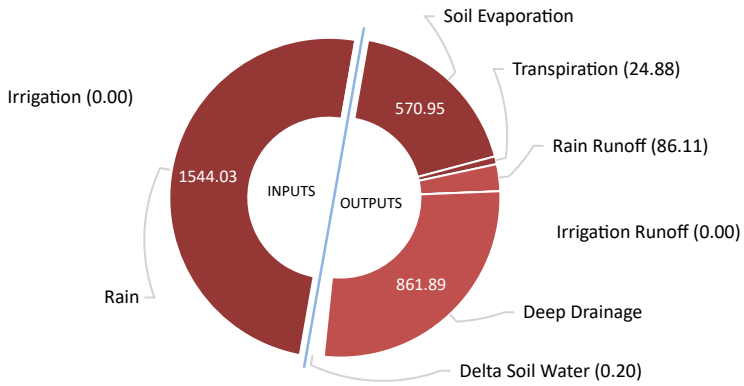
PERFORMANCE

Land Performance - Soil Water

Paddock: Stage 2 irrigation, 100 ha
Soil Type: Lambells, 95.70 mm PAWC at maximum root depth

Land Water Balance (mm/year):

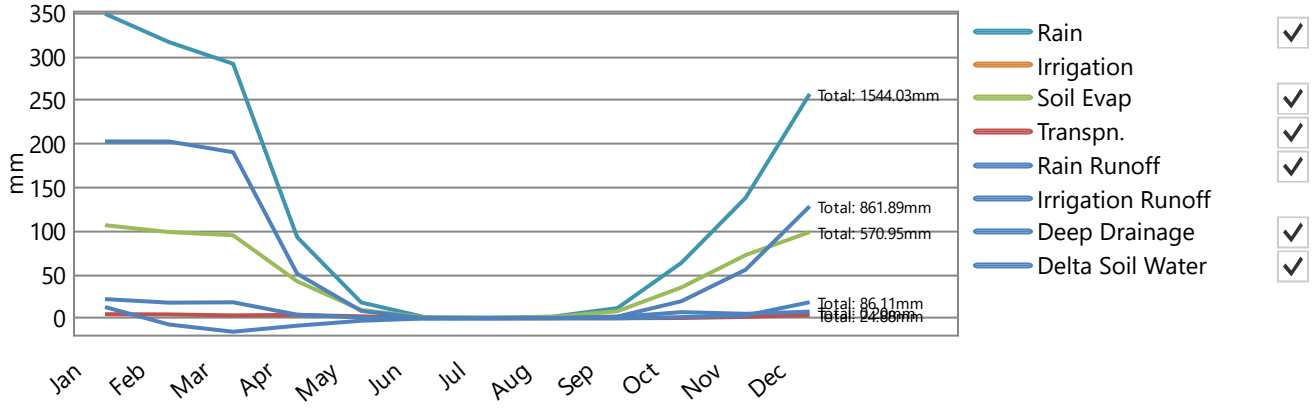
mm/year % Total inputs



Name	Value
Rain	1544.03
Irrigation	0.00
Soil Evaporation	570.95
Transpiration	24.88
Rain Runoff	86.11
Irrigation Runoff	0.00
Deep Drainage	861.89
Delta Soil Water	0.20

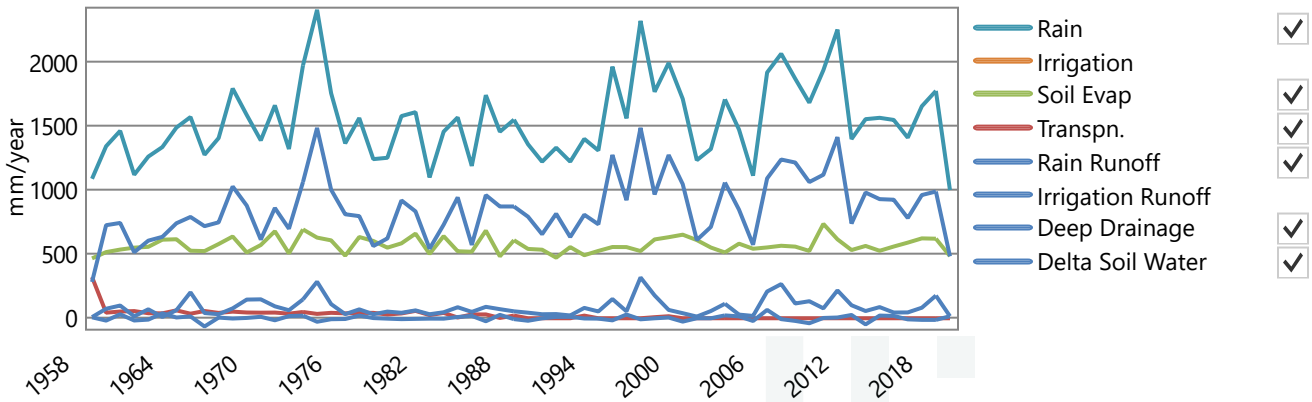
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



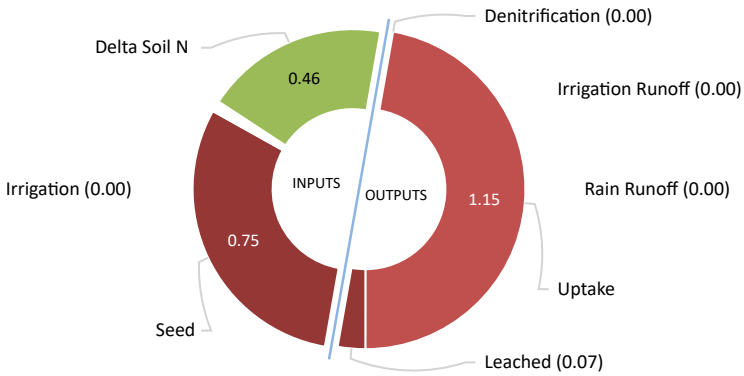
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

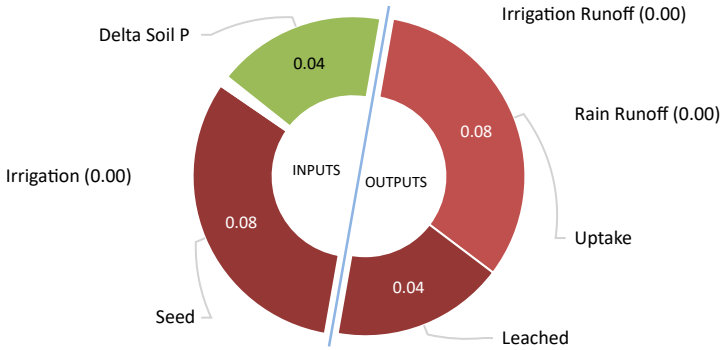
Irrigation ammonium volatilisation losses (kg/ha/year): 0.00
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.75
Irrigation	0.00
Denitrification	1.13E-04
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	1.15
Leached	0.07
Delta Soil N	-0.46

Land Phosphorus Balance (kg/ha/year)



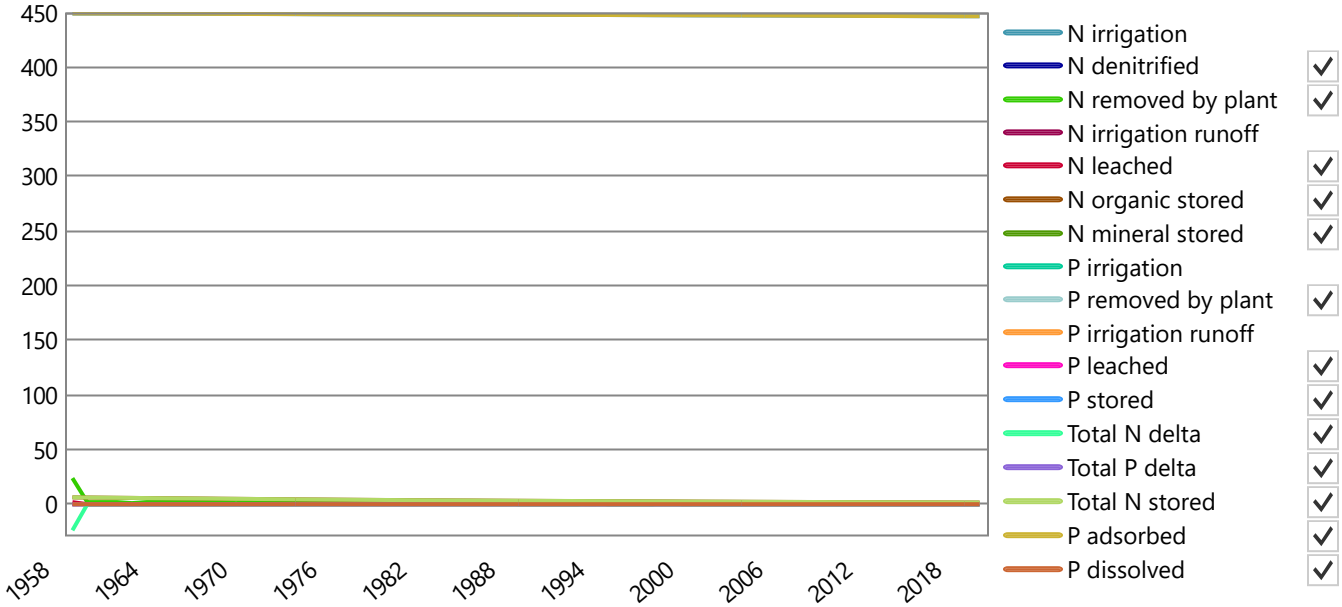
Name	Value
Seed	0.08
Irrigation	0.00
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	0.08
Leached	0.04
Delta Soil P	-0.04

PERFORMANCE

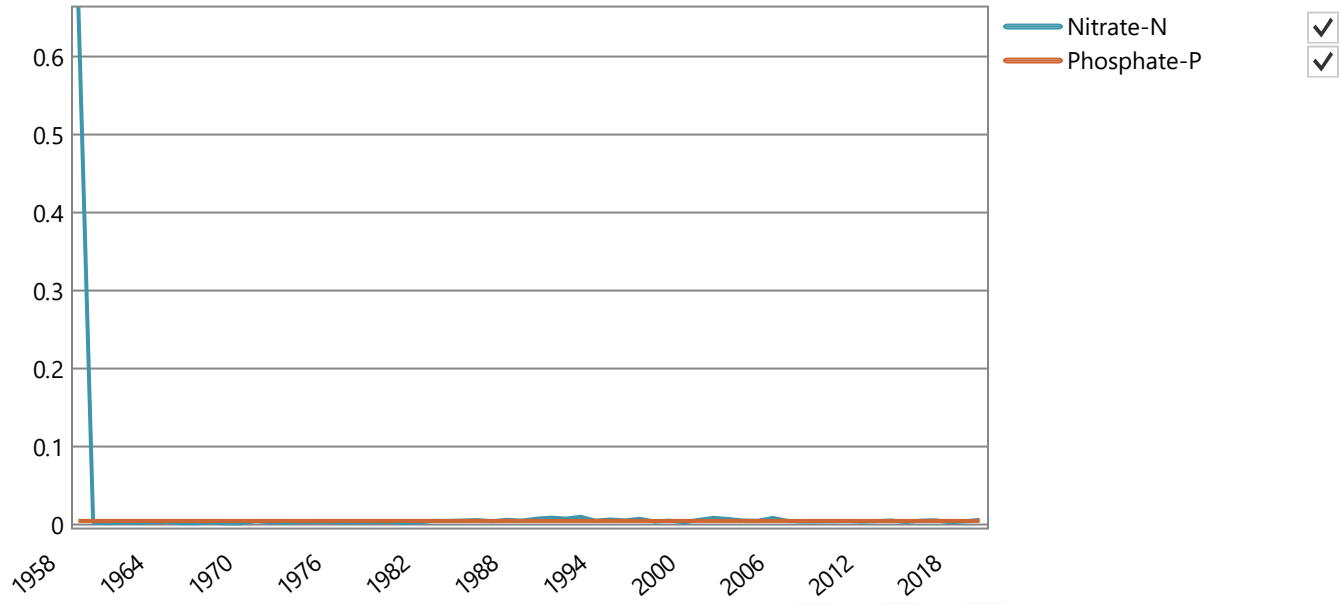
Land Performance - Soil Nutrient

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

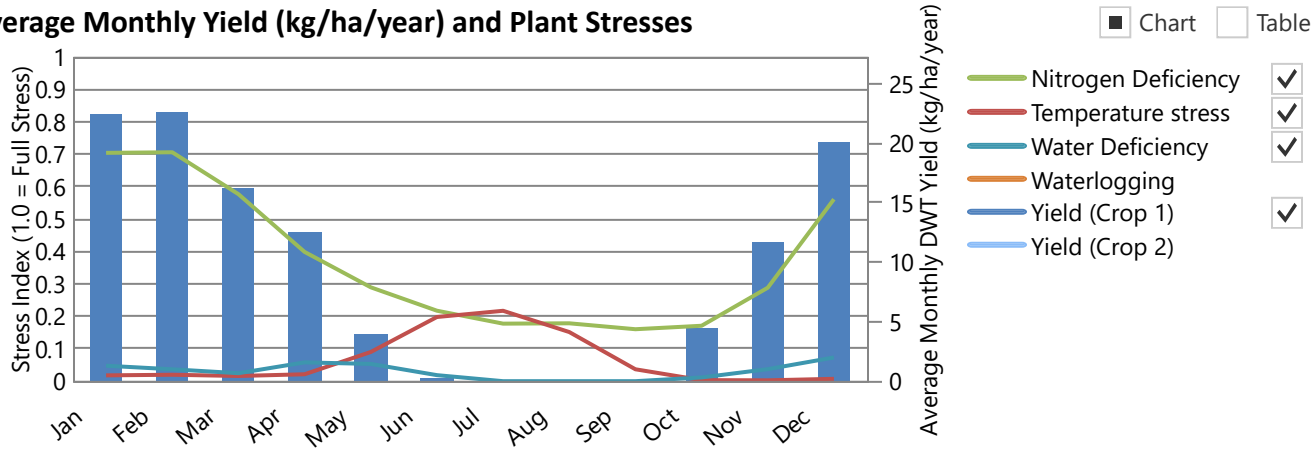
Plant: Continuous Forage Sorghum Pasture

Average annual shoot dry matter yield (kg/ha/year)	139.72 (0.00 - 2821.17)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.02 (0.00 - 0.04)
Average monthly root depth (mm) (minimum - maximum)	54.04 (0.00 - 119.09)

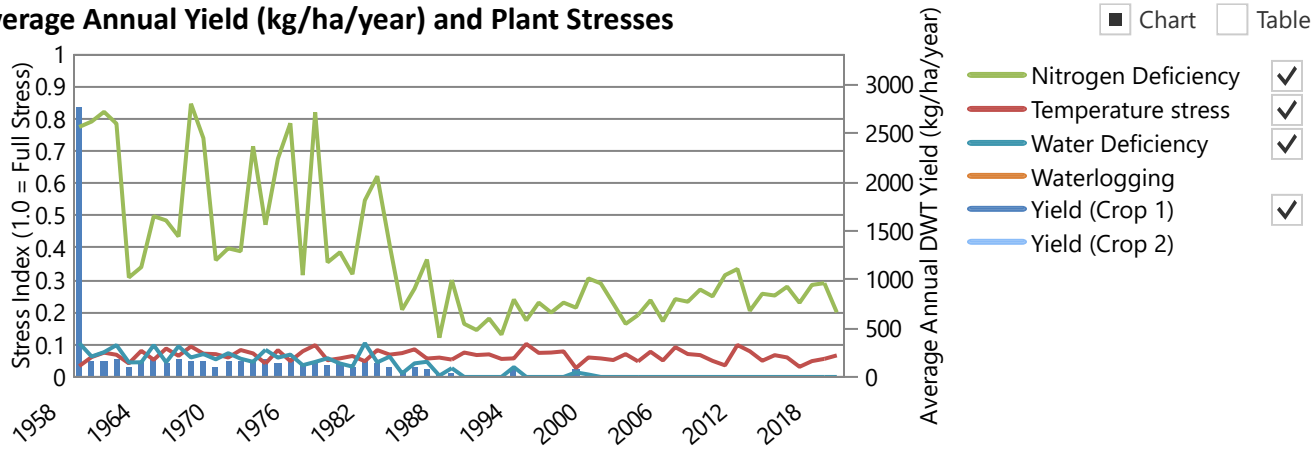
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	1.15 (0.00 - 23.85)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	0.08 (0.00 - 0.18)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.00 - 0.02)
Average annual shoot phosphorus concentration (fraction dwt)	0.001 (0.000 - 0.002)

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 0.84 (forced by crop death due to nitrogen stress (0.82), water stress (0.02))
No. days without crop/year (days/year): 299.81 due to nitrogen stress (29.53), water stress (270.27)

PERFORMANCE

Land Performance

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

Plant: Continuous Forage Sorghum Pasture

Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11
No. years assumed for leaching to reach steady-state (years)	10.00

Soil Salinity:

Average Infiltrate Salinity (dS/m)	0.03

Insufficient deep drainage to run steady state salinity calculations.

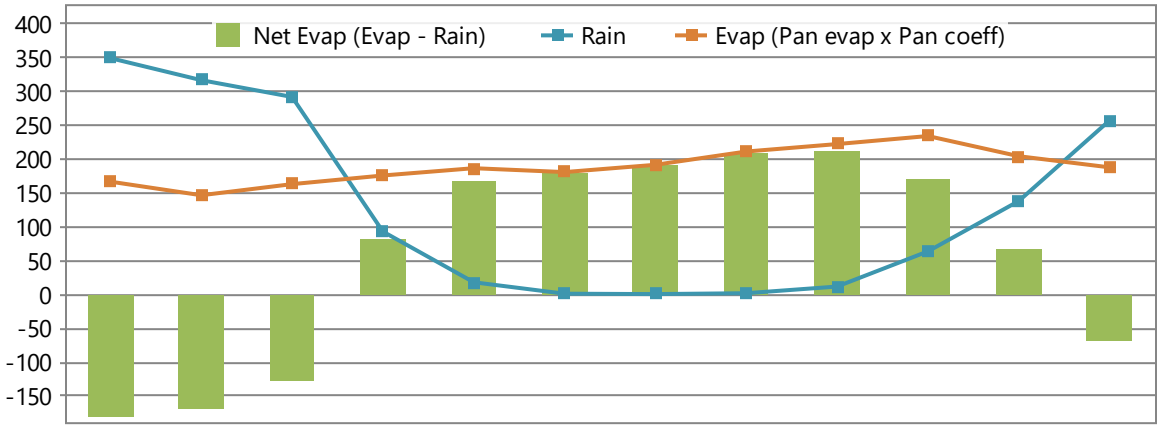
DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Averaged Historical Climate Data Used in Simulation (mm)

Location: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Evap	166.8	146.7	163.1	175.9	186.7	180.9	191.7	211.3	222.3	234.2	204.4	188.0	2272.1
Net Evap	-182.6	-170.1	-128.9	82.9	168.6	179.7	191.1	209.4	210.6	170.5	66.3	-69.4	728.1
Net Evap/day	-5.9	-6.0	-4.2	2.8	5.4	6.0	6.2	6.8	7.0	5.5	2.2	-2.2	2.0

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Pond System: 1 facultative, aerobic or storage pond

New Generic System - 394710.92 m3/year or 1080.68 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	8.76 (6.00 - 13.00)	3457.43 (3456.46 - 3460.48)
Total Phosphorus	2.00 (0.70 - 4.00)	789.76 (789.65 - 790.12)
Total Dissolved Salts	153.00 (153.00 - 153.00)	60390.77 (60365.98 - 60468.45)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	500.00 (500.00 - 500.00)	197355.46 (197274.45 - 197609.30)

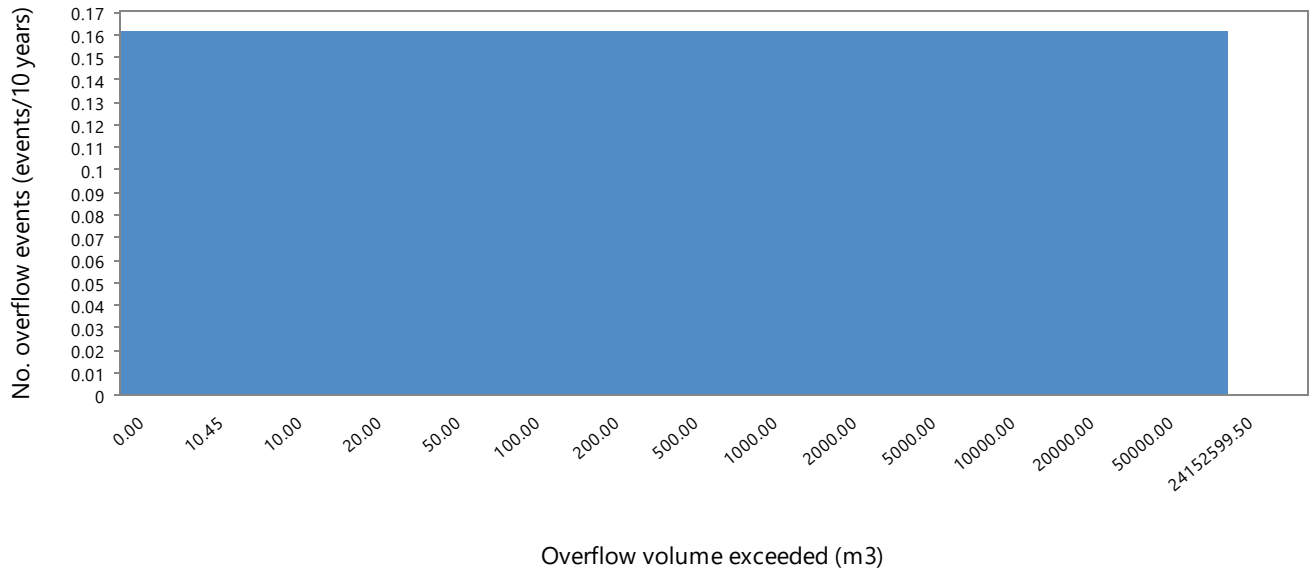
Last pond (Wet weather store): 60000.00 m3

Theoretical hydraulic retention time (days)	55.52
Average volume of overflow (m3/year)	389558.06
No. overflow events per year exceeding threshold* of 10.45 m3 (no./year)	0.02
Average duration of overflow (days)	22567.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.00
Probability of at least 90% effluent reuse (fraction)	0.00
Average salinity of last pond (dS/m)	0.24
Salinity of last pond on final day of simulation (dS/m)	0.26
Ammonia loss from pond system water area (kg/m2/year)	0.00

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Irrigation Information

Irrigation: 100 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	0.00	0.00
Total nitrogen applied (kg)	0.00	0.00
Total phosphorus applied (kg)	0.00	0.00
Total salts applied (kg)	0.00	0.00

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is turned off (fraction)	1.00

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Paddock Land: Stage 2 irrigation: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Irrigation triggered every 0 days
Irrigate a fixed amount of 0.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Lambells, 95.70 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Irrigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soil Evap	106.8	98.9	95.2	42.4	9.6	1.0	0.6	1.5	8.1	35.5	72.5	98.9	570.9
Transpn.	4.7	4.4	3.3	3.9	2.2	0.4	0.0	0.0	0.0	0.3	1.6	4.0	24.9
Runoff	22.0	17.9	18.3	4.1	0.8	0.0	0.0	0.0	0.0	1.3	3.2	18.4	86.1
Drainage	202.9	202.8	190.5	51.1	8.4	0.0	0.0	0.4	2.0	19.6	55.7	128.5	861.9
Delta	12.9	-7.2	-15.4	-8.5	-2.9	-0.2	0.0	0.1	1.6	7.0	5.1	7.6	0.2

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	0.00
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	1.15
Average annual soil nitrogen removed by denitrification (kg/ha/year)	1.13E-04
Average annual soil nitrogen leached (kg/ha/year)	0.07
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.07
Soil organic-N kg/ha (Initial - Final)	6.41 - 1.51
	23.77 - 0.02
Average nitrate-N concentration of deep drainage (mg/L)	0.01
Max. annual nitrate-N concentration of deep drainage (mg/L)	0.66

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	0.00
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	0.08
Average annual soil phosphorus leached (kg/ha/year)	0.04
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.01
Adsorbed phosphorus (kg/ha) (Initial - Final)	449.15 - 446.63
Average phosphate-P concentration in rootzone (mg/L)	0.01
Average phosphate-P concentration of deep drainage (mg/L)	4.71E-03
Max. annual phosphate-P concentration of deep drainage (mg/L)	4.74E-03
Design soil profile storage life based on average infiltrated water phosphorus concn. of 0.00 mg/L (years)	0.00

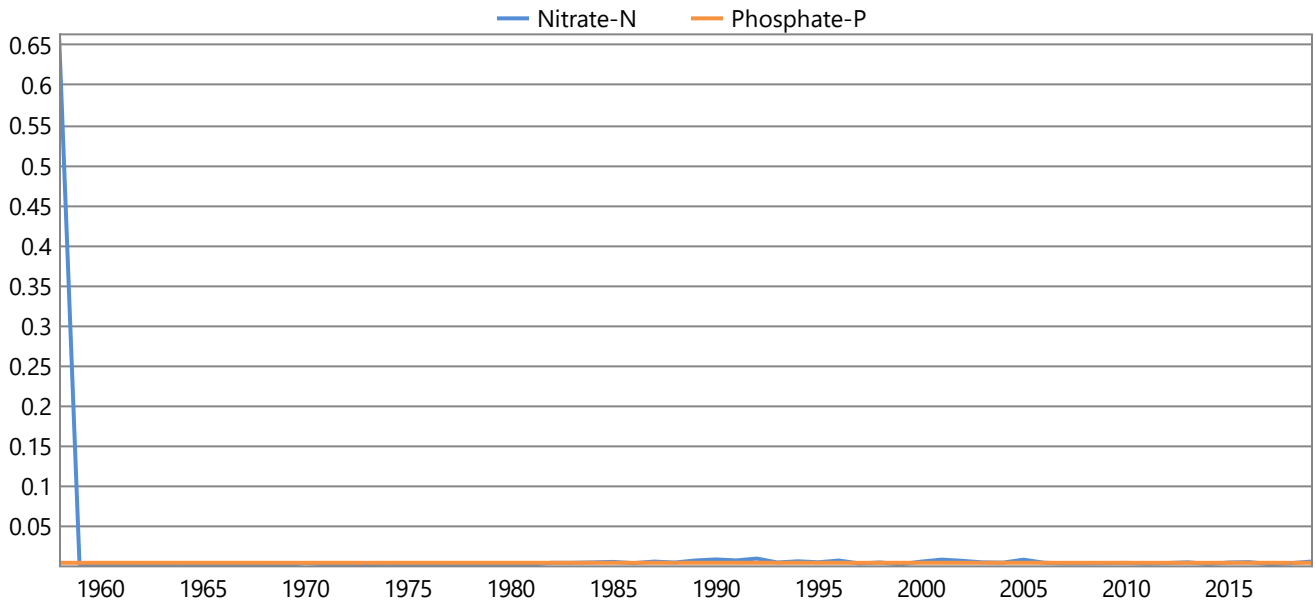
DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

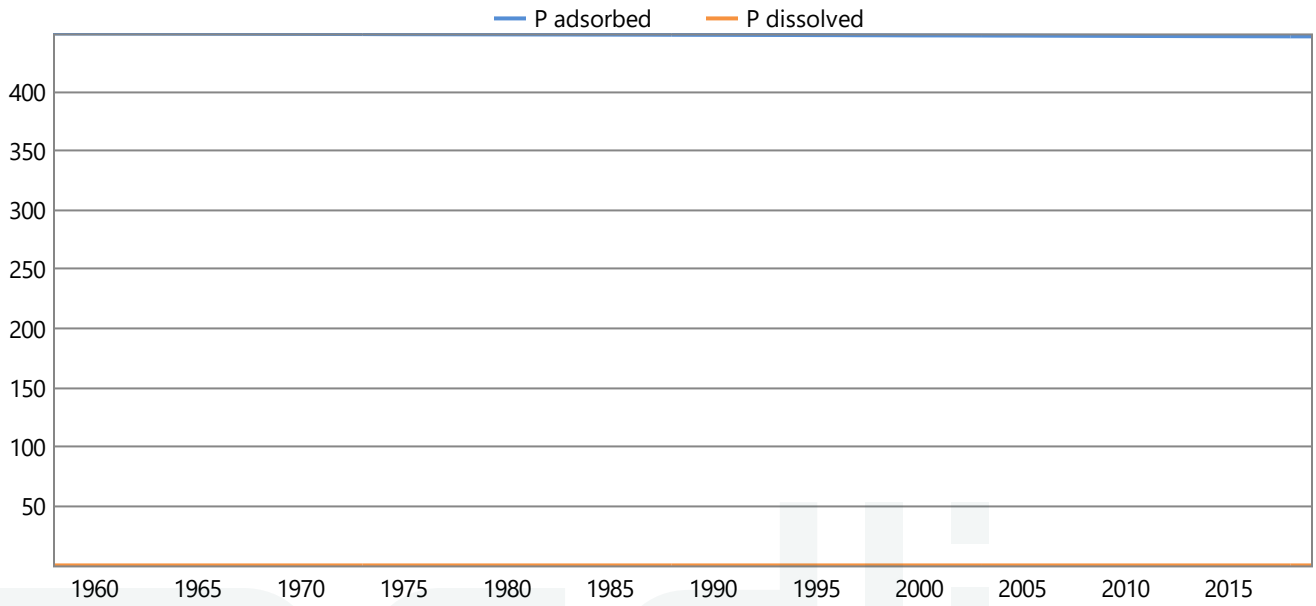
Paddock Land: Stage 2 irrigation: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Paddock Plant Performance: Stage 2 irrigation: 100 ha

Average Plant Performance (Minimum - Maximum): Continuous Forage Sorghum Pasture

Average annual shoot dry matter yield (kg/ha/year)	139.72 (0.00 - 2821.17)
Average monthly plant (green) cover (fraction)	0.02 (0.00 - 0.04)
Average monthly crop factor (fraction)	0.02 (0.00 - 0.03)
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Average monthly root depth (mm)	54.04 (0.00 - 119.09)
Average number of normal harvests per year (no./year)	0.00 (0.00 - 0.00)
Average number of normal harvests for last five years only (no./year)	0.00
Average number of crop deaths per year (no./year)	0.84 (0.00 - 3.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.37 (0.12 - 0.85)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.22 (0.07 - 0.37)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.03 (0.00 - 0.07)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	299.81

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts
All values based on 10 year running averages

Insufficient deep drainage to run steady state salinity calculations.

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

This is a Dryland scenario
No effluent irrigation has occurred!
Full run chosen

Attachment B. MEDLI Report: 0% reuse, 100ML storage, 100ha irrigation area

MEDLI REPORT - FULL RUN

Enterprise: **MARPU - Lambells Lagoon Crocodile Farm**

Description:
Marpu Stage 2 irrigation and storage modelling

Client: **PRI Farming Pty Ltd**

MEDLI User: ECOZ\adele.faraone

Scenario Details:
Updated inflows = 30% rainfall infiltration

DESCRIPTION

Climate Data: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days

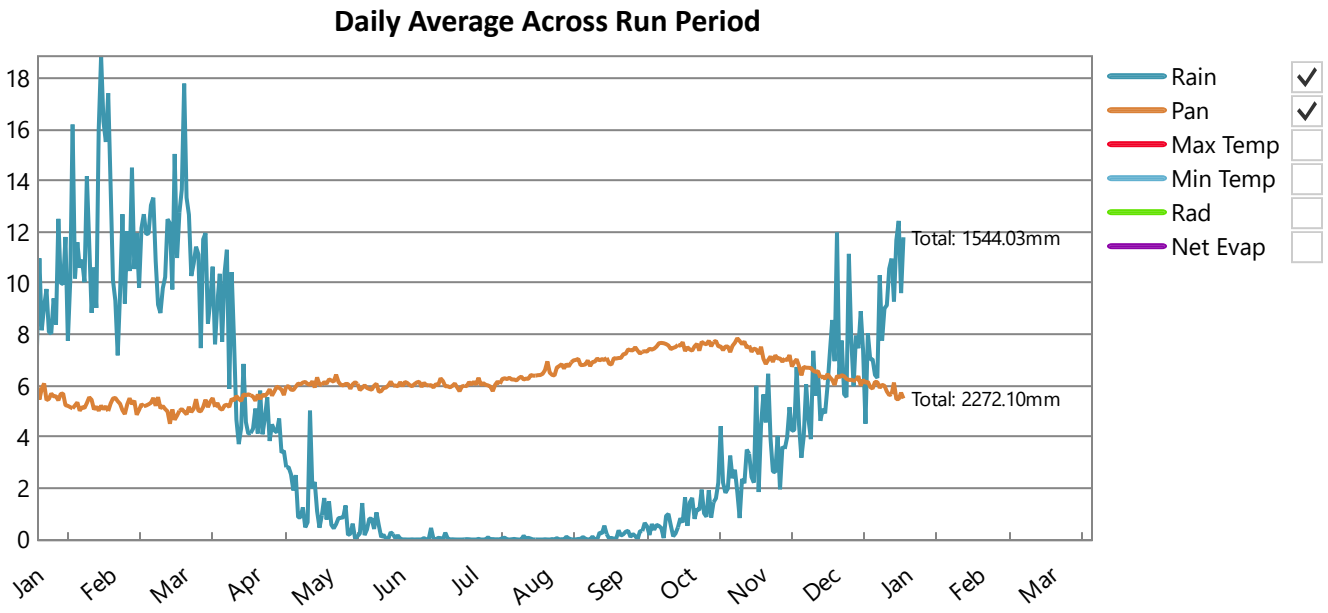
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	1108	1521	2163
Pan Evaporation (mm/year)	2100	2273	2448

Climate Data:

Chart Table

Monthly Daily

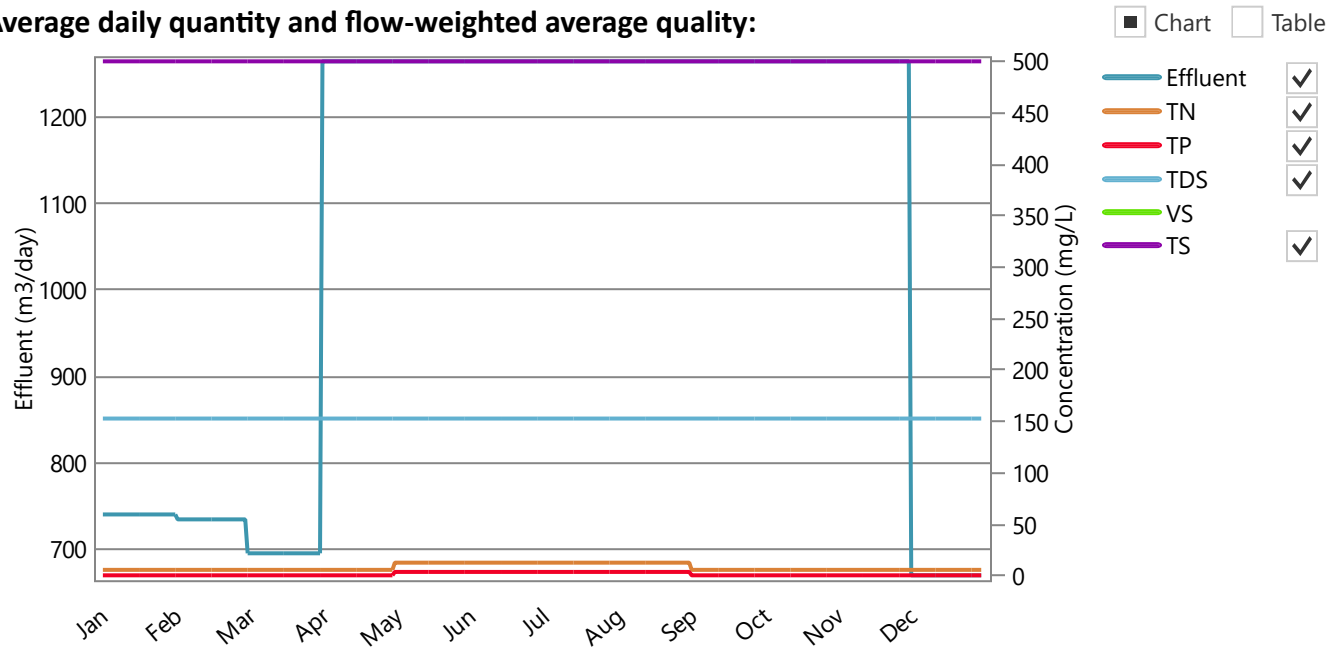


DESCRIPTION

Effluent type: New Generic System

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 394710.92 m3/year or 1080.68 m3/day (Min-Max: 669.70 - 1265.00)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

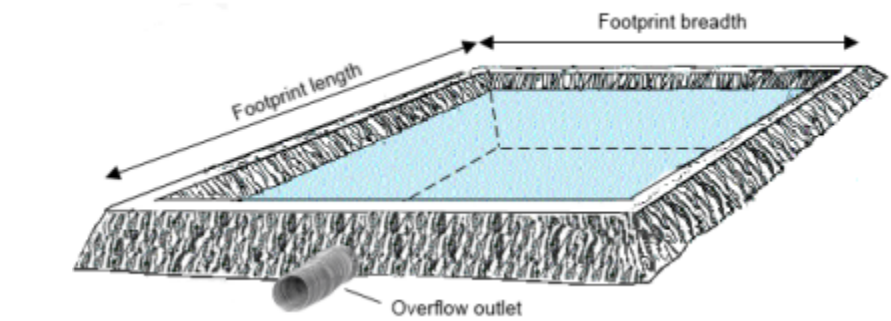
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	8.76 (6.00 - 13.00)	3457.43 (3456.46 - 3460.48)
Total Phosphorus	2.00 (0.70 - 4.00)	789.76 (789.65 - 790.12)
Total Dissolved Salts	153.00 (153.00 - 153.00)	60390.77 (60365.98 - 60468.45)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	500.00 (500.00 - 500.00)	197355.46 (197274.45 - 197609.30)

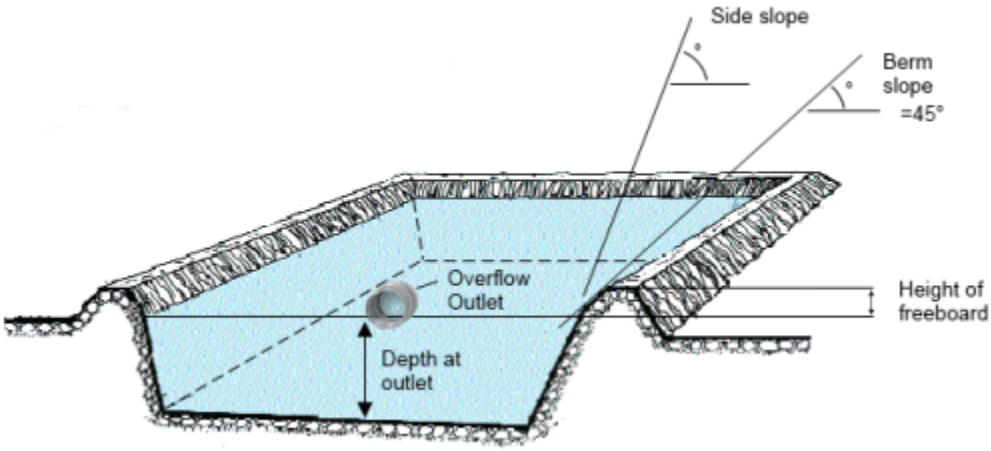
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (m3)	100000.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	3.00
Maximum water surface area (m2)	34503.45
Pond footprint length (m)	265.89
Pond footprint width (m)	134.55
Pond catchment area (m2)	35774.60
Average active volume (m3)	7261.69





Irrigation pump limits:

Minimum pump rate per area limit (ML/day/ha)	0.00
Maximum pump rate per area limit (ML/day/ha)	1.00

Shandying water:

Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

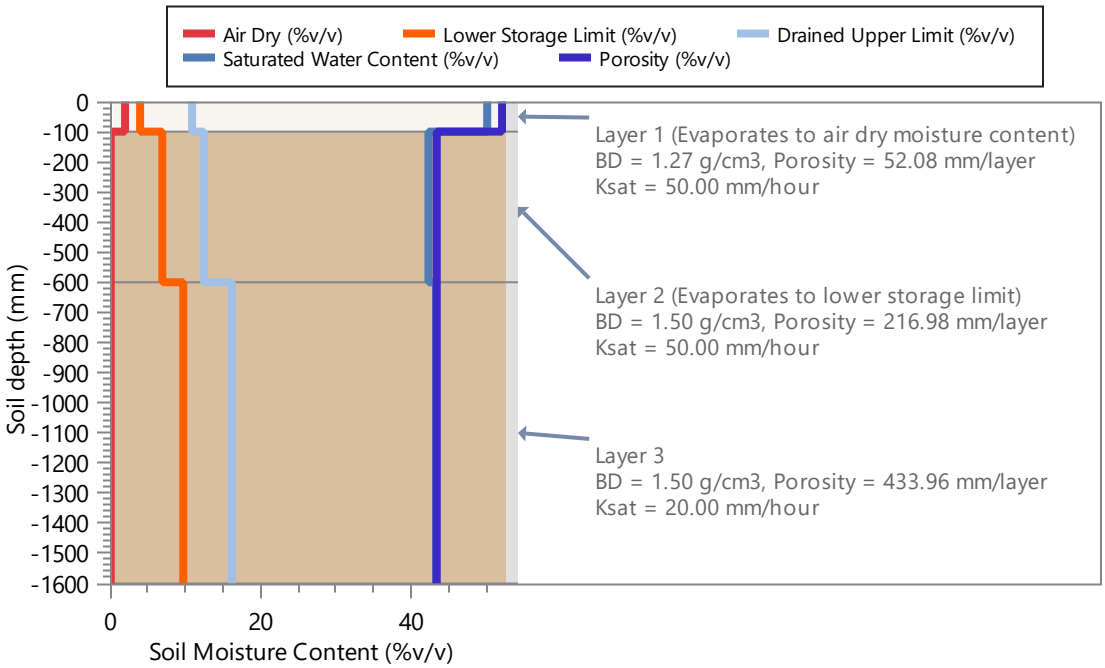
DESCRIPTION

Land: Stage 2 irrigation

Area (ha): 100.00

Soil Type: Lambells, 1600.00 mm defined profile depth

Profile Porosity (mm)	703.02
Profile saturation water content (mm)	694.60
Profile drained upper limit (or field capacity) (mm)	235.10
Profile lower storage limit (or permanent wilting point) (mm)	136.05
Profile available water capacity (mm)	99.05
Profile limiting saturated hydraulic conductivity (mm/hour)	20.00
Surface saturated hydraulic conductivity (mm/hour)	50.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Forage Sorghum Pasture

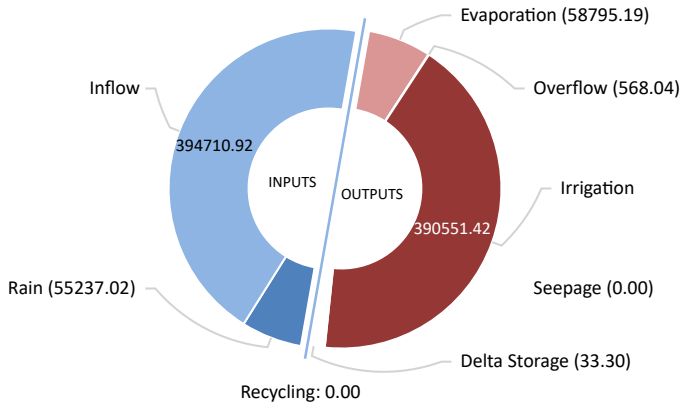
Average monthly cover (fraction) (minimum - maximum)	0.42 (0.00 - 0.78)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Maximum potential root depth in defined soil profile (mm)	1600.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **100000 m3**

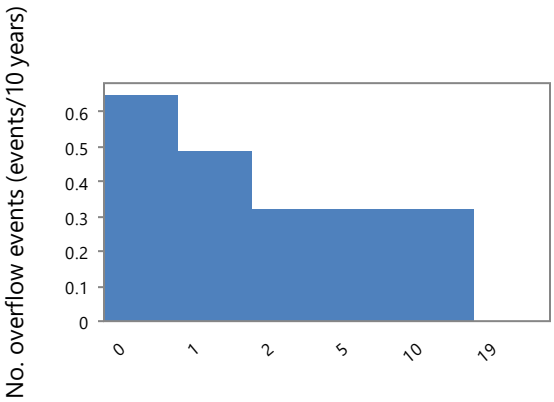
Pond System Water Balance (m3/year)



Name	Value
Rain	55237.02
Inflow	394710.92
Recycling	0.00
Evaporation	58795.19
Overflow	568.04
Irrigation	390551.42
Seepage	0.00
Delta Storage	33.30

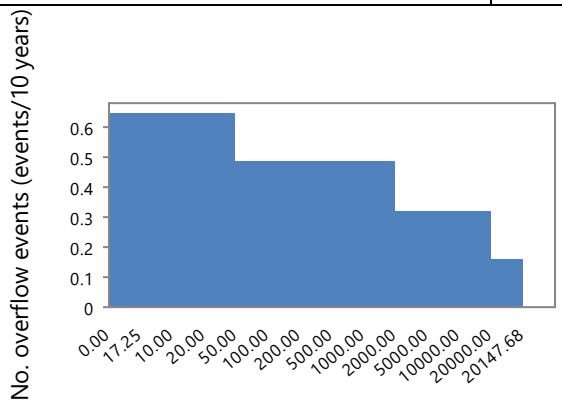
Overflow Diagnostics

Volume of overflow (m3/year)	568.04
No. days pond overflows (days/year)	0.53
Average duration of overflow (days)	8.25
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% reuse (fraction)	1.00



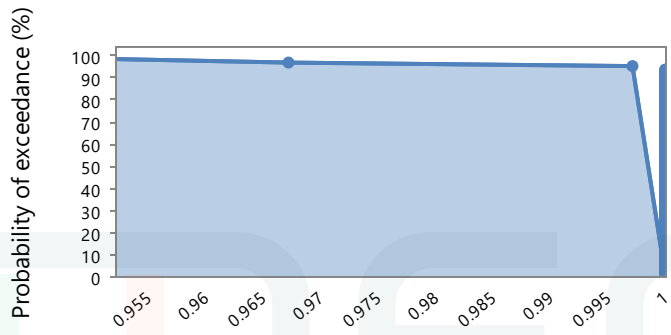
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

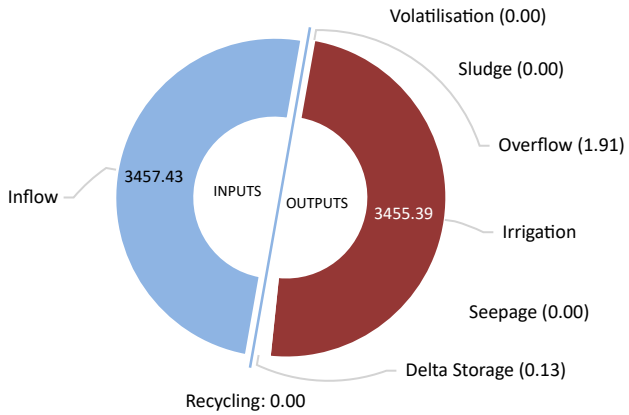
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

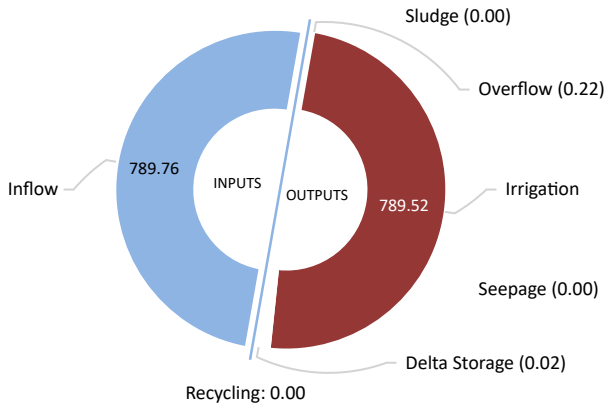
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



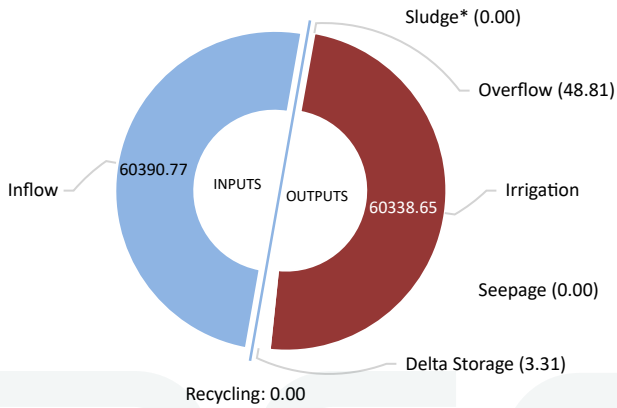
Name	Value
Inflow	3457.43
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	1.91
Irrigation	3455.39
Seepage	0.00
Delta Storage	0.13

Phosphorus Balance (kg/year)



Name	Value
Inflow	789.76
Recycling	0.00
Sludge	0.00
Overflow	0.22
Irrigation	789.52
Seepage	0.00
Delta Storage	0.02

Salt Balance (kg/year)



Name	Value
Inflow	60390.77
Recycling	0.00
Sludge*	0.00
Overflow	48.81
Irrigation	60338.65
Seepage	0.00
Delta Storage	3.31

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	3.94
Average phosphorus concentration of pond liquid (mg/L)	0.47
Average salinity of pond liquid (dS/m)	0.16

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	3.89
Final phosphorus concentration of pond liquid (mg/L)	0.45
Final salinity of pond liquid (dS/m)	0.16

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	390551.42
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	390551.42
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	8.85
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	8.62
Average phosphorus concentration of irrigation water (mg/L)	2.02
Average salinity of irrigation water (dS/m)	0.24

Irrigation Diagnostics:

Proportion of Days rain prevents irrigation (fraction)	0.13
Proportion of Days water demand too small to trigger irrigation (fraction)	0.14
Proportion of Days irrigation occurs (fraction)	0.73

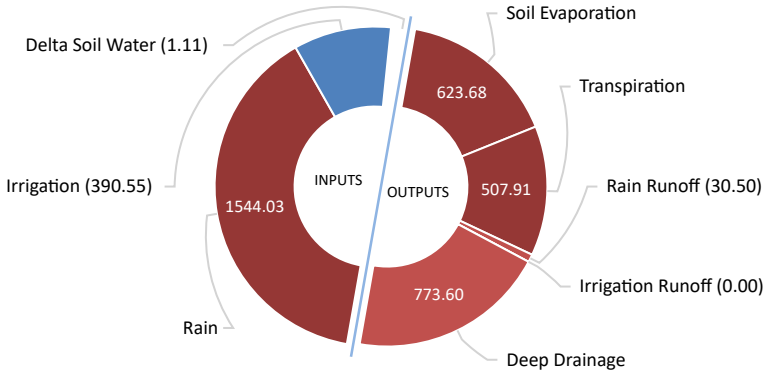
PERFORMANCE

Land Performance - Soil Water

Paddock: Stage 2 irrigation, 100 ha
Soil Type: Lambells, 99.05 mm PAWC at maximum root depth

Land Water Balance (mm/year):

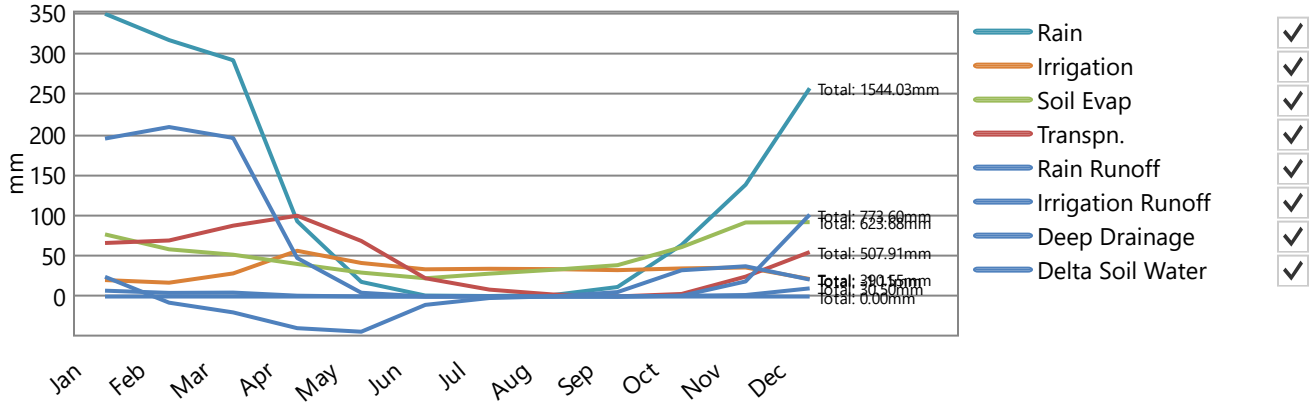
mm/year % Total inputs



Name	Value
Rain	1544.03
Irrigation	390.55
Soil Evaporation	623.68
Transpiration	507.91
Rain Runoff	30.50
Irrigation Runoff	0.00
Deep Drainage	773.60
Delta Soil Water	-1.11

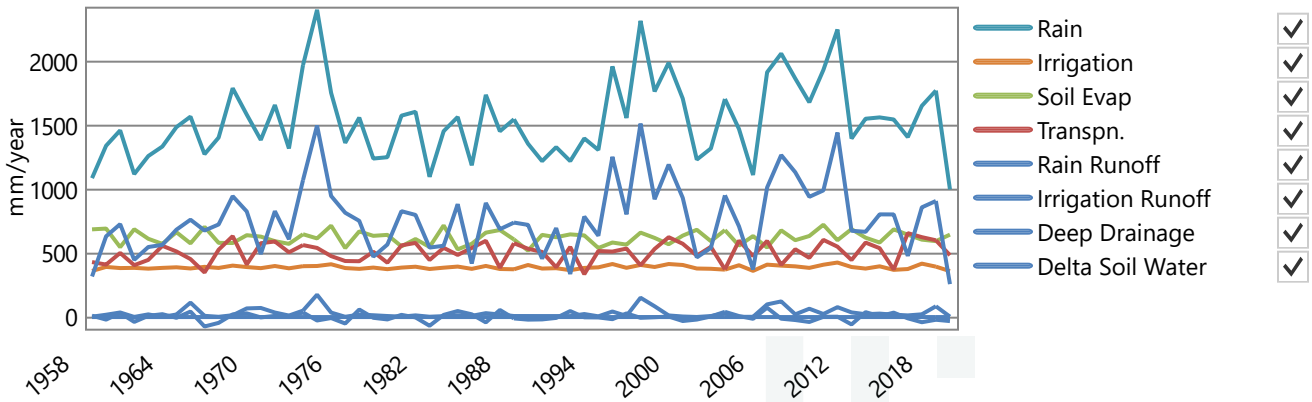
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



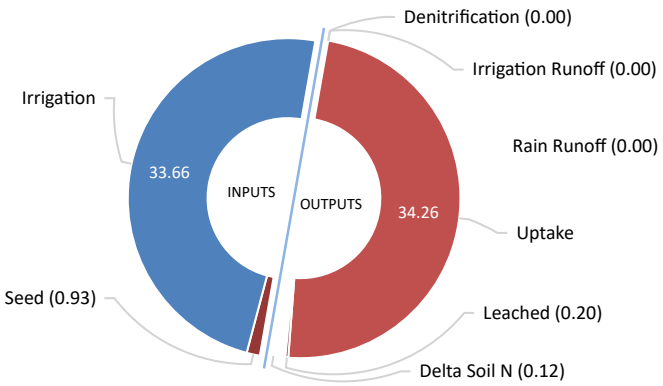
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

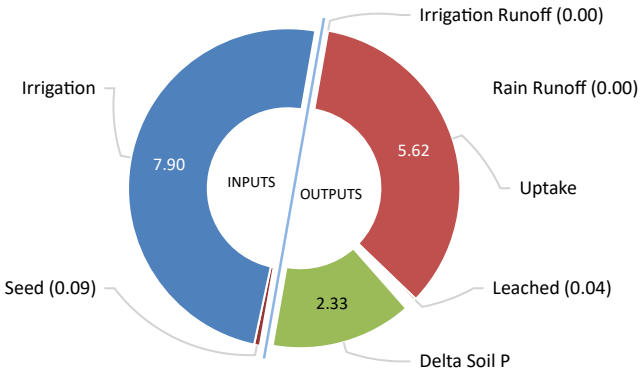
Irrigation ammonium volatilisation losses (kg/ha/year): 0.90
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.93
Irrigation	33.66
Denitrification	3.77E-03
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	34.26
Leached	0.20
Delta Soil N	0.12

Land Phosphorus Balance (kg/ha/year)



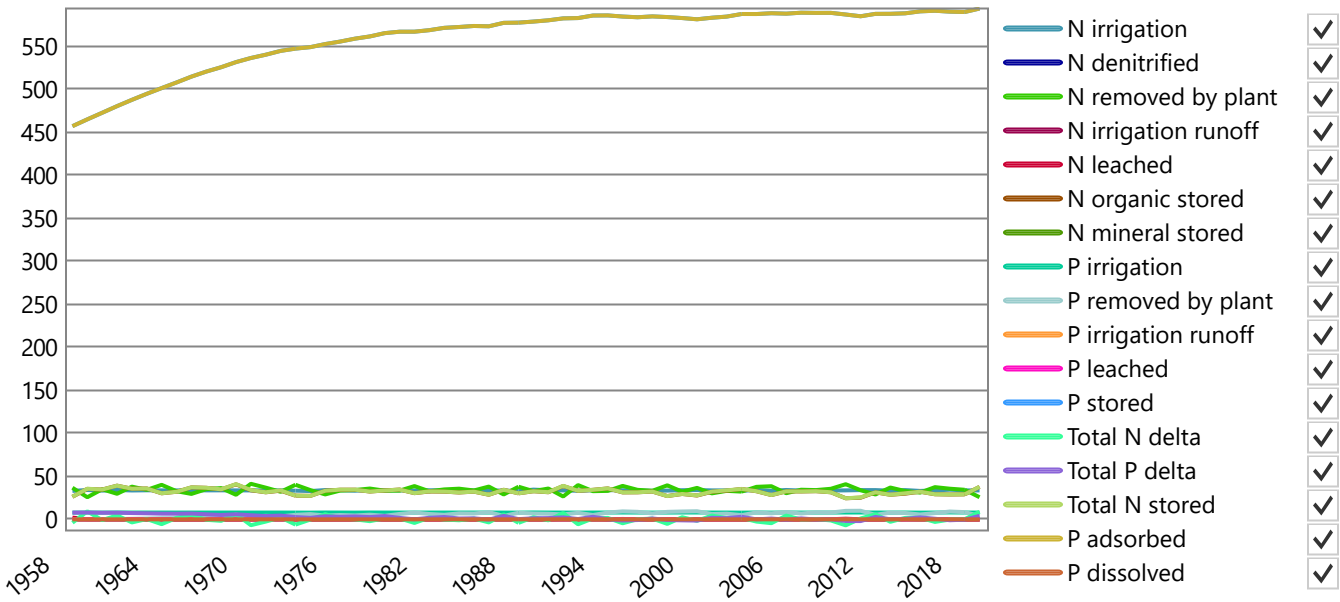
Name	Value
Seed	0.09
Irrigation	7.90
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	5.62
Leached	0.04
Delta Soil P	2.33

PERFORMANCE

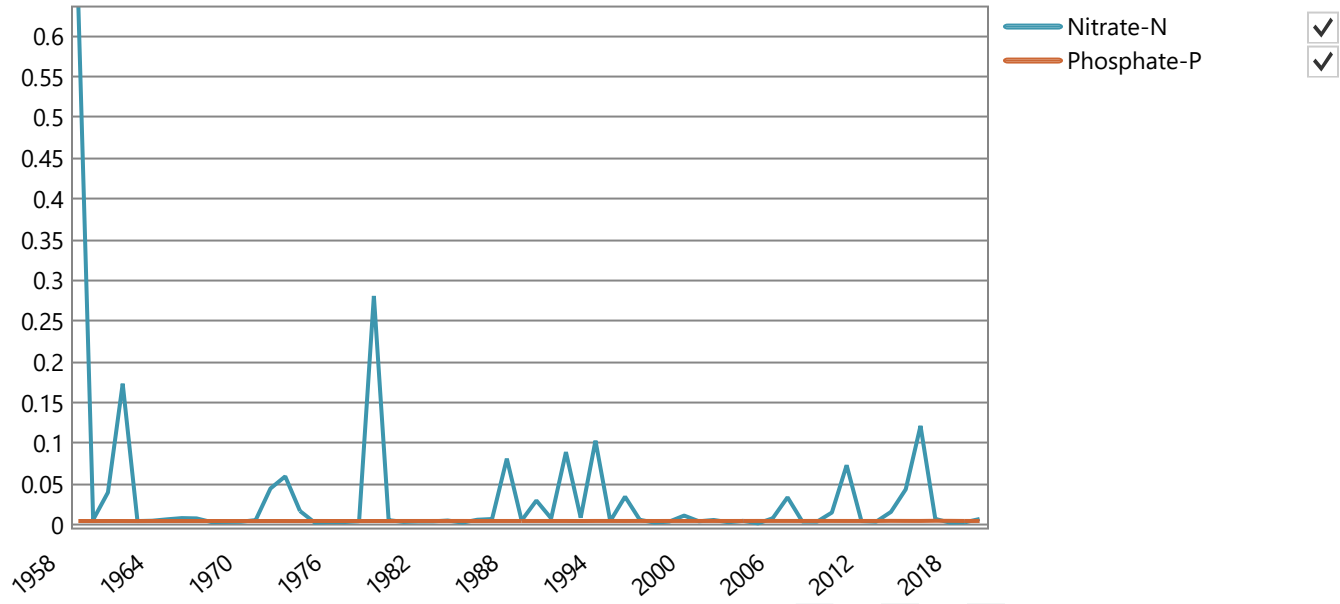
Land Performance - Soil Nutrient

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

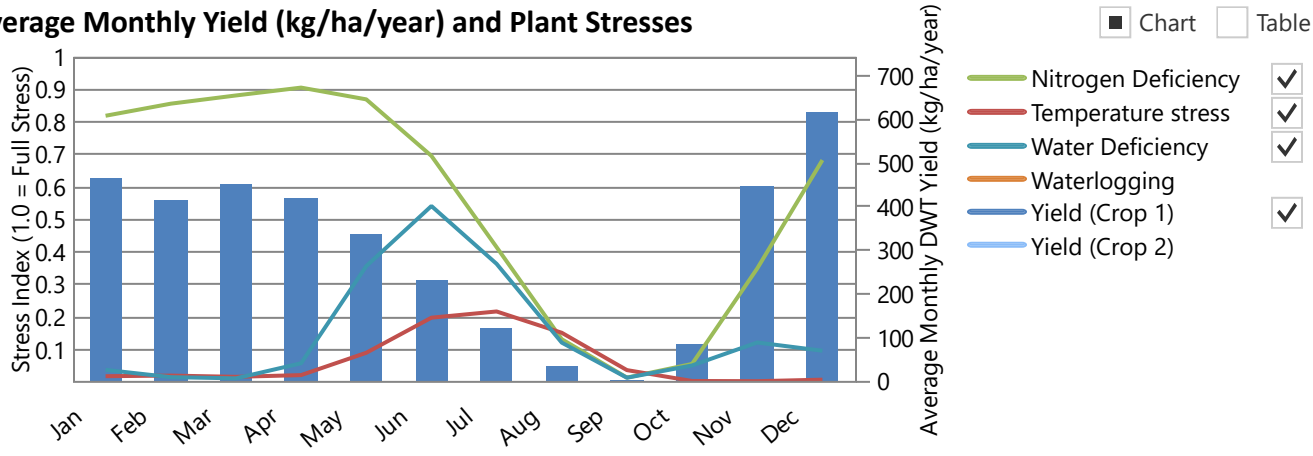
Plant: Continuous Forage Sorghum Pasture

Average annual shoot dry matter yield (kg/ha/year)	3663.65 (2591.92 - 4546.51)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.42 (0.00 - 0.78)
Average monthly root depth (mm) (minimum - maximum)	845.51 (21.94 - 1519.39)

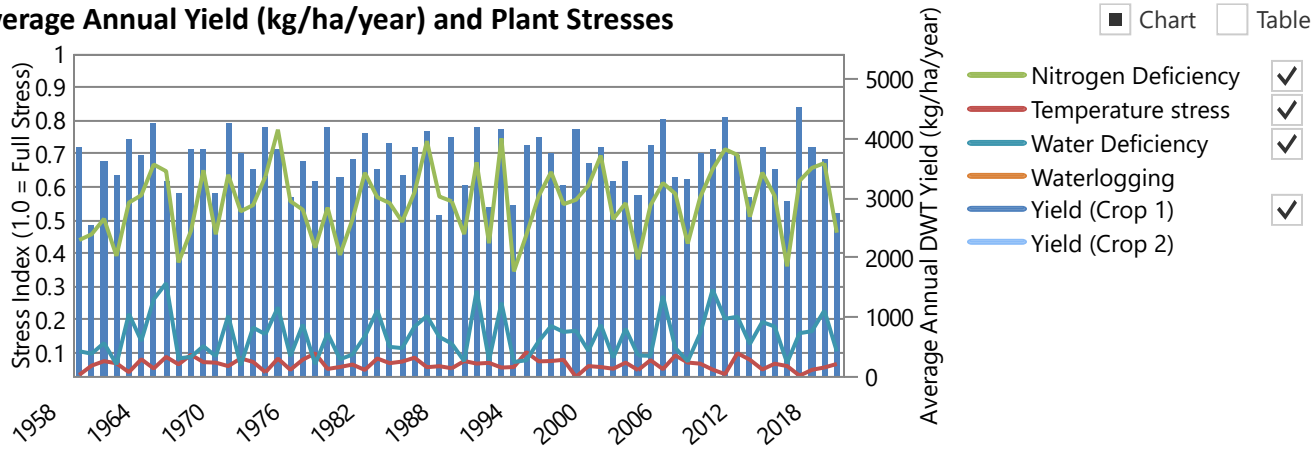
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	34.26 (25.68 - 41.31)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	5.62 (0.11 - 9.97)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.001 (0.000 - 0.003)

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 0.69 (normal), 1.02 (forced by crop death due to nitrogen stress (0.02), water stress (1.00))

No. days without crop/year (days/year): 113.52 due to water stress (113.52)

PERFORMANCE

Land Performance

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

Plant: Continuous Forage Sorghum Pasture

Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11
No. years assumed for leaching to reach steady-state (years)	10.00

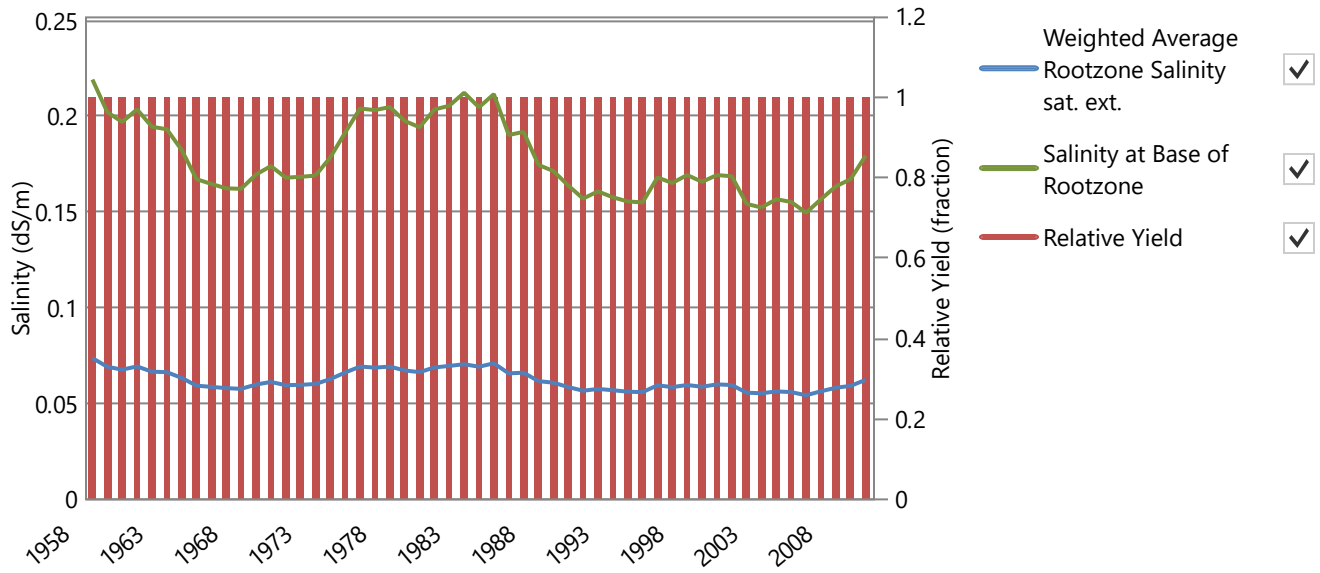
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.07
Salt added by rainfall (kg/ha/year)	290.60
Average annual effluent salt added & leached at steady state (kg/ha/year)	893.98
Average leaching fraction based on 10 year running averages (fraction)	0.53
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.06
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.18
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



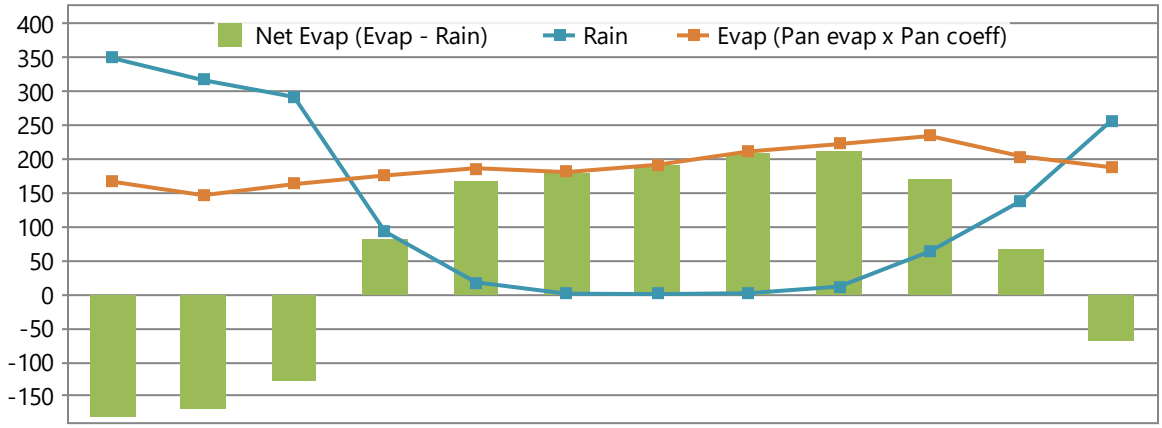
DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Averaged Historical Climate Data Used in Simulation (mm)

Location: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Evap	166.8	146.7	163.1	175.9	186.7	180.9	191.7	211.3	222.3	234.2	204.4	188.0	2272.1
Net Evap	-182.6	-170.1	-128.9	82.9	168.6	179.7	191.1	209.4	210.6	170.5	66.3	-69.4	728.1
Net Evap/day	-5.9	-6.0	-4.2	2.8	5.4	6.0	6.2	6.8	7.0	5.5	2.2	-2.2	2.0

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Pond System: 1 facultative, aerobic or storage pond

New Generic System - 394710.92 m3/year or 1080.68 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	8.76 (6.00 - 13.00)	3457.43 (3456.46 - 3460.48)
Total Phosphorus	2.00 (0.70 - 4.00)	789.76 (789.65 - 790.12)
Total Dissolved Salts	153.00 (153.00 - 153.00)	60390.77 (60365.98 - 60468.45)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	500.00 (500.00 - 500.00)	197355.46 (197274.45 - 197609.30)

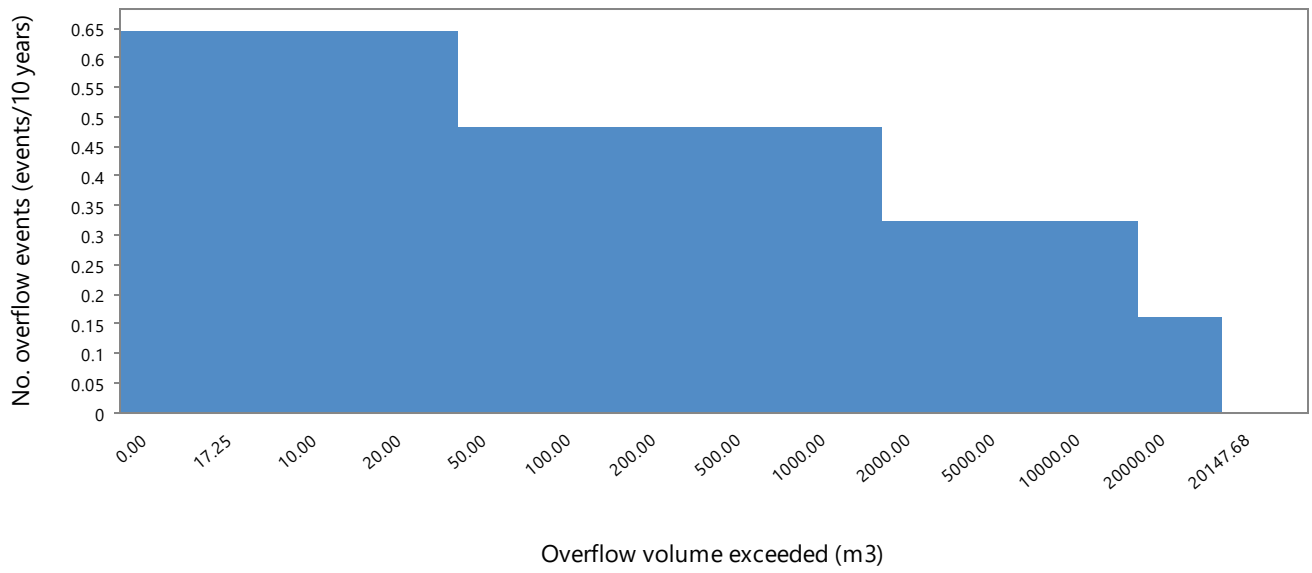
Last pond (Wet weather store): 100000.00 m3

Theoretical hydraulic retention time (days)	92.53
Average volume of overflow (m3/year)	568.04
No. overflow events per year exceeding threshold* of 17.25 m3 (no./year)	0.06
Average duration of overflow (days)	8.25
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	0.16
Salinity of last pond on final day of simulation (dS/m)	0.16
Ammonia loss from pond system water area (kg/m2/year)	0.00

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Irrigation Information

Irrigation: 100 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	390551.42	3905.51
Total nitrogen applied (kg)	3365.55	33.66
Total phosphorus applied (kg)	789.52	7.90
Total salts applied (kg)	60338.65	603.39

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.13
Proportion of Days water demand is too small to trigger irrigation (fraction)	0.14
Proportion of Days irrigation occurs (fraction)	0.73

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Paddock Land: Stage 2 irrigation: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Irrigation triggered when soil water deficit reaches 5.00 mm and rainfall is less than or equal to 10.00 mm
Irrigate a fixed amount of 5.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Lambells, 99.05 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Irrigation	20.3	17.1	28.5	56.5	41.5	33.6	34.3	33.8	32.6	34.7	35.9	21.7	390.6
Soil Evap	76.8	58.3	51.7	40.2	29.6	22.5	28.2	33.1	38.7	61.0	91.5	91.9	623.7
Transpn.	66.1	69.2	87.6	99.8	68.7	22.6	8.5	2.5	0.1	3.2	24.6	54.9	507.9
Rain Runoff	7.2	4.5	4.9	1.0	0.1	0.0	0.0	0.0	0.0	0.9	1.9	10.1	30.5
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	195.2	209.4	196.0	47.6	4.7	0.0	0.0	0.0	0.0	1.0	18.7	101.1	773.6
Delta	24.4	-7.6	-19.6	-39.1	-43.5	-10.3	-1.9	0.2	5.5	32.4	37.4	21.0	-1.1

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	33.66
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	34.26
Average annual soil nitrogen removed by denitrification (kg/ha/year)	3.77E-03
Average annual soil nitrogen leached (kg/ha/year)	0.20
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.20
Soil organic-N kg/ha (Initial - Final)	6.41 - 37.74
	23.77 - 0.07
Average nitrate-N concentration of deep drainage (mg/L)	0.03
Max. annual nitrate-N concentration of deep drainage (mg/L)	0.64

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	7.90
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	5.62
Average annual soil phosphorus leached (kg/ha/year)	0.04
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.01
Adsorbed phosphorus (kg/ha) (Initial - Final)	449.15 - 593.68
Average phosphate-P concentration in rootzone (mg/L)	0.01
Average phosphate-P concentration of deep drainage (mg/L)	4.78E-03
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.01
Design soil profile storage life based on average infiltrated water phosphorus concn. of 0.41 mg/L (years)	264.79

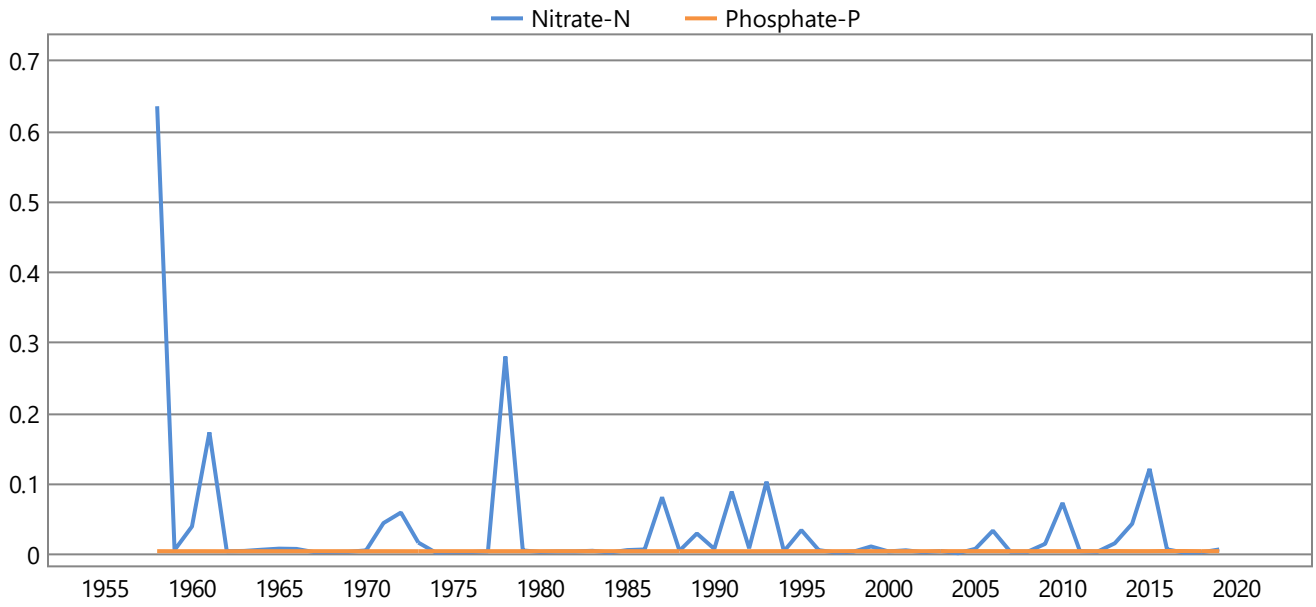
DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

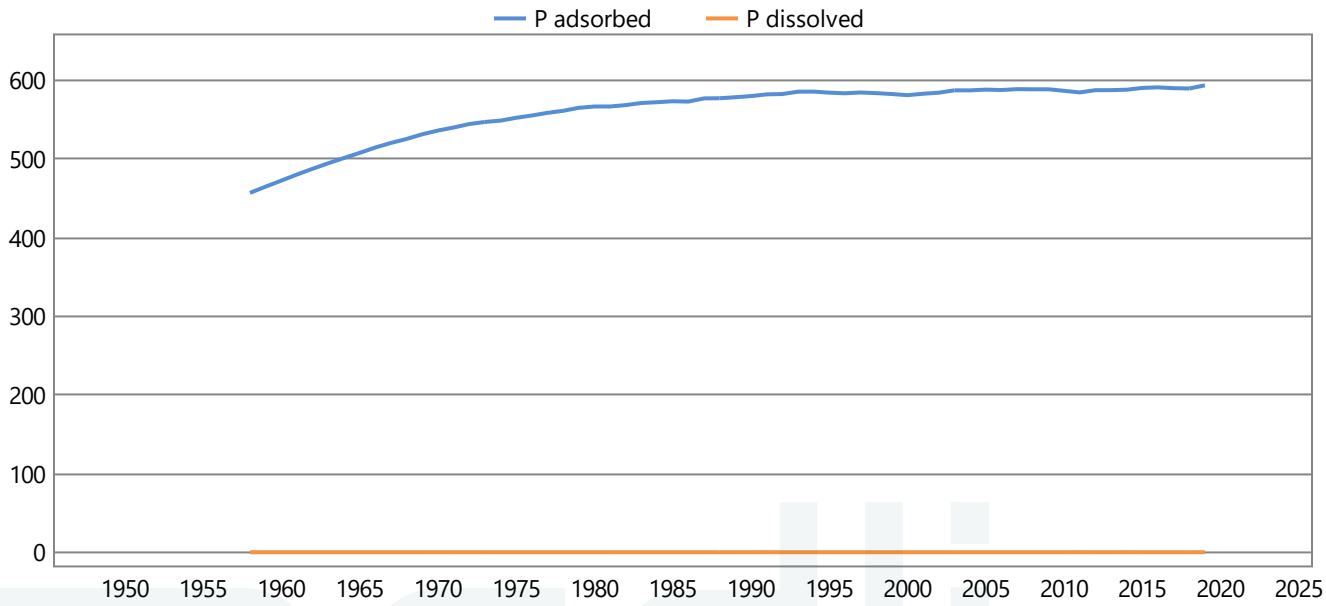
Paddock Land: Stage 2 irrigation: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Paddock Plant Performance: Stage 2 irrigation: 100 ha

Average Plant Performance (Minimum - Maximum): Continuous Forage Sorghum Pasture

Average annual shoot dry matter yield (kg/ha/year)	3663.65 (2591.92 - 4546.51)
Average monthly plant (green) cover (fraction)	0.42 (0.00 - 0.78)
Average monthly crop factor (fraction)	0.33 (0.00 - 0.62)
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Average monthly root depth (mm)	845.51 (21.94 - 1519.39)
Average number of normal harvests per year (no./year)	0.69 (0.00 - 1.00)
Average number of normal harvests for last five years only (no./year)	0.60
Average number of crop deaths per year (no./year)	1.02 (1.00 - 2.00)
Average number of crop deaths for last five years only (no./year)	1.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.55 (0.35 - 0.77)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.22 (0.07 - 0.37)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.15 (0.01 - 0.54)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	113.52

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.07
Salt added by rainfall (kg/ha/year)	290.60
Average annual effluent salt added & leached at steady state (kg/ha/year)	893.98
Average leaching fraction based on 10 year running averages (fraction)	0.53
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.06
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.18
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

Attachment C. MEDLI Report: 0% reuse, 80ML storage, 100ha irrigation area

MEDLI REPORT - FULL RUN

Enterprise: **MARPU - Lambells Lagoon Crocodile Farm**

Description:
Marpu Stage 2 irrigation and storage modelling

Client: **PRI Farming Pty Ltd**

MEDLI User: ECOZ\adele.faraone

Scenario Details:
Updated inflows = 30% rainfall infiltration

DESCRIPTION

Climate Data: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days

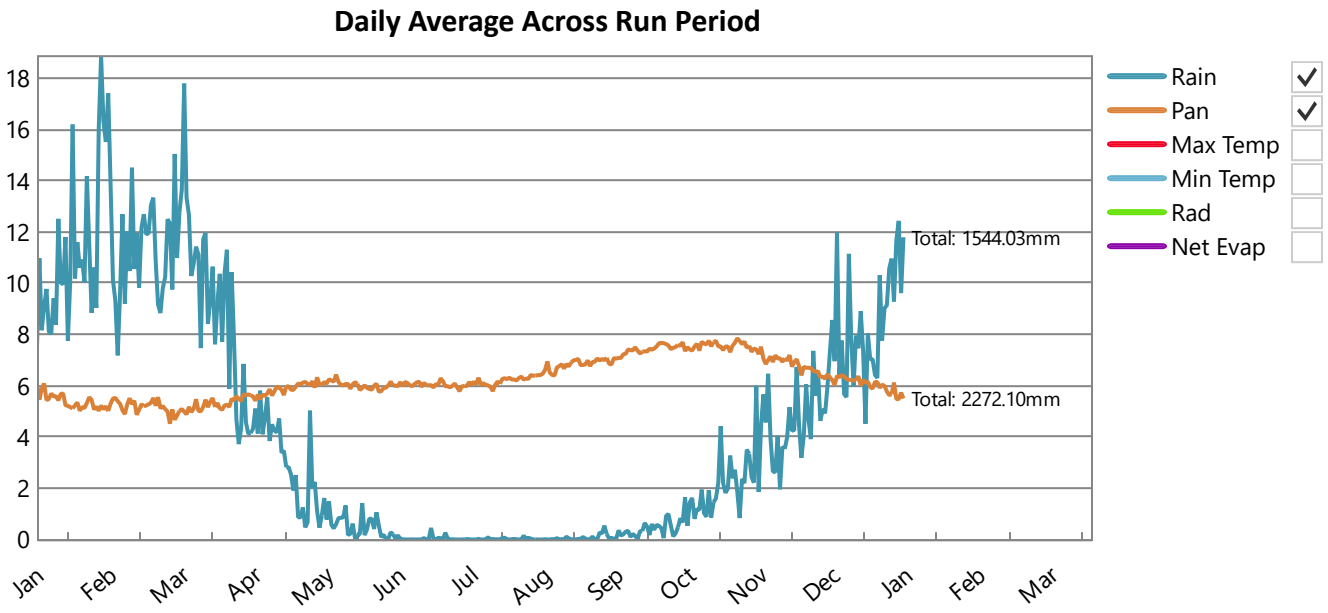
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	1108	1521	2163
Pan Evaporation (mm/year)	2100	2273	2448

Climate Data:

Chart Table

Monthly Daily

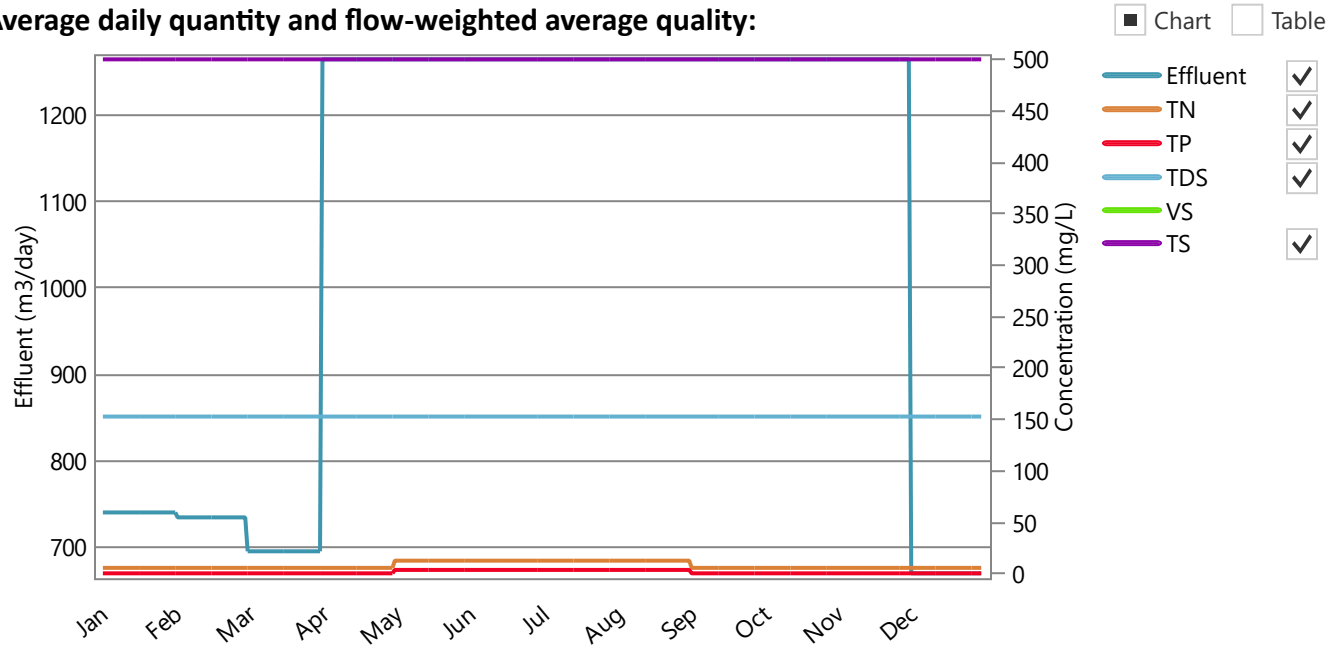


DESCRIPTION

Effluent type: New Generic System

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 394710.92 m3/year or 1080.68 m3/day (Min-Max: 669.70 - 1265.00)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

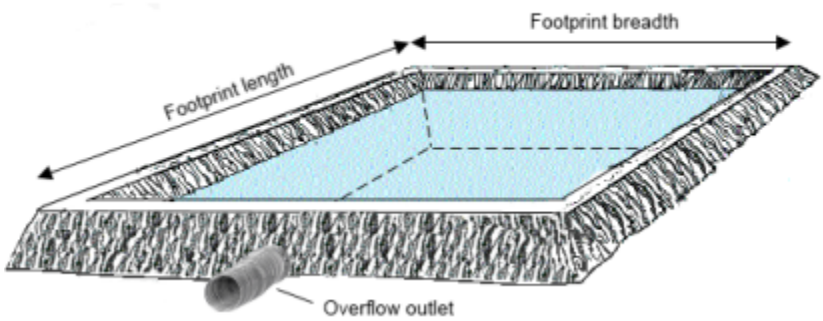
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	8.76 (6.00 - 13.00)	3457.43 (3456.46 - 3460.48)
Total Phosphorus	2.00 (0.70 - 4.00)	789.76 (789.65 - 790.12)
Total Dissolved Salts	153.00 (153.00 - 153.00)	60390.77 (60365.98 - 60468.45)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	500.00 (500.00 - 500.00)	197355.46 (197274.45 - 197609.30)

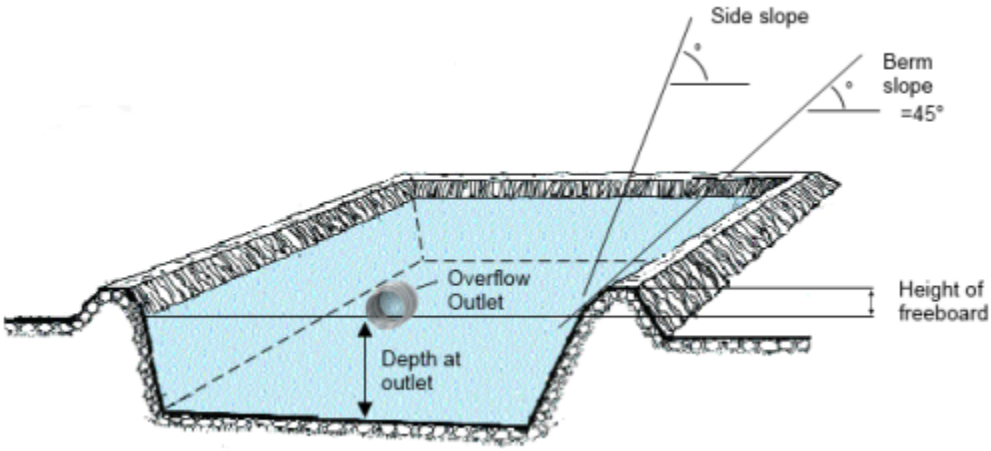
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (m3)	80000.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	3.00
Maximum water surface area (m2)	27714.11
Pond footprint length (m)	238.63
Pond footprint width (m)	120.92
Pond catchment area (m2)	28854.42
Average active volume (m3)	6369.39





Irrigation pump limits:

Minimum pump rate per area limit (ML/day/ha)	0.00
Maximum pump rate per area limit (ML/day/ha)	1.00

Shandying water:

Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

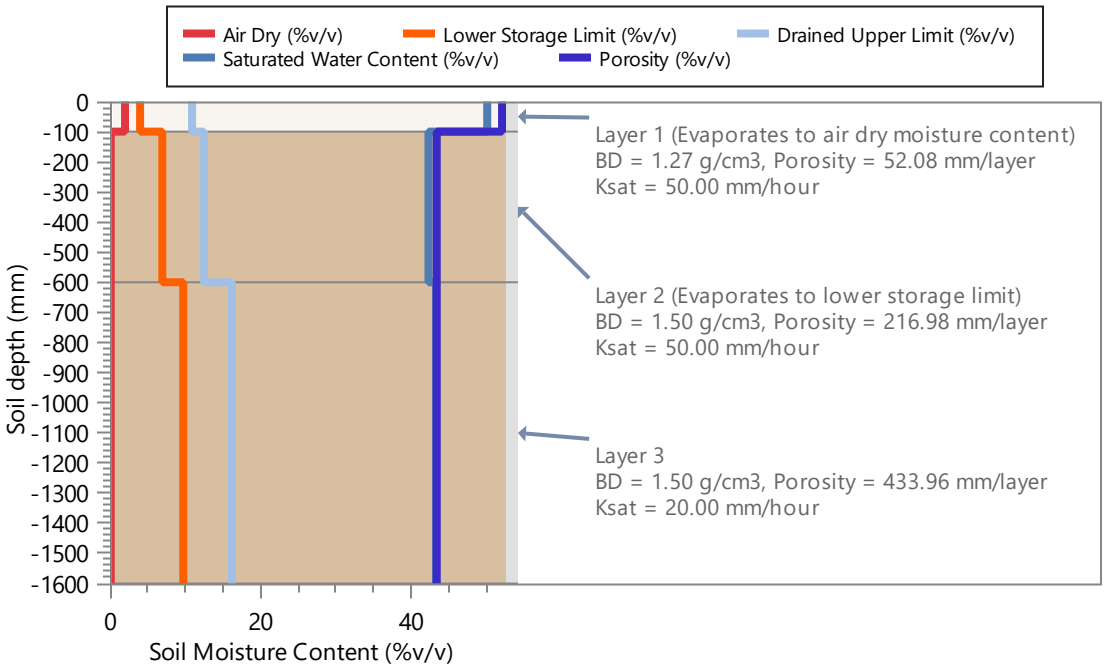
DESCRIPTION

Land: Stage 2 irrigation

Area (ha): 100.00

Soil Type: Lambells, 1600.00 mm defined profile depth

Profile Porosity (mm)	703.02
Profile saturation water content (mm)	694.60
Profile drained upper limit (or field capacity) (mm)	235.10
Profile lower storage limit (or permanent wilting point) (mm)	136.05
Profile available water capacity (mm)	99.05
Profile limiting saturated hydraulic conductivity (mm/hour)	20.00
Surface saturated hydraulic conductivity (mm/hour)	50.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Forage Sorghum Pasture

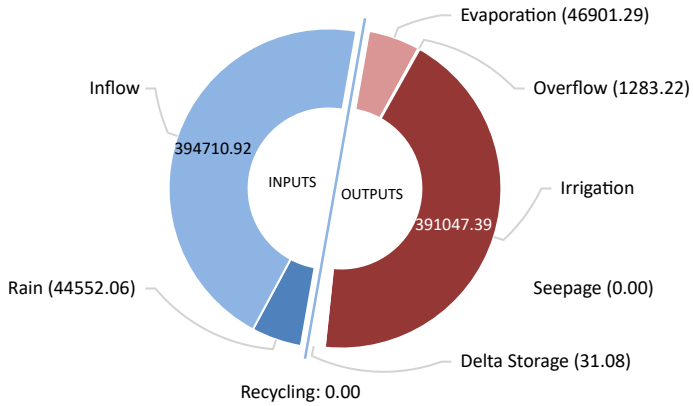
Average monthly cover (fraction) (minimum - maximum)	0.41 (0.00 - 0.77)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Maximum potential root depth in defined soil profile (mm)	1600.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **80000 m3**

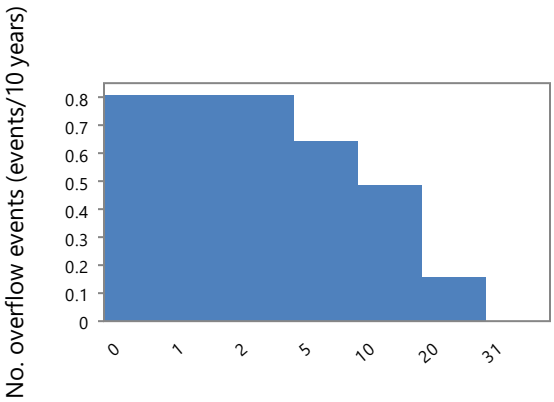
Pond System Water Balance (m3/year)



Name	Value
Rain	44552.06
Inflow	394710.92
Recycling	0.00
Evaporation	46901.29
Overflow	1283.22
Irrigation	391047.39
Seepage	0.00
Delta Storage	31.08

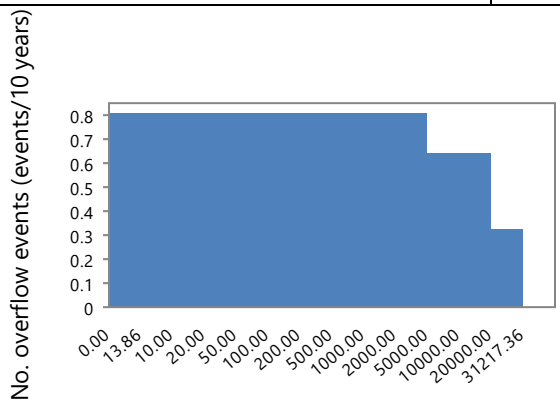
Overflow Diagnostics

Volume of overflow (m3/year)	1283.22
No. days pond overflows (days/year)	1.18
Average duration of overflow (days)	14.60
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% reuse (fraction)	1.00



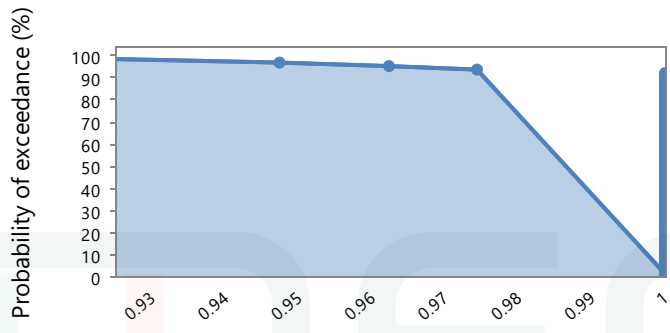
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

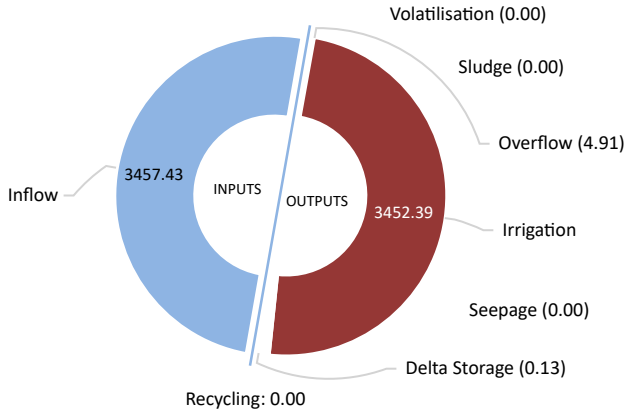
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

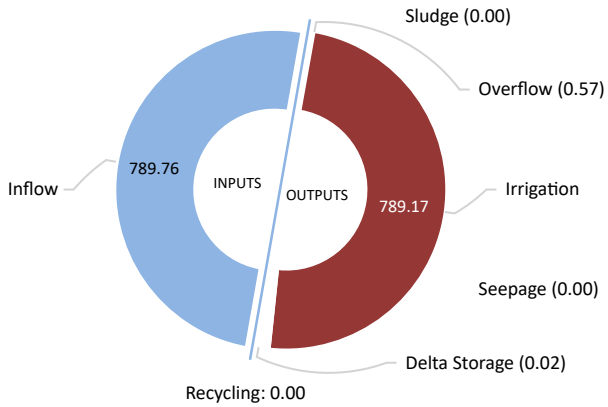
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



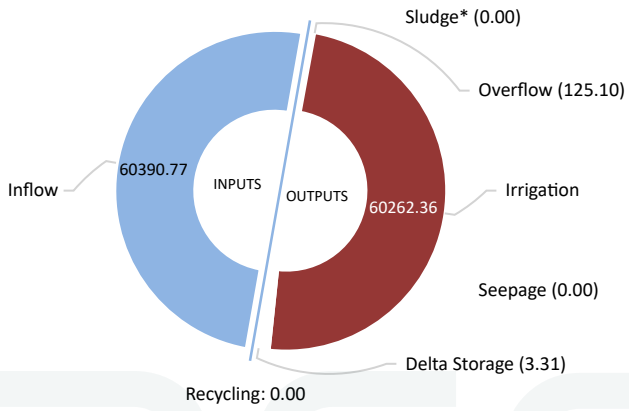
Name	Value
Inflow	3457.43
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	4.91
Irrigation	3452.39
Seepage	0.00
Delta Storage	0.13

Phosphorus Balance (kg/year)



Name	Value
Inflow	789.76
Recycling	0.00
Sludge	0.00
Overflow	0.57
Irrigation	789.17
Seepage	0.00
Delta Storage	0.02

Salt Balance (kg/year)



Name	Value
Inflow	60390.77
Recycling	0.00
Sludge*	0.00
Overflow	125.10
Irrigation	60262.36
Seepage	0.00
Delta Storage	3.31

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	4.20
Average phosphorus concentration of pond liquid (mg/L)	0.50
Average salinity of pond liquid (dS/m)	0.17

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	4.17
Final phosphorus concentration of pond liquid (mg/L)	0.49
Final salinity of pond liquid (dS/m)	0.17

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	391047.39
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	391047.39
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	8.83
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	8.60
Average phosphorus concentration of irrigation water (mg/L)	2.02
Average salinity of irrigation water (dS/m)	0.24

Irrigation Diagnostics:

Proportion of Days rain prevents irrigation (fraction)	0.13
Proportion of Days water demand too small to trigger irrigation (fraction)	0.14
Proportion of Days irrigation occurs (fraction)	0.73

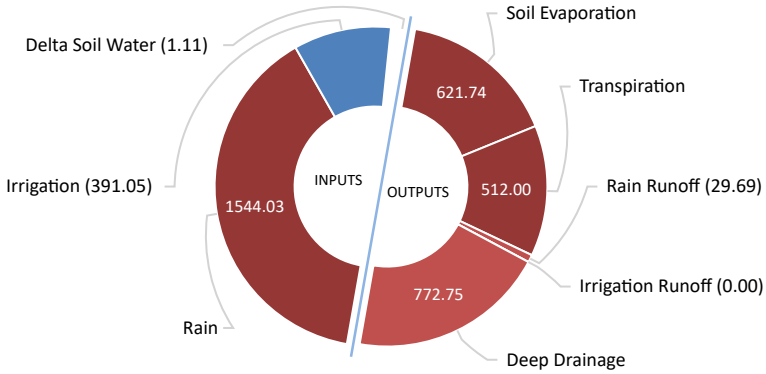
PERFORMANCE

Land Performance - Soil Water

Paddock: Stage 2 irrigation, 100 ha
Soil Type: Lambells, 99.05 mm PAWC at maximum root depth

Land Water Balance (mm/year):

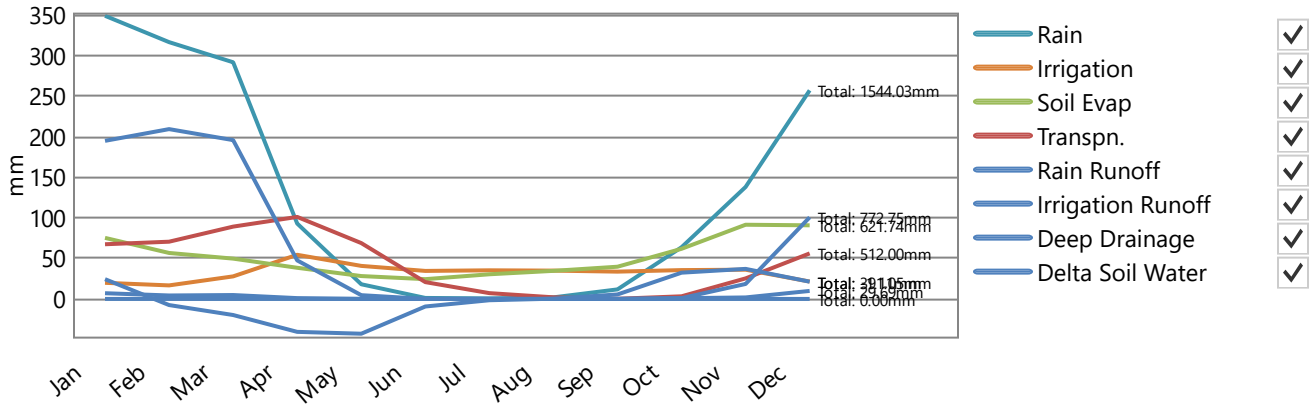
mm/year % Total inputs



Name	Value
Rain	1544.03
Irrigation	391.05
Soil Evaporation	621.74
Transpiration	512.00
Rain Runoff	29.69
Irrigation Runoff	0.00
Deep Drainage	772.75
Delta Soil Water	-1.11

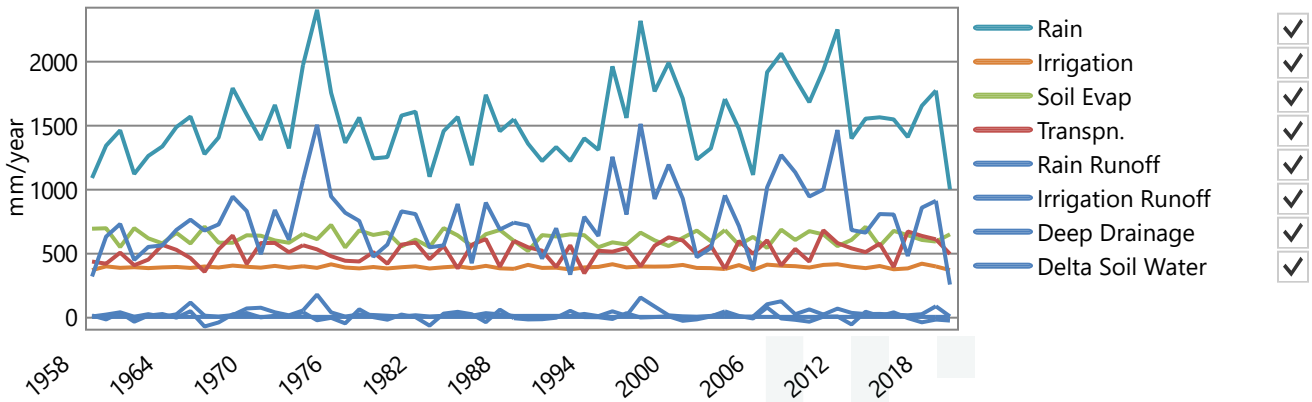
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



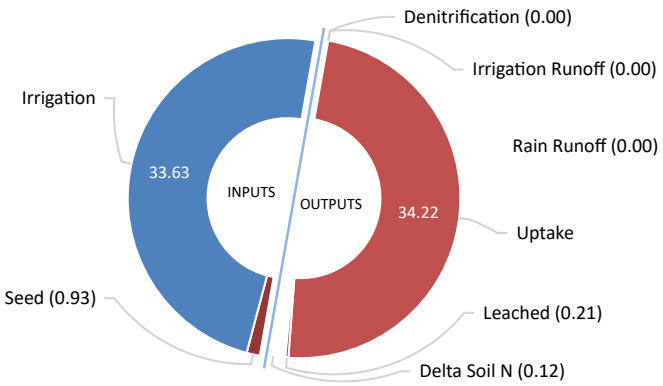
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

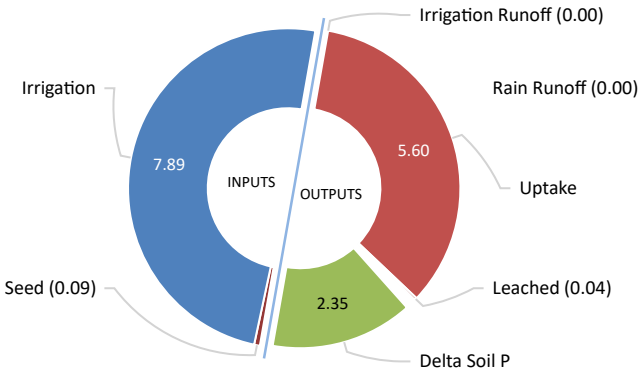
Irrigation ammonium volatilisation losses (kg/ha/year): 0.90
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.93
Irrigation	33.63
Denitrification	4.14E-03
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	34.22
Leached	0.21
Delta Soil N	0.12

Land Phosphorus Balance (kg/ha/year)



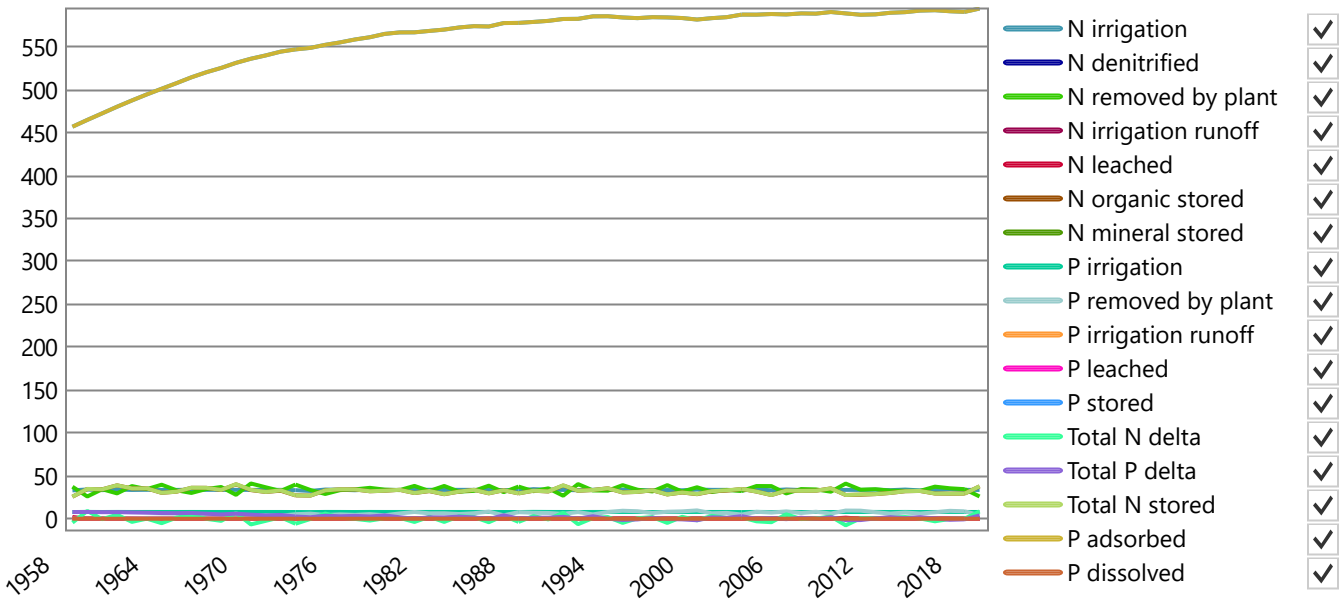
Name	Value
Seed	0.09
Irrigation	7.89
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	5.60
Leached	0.04
Delta Soil P	2.35

PERFORMANCE

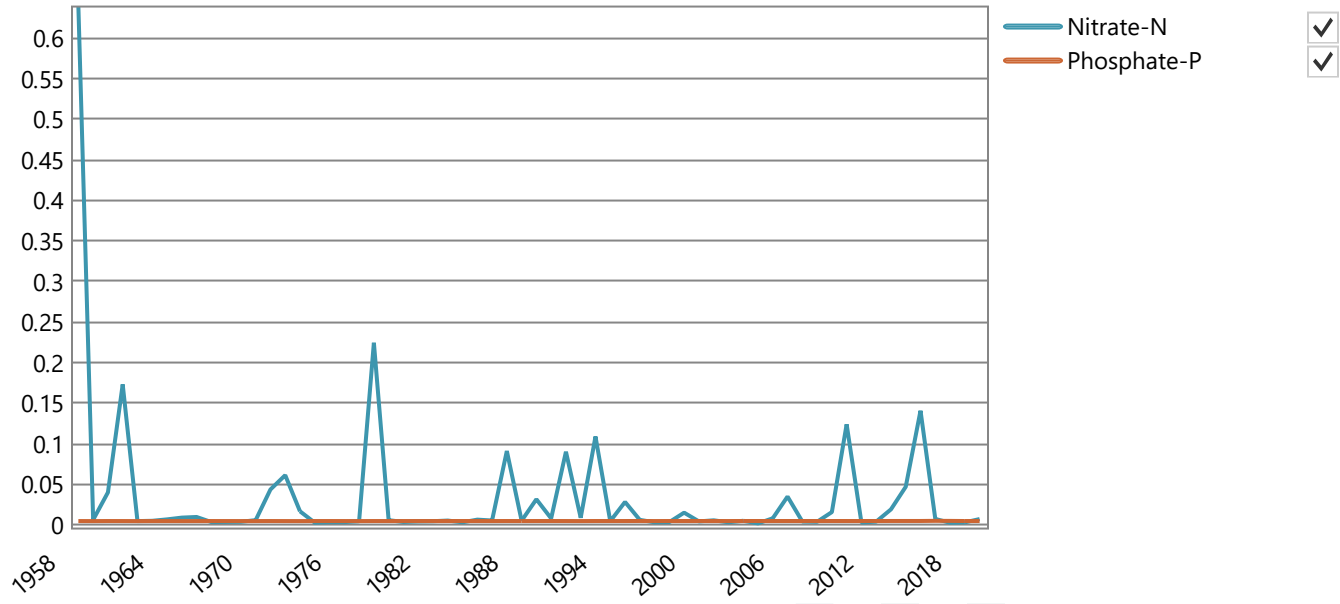
Land Performance - Soil Nutrient

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

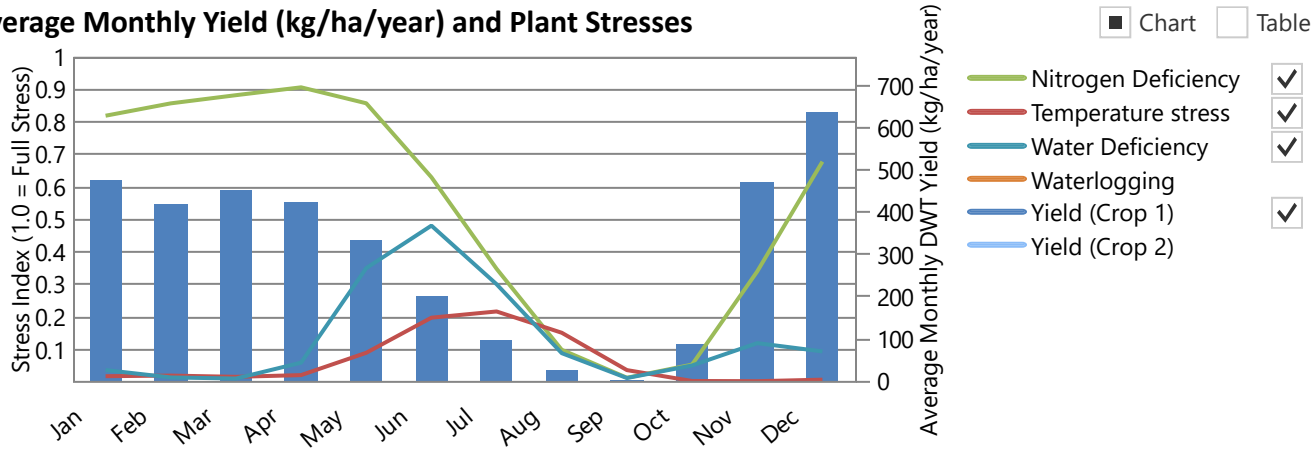
Plant: Continuous Forage Sorghum Pasture

Average annual shoot dry matter yield (kg/ha/year)	3659.84 (2601.93 - 4590.38)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.41 (0.00 - 0.77)
Average monthly root depth (mm) (minimum - maximum)	827.92 (19.37 - 1530.41)

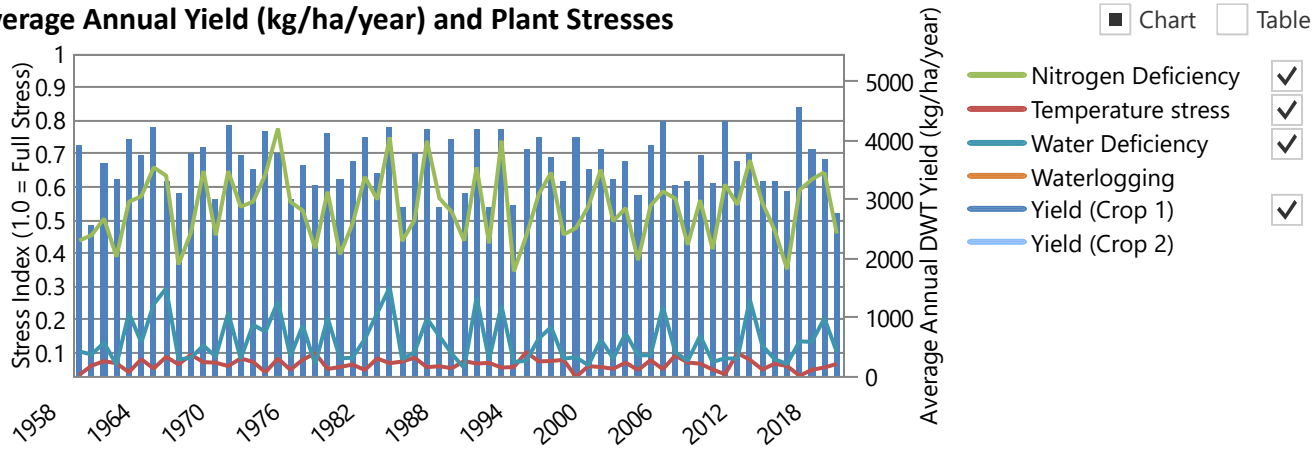
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	34.22 (25.93 - 41.12)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	5.60 (0.11 - 9.74)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.001 (0.000 - 0.002)

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 0.68 (normal), 1.02 (forced by crop death due to nitrogen stress (0.03), water stress (0.98))

No. days without crop/year (days/year): 119.42 due to water stress (119.42)

PERFORMANCE

Land Performance

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

Plant: Continuous Forage Sorghum Pasture

Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11
No. years assumed for leaching to reach steady-state (years)	10.00

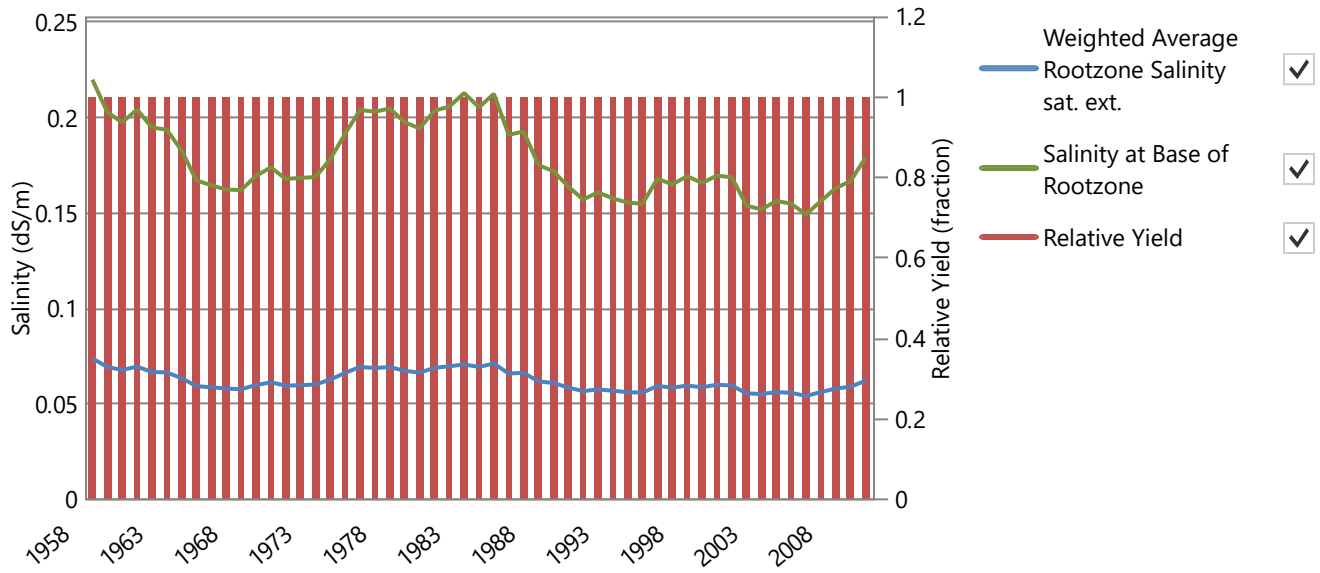
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.07
Salt added by rainfall (kg/ha/year)	290.75
Average annual effluent salt added & leached at steady state (kg/ha/year)	893.38
Average leaching fraction based on 10 year running averages (fraction)	0.53
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.06
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.18
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



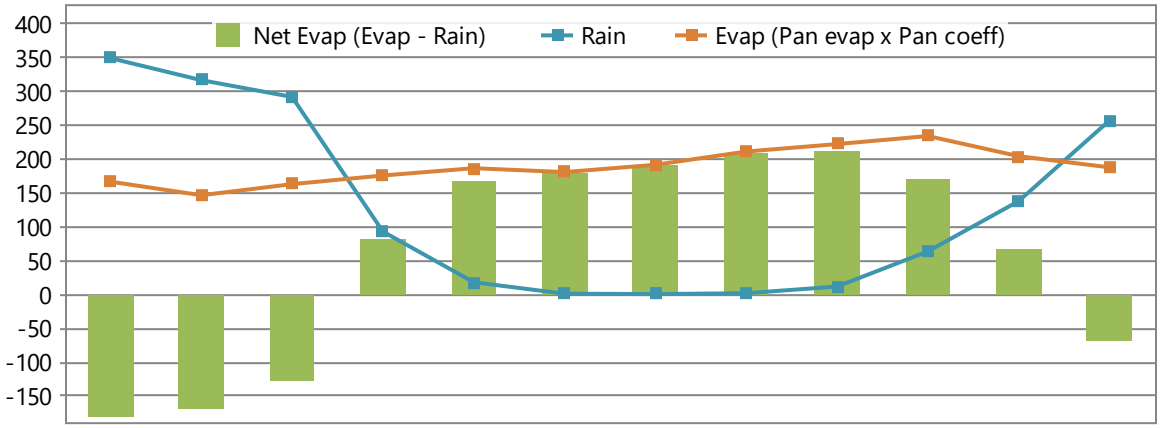
DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Averaged Historical Climate Data Used in Simulation (mm)

Location: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Evap	166.8	146.7	163.1	175.9	186.7	180.9	191.7	211.3	222.3	234.2	204.4	188.0	2272.1
Net Evap	-182.6	-170.1	-128.9	82.9	168.6	179.7	191.1	209.4	210.6	170.5	66.3	-69.4	728.1
Net Evap/day	-5.9	-6.0	-4.2	2.8	5.4	6.0	6.2	6.8	7.0	5.5	2.2	-2.2	2.0

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Pond System: 1 facultative, aerobic or storage pond

New Generic System - 394710.92 m3/year or 1080.68 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	8.76 (6.00 - 13.00)	3457.43 (3456.46 - 3460.48)
Total Phosphorus	2.00 (0.70 - 4.00)	789.76 (789.65 - 790.12)
Total Dissolved Salts	153.00 (153.00 - 153.00)	60390.77 (60365.98 - 60468.45)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	500.00 (500.00 - 500.00)	197355.46 (197274.45 - 197609.30)

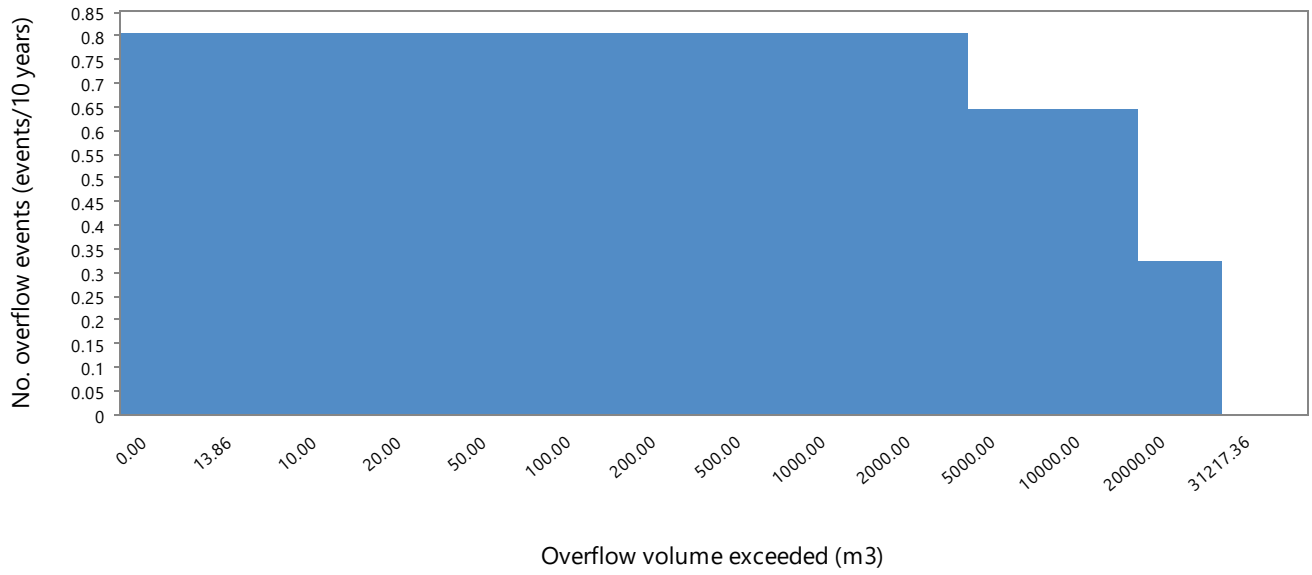
Last pond (Wet weather store): 80000.00 m3

Theoretical hydraulic retention time (days)	74.03
Average volume of overflow (m3/year)	1283.22
No. overflow events per year exceeding threshold* of 13.86 m3 (no./year)	0.08
Average duration of overflow (days)	14.60
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	0.17
Salinity of last pond on final day of simulation (dS/m)	0.17
Ammonia loss from pond system water area (kg/m2/year)	0.00

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Irrigation Information

Irrigation: 100 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	391047.39	3910.47
Total nitrogen applied (kg)	3362.63	33.63
Total phosphorus applied (kg)	789.17	7.89
Total salts applied (kg)	60262.36	602.62

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.13
Proportion of Days water demand is too small to trigger irrigation (fraction)	0.14
Proportion of Days irrigation occurs (fraction)	0.73

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Paddock Land: Stage 2 irrigation: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Irrigation triggered when soil water deficit reaches 5.00 mm and rainfall is less than or equal to 10.00 mm
Irrigate a fixed amount of 5.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Lambells, 99.05 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Irrigation	19.9	16.7	27.8	54.4	40.8	34.5	35.3	34.9	33.7	35.6	36.1	21.4	391.0
Soil Evap	75.3	56.7	49.7	38.4	28.2	24.4	30.4	34.6	39.7	61.8	91.5	90.8	621.7
Transpn.	67.4	70.6	89.2	101.2	68.9	20.7	7.1	2.0	0.2	3.2	25.3	56.1	512.0
Rain Runoff	7.0	4.2	4.8	1.0	0.1	0.0	0.0	0.0	0.0	0.9	1.8	9.9	29.7
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	195.0	209.5	195.9	47.5	4.6	0.0	0.0	0.0	0.0	1.0	18.5	100.7	772.8
Delta	24.4	-7.6	-19.9	-40.6	-42.9	-9.3	-1.6	0.3	5.5	32.4	37.1	21.3	-1.1

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	33.63
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	34.22
Average annual soil nitrogen removed by denitrification (kg/ha/year)	4.14E-03
Average annual soil nitrogen leached (kg/ha/year)	0.21
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.21
Soil organic-N kg/ha (Initial - Final)	6.41 - 37.77
	23.77 - 0.07
Average nitrate-N concentration of deep drainage (mg/L)	0.03
Max. annual nitrate-N concentration of deep drainage (mg/L)	0.64

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	7.89
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	5.60
Average annual soil phosphorus leached (kg/ha/year)	0.04
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.01
Adsorbed phosphorus (kg/ha) (Initial - Final)	449.15 - 594.70
Average phosphate-P concentration in rootzone (mg/L)	0.01
Average phosphate-P concentration of deep drainage (mg/L)	4.77E-03
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.01
Design soil profile storage life based on average infiltrated water phosphorus concn. of 0.41 mg/L (years)	264.77

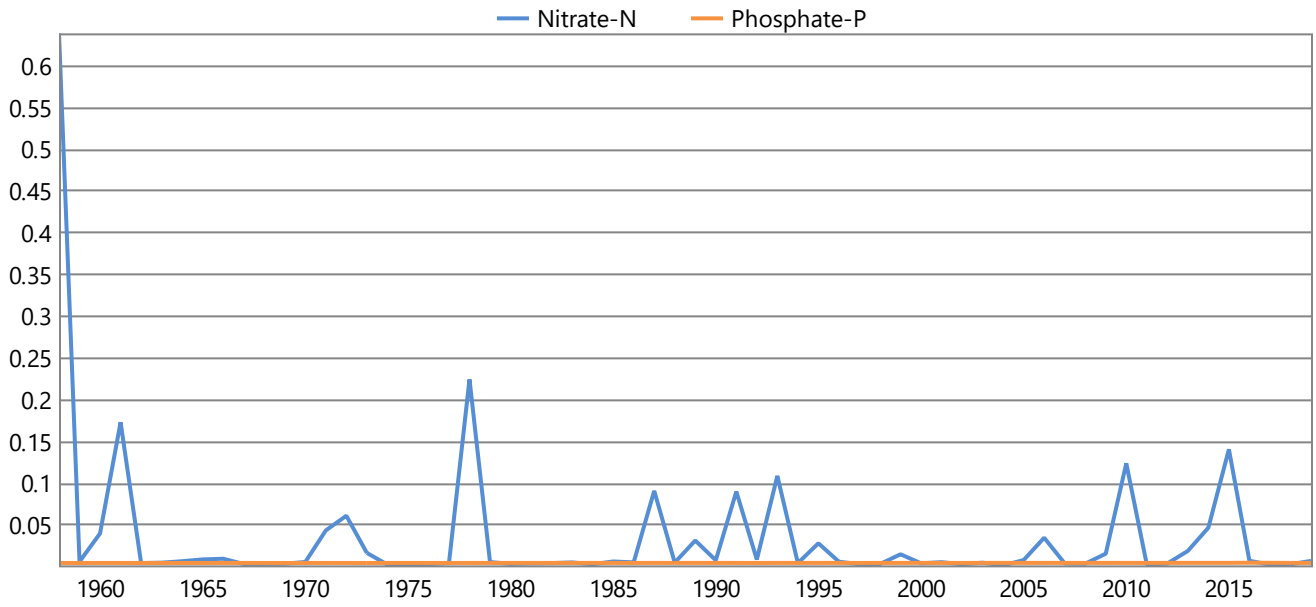
DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

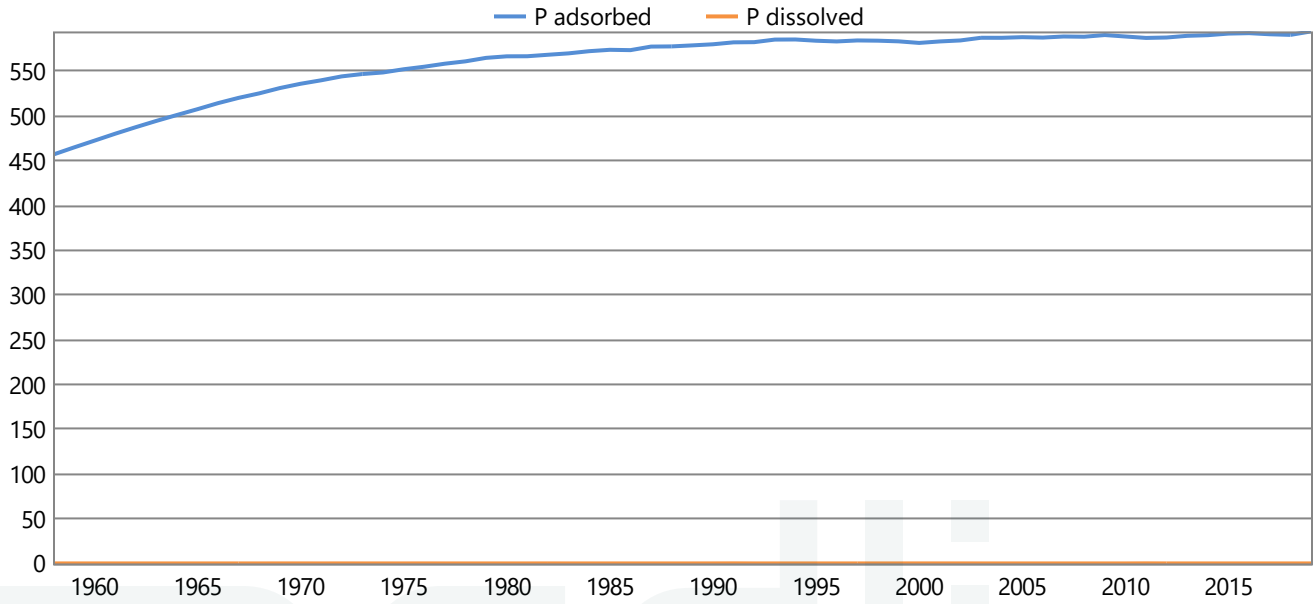
Paddock Land: Stage 2 irrigation: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Paddock Plant Performance: Stage 2 irrigation: 100 ha

Average Plant Performance (Minimum - Maximum): Continuous Forage Sorghum Pasture

Average annual shoot dry matter yield (kg/ha/year)	3659.84 (2601.93 - 4590.38)
Average monthly plant (green) cover (fraction)	0.41 (0.00 - 0.77)
Average monthly crop factor (fraction)	0.33 (0.00 - 0.62)
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Average monthly root depth (mm)	827.92 (19.37 - 1530.41)
Average number of normal harvests per year (no./year)	0.68 (0.00 - 1.00)
Average number of normal harvests for last five years only (no./year)	0.60
Average number of crop deaths per year (no./year)	1.02 (1.00 - 2.00)
Average number of crop deaths for last five years only (no./year)	1.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.54 (0.35 - 0.78)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.22 (0.07 - 0.37)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.13 (0.01 - 0.48)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	119.42

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.07
Salt added by rainfall (kg/ha/year)	290.75
Average annual effluent salt added & leached at steady state (kg/ha/year)	893.38
Average leaching fraction based on 10 year running averages (fraction)	0.53
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.06
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.18
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

Attachment D. MEDLI Report: 0% reuse, 60ML storage, 100ha irrigation area

MEDLI REPORT - FULL RUN

Enterprise: **MARPU - Lambells Lagoon Crocodile Farm**

Description:
Marpu Stage 2 irrigation and storage modelling

Client: **PRI Farming Pty Ltd**

MEDLI User: ECOZ\adele.faraone

Scenario Details:
Updated inflows = 30% rainfall infiltration

DESCRIPTION

Climate Data: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days

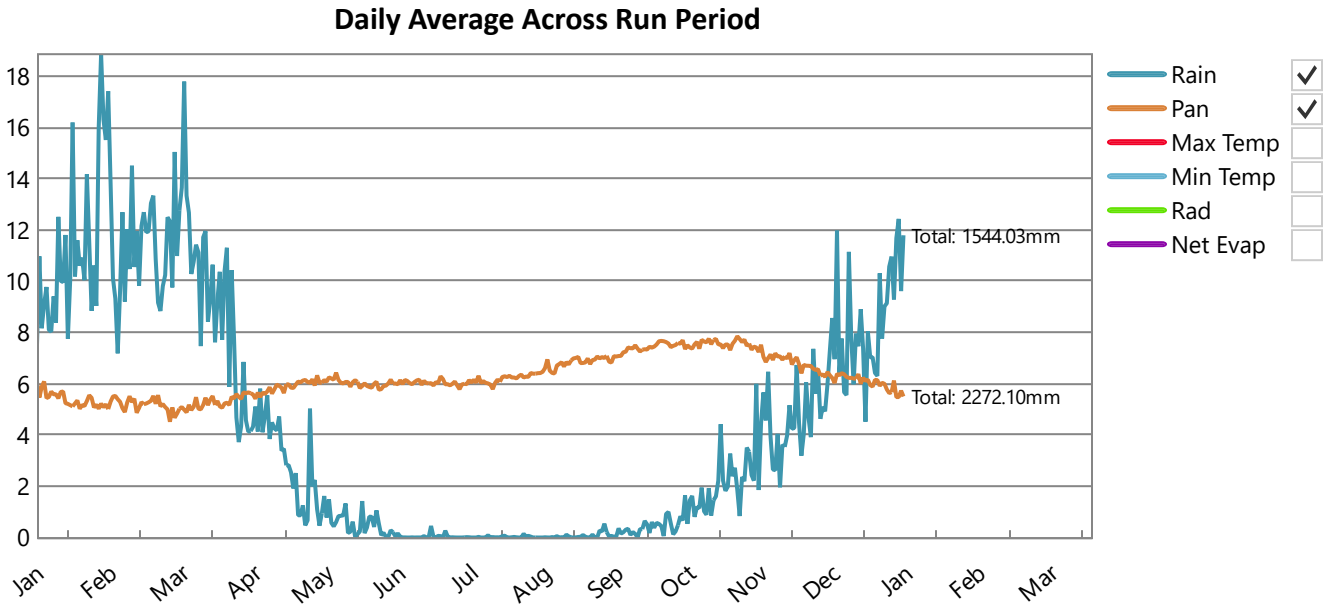
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	1108	1521	2163
Pan Evaporation (mm/year)	2100	2273	2448

Climate Data:

Chart Table

Monthly Daily

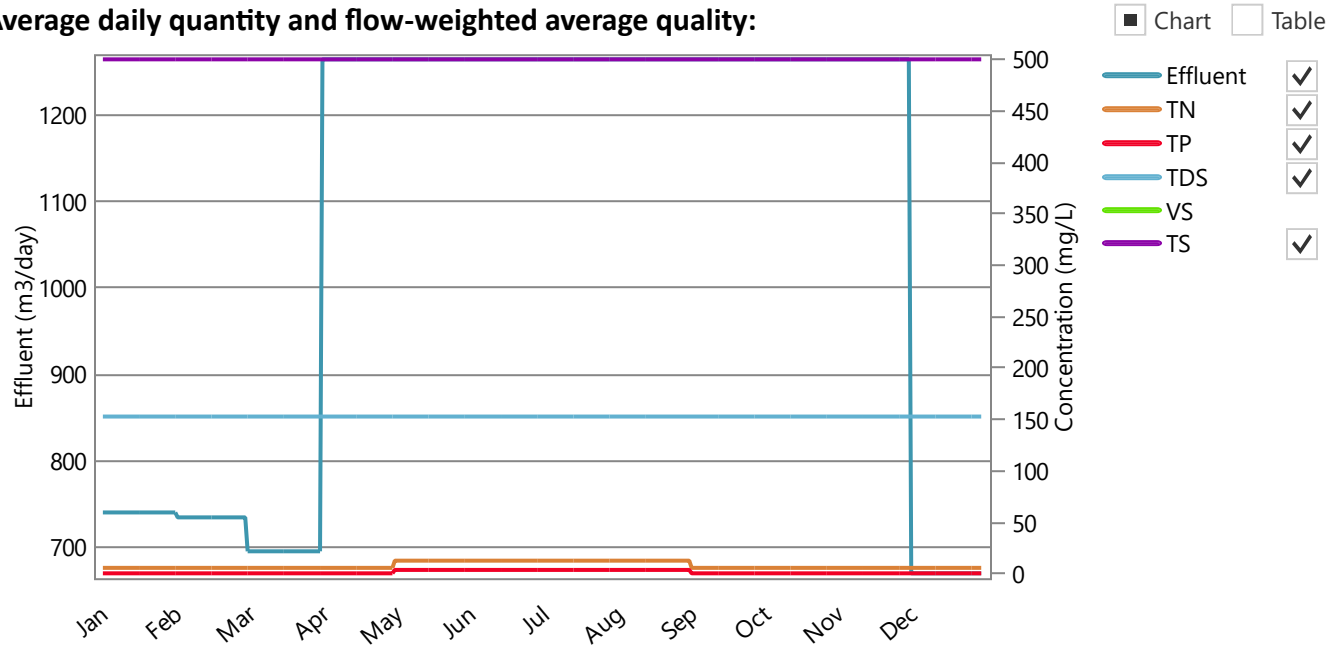


DESCRIPTION

Effluent type: New Generic System

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 394710.92 m3/year or 1080.68 m3/day (Min-Max: 669.70 - 1265.00)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

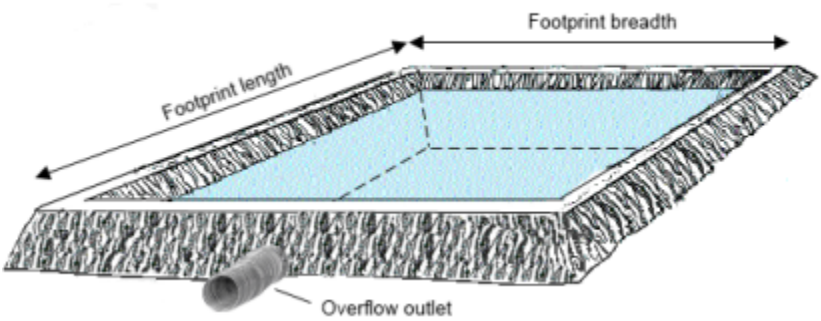
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	8.76 (6.00 - 13.00)	3457.43 (3456.46 - 3460.48)
Total Phosphorus	2.00 (0.70 - 4.00)	789.76 (789.65 - 790.12)
Total Dissolved Salts	153.00 (153.00 - 153.00)	60390.77 (60365.98 - 60468.45)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	500.00 (500.00 - 500.00)	197355.46 (197274.45 - 197609.30)

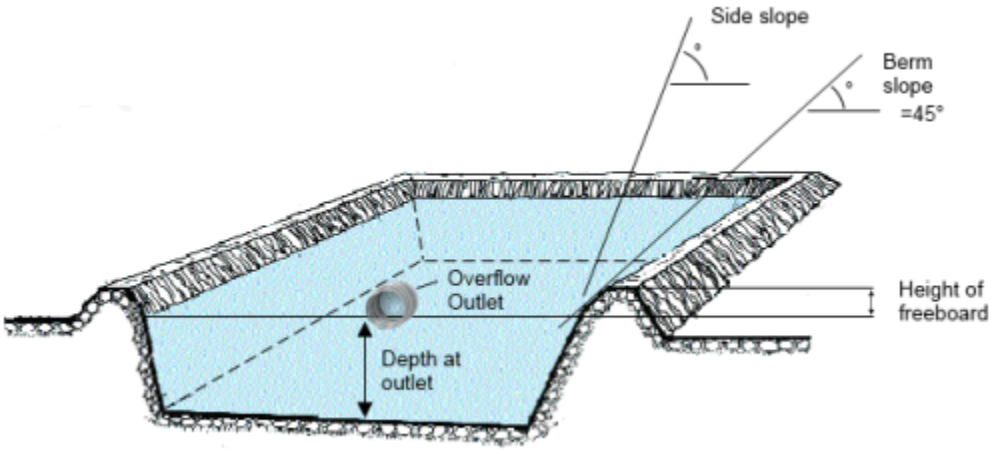
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (m3)	60000.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	3.00
Maximum water surface area (m2)	20908.21
Pond footprint length (m)	207.69
Pond footprint width (m)	105.45
Pond catchment area (m2)	21900.00
Average active volume (m3)	5545.57





Irrigation pump limits:

Minimum pump rate per area limit (ML/day/ha)	0.00
Maximum pump rate per area limit (ML/day/ha)	1.00

Shandying water:

Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

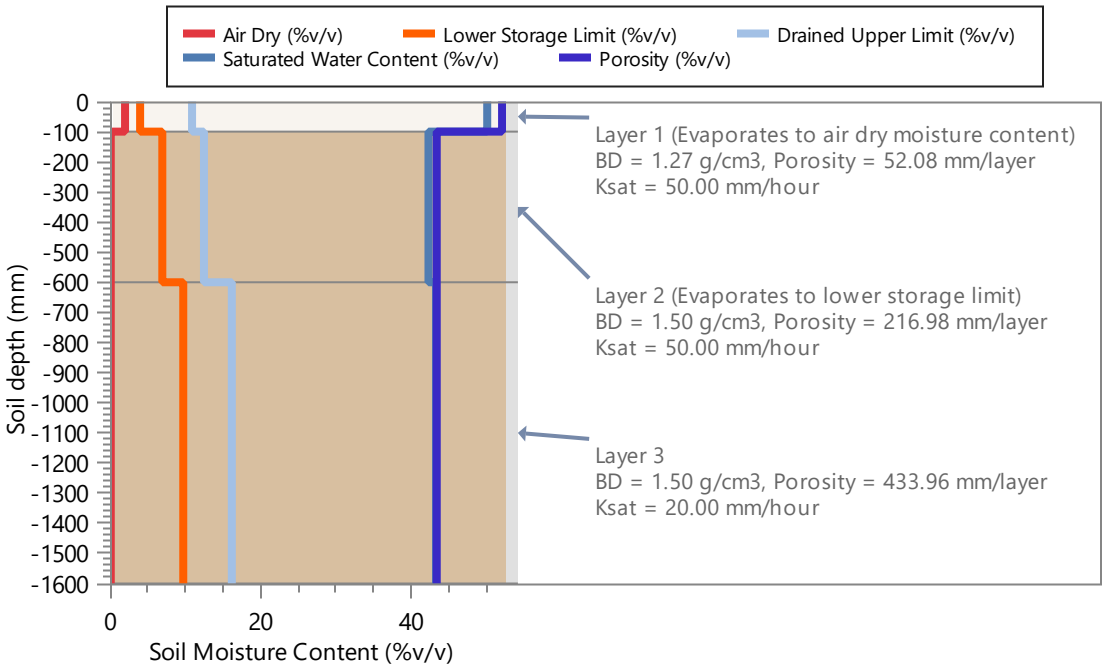
DESCRIPTION

Land: Stage 2 irrigation

Area (ha): 100.00

Soil Type: Lambells, 1600.00 mm defined profile depth

Profile Porosity (mm)	703.02
Profile saturation water content (mm)	694.60
Profile drained upper limit (or field capacity) (mm)	235.10
Profile lower storage limit (or permanent wilting point) (mm)	136.05
Profile available water capacity (mm)	99.05
Profile limiting saturated hydraulic conductivity (mm/hour)	20.00
Surface saturated hydraulic conductivity (mm/hour)	50.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Forage Sorghum Pasture

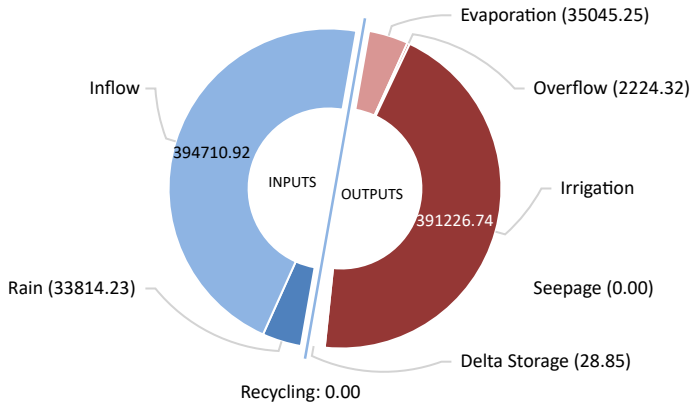
Average monthly cover (fraction) (minimum - maximum)	0.41 (0.00 - 0.78)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Maximum potential root depth in defined soil profile (mm)	1600.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **60000 m3**

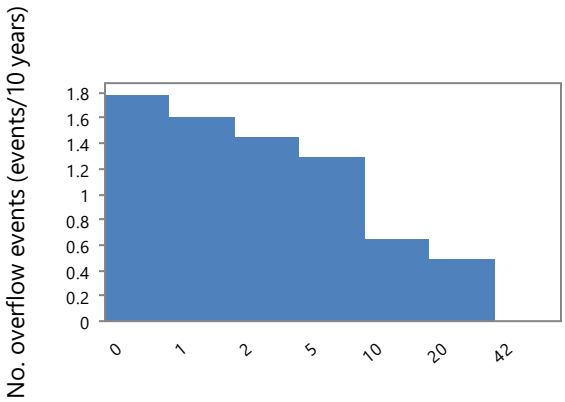
Pond System Water Balance (m3/year)



Name	Value
Rain	33814.23
Inflow	394710.92
Recycling	0.00
Evaporation	35045.25
Overflow	2224.32
Irrigation	391226.74
Seepage	0.00
Delta Storage	28.85

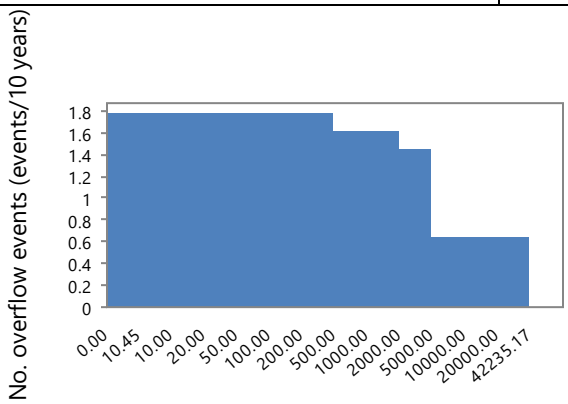
Overflow Diagnostics

Volume of overflow (m3/year)	2224.32
No. days pond overflows (days/year)	2.26
Average duration of overflow (days)	12.73
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.99
Probability of at least 90% reuse (fraction)	0.98



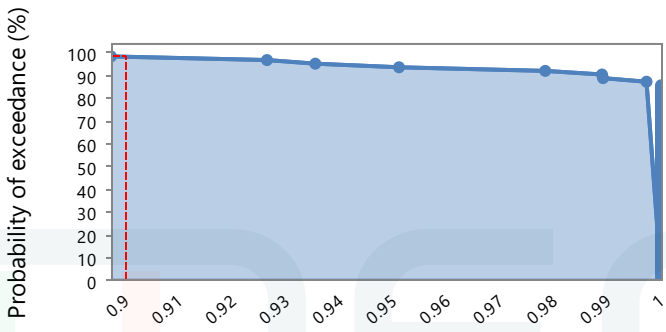
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

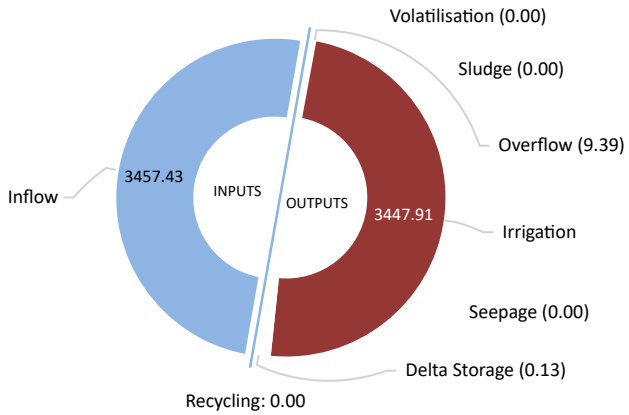
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

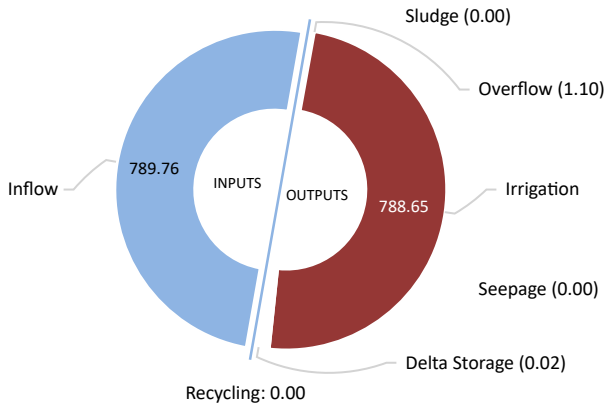
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



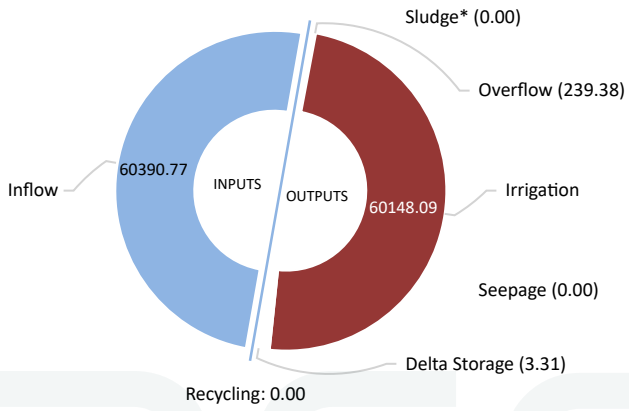
Name	Value
Inflow	3457.43
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	9.39
Irrigation	3447.91
Seepage	0.00
Delta Storage	0.13

Phosphorus Balance (kg/year)



Name	Value
Inflow	789.76
Recycling	0.00
Sludge	0.00
Overflow	1.10
Irrigation	788.65
Seepage	0.00
Delta Storage	0.02

Salt Balance (kg/year)



Name	Value
Inflow	60390.77
Recycling	0.00
Sludge*	0.00
Overflow	239.38
Irrigation	60148.09
Seepage	0.00
Delta Storage	3.31

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	4.51
Average phosphorus concentration of pond liquid (mg/L)	0.54
Average salinity of pond liquid (dS/m)	0.18

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	4.49
Final phosphorus concentration of pond liquid (mg/L)	0.52
Final salinity of pond liquid (dS/m)	0.18

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	391226.74
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	391226.74
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	8.81
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	8.58
Average phosphorus concentration of irrigation water (mg/L)	2.02
Average salinity of irrigation water (dS/m)	0.24

Irrigation Diagnostics:

Proportion of Days rain prevents irrigation (fraction)	0.13
Proportion of Days water demand too small to trigger irrigation (fraction)	0.14
Proportion of Days irrigation occurs (fraction)	0.73

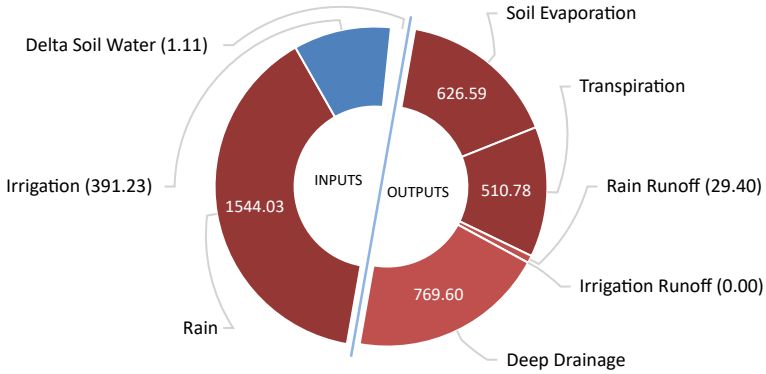
PERFORMANCE

Land Performance - Soil Water

Paddock: Stage 2 irrigation, 100 ha
Soil Type: Lambells, 99.05 mm PAWC at maximum root depth

Land Water Balance (mm/year):

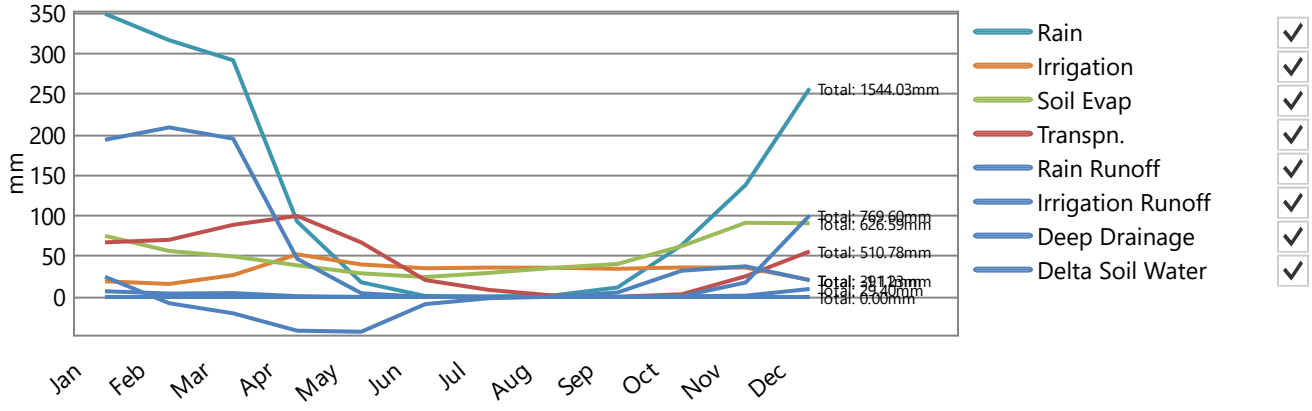
mm/year % Total inputs



Name	Value
Rain	1544.03
Irrigation	391.23
Soil Evaporation	626.59
Transpiration	510.78
Rain Runoff	29.40
Irrigation Runoff	0.00
Deep Drainage	769.60
Delta Soil Water	-1.11

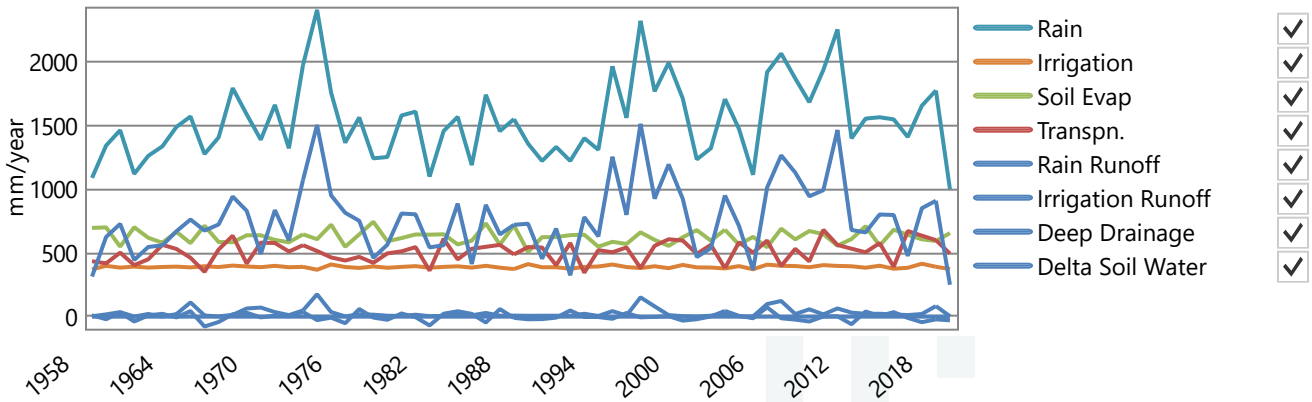
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



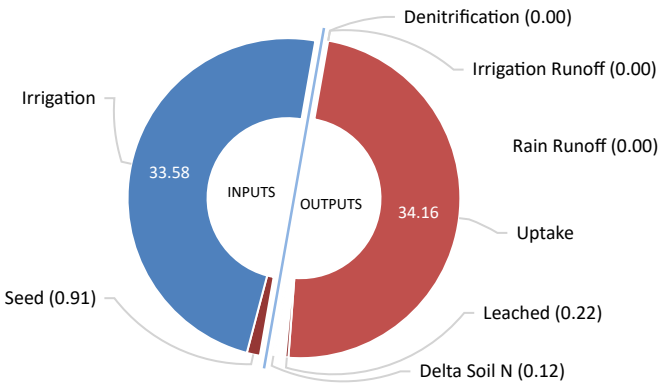
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

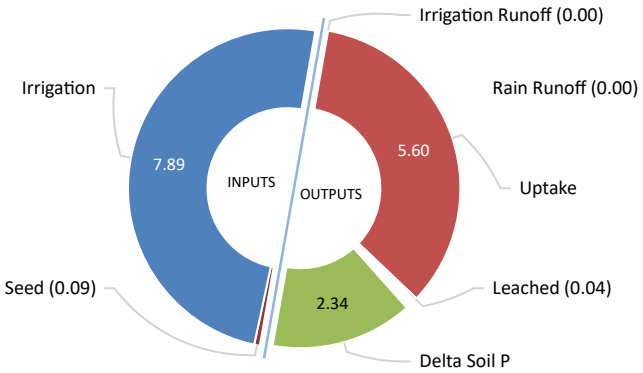
Irrigation ammonium volatilisation losses (kg/ha/year): 0.90
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.91
Irrigation	33.58
Denitrification	4.22E-03
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	34.16
Leached	0.22
Delta Soil N	0.12

Land Phosphorus Balance (kg/ha/year)



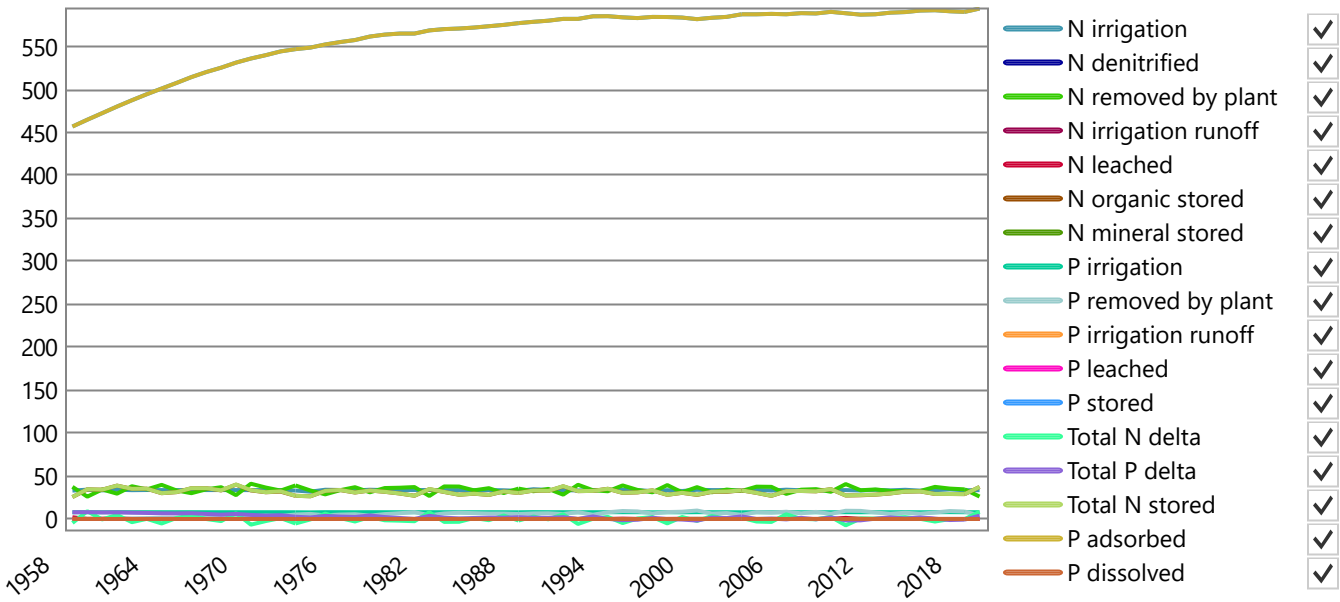
Name	Value
Seed	0.09
Irrigation	7.89
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	5.60
Leached	0.04
Delta Soil P	2.34

PERFORMANCE

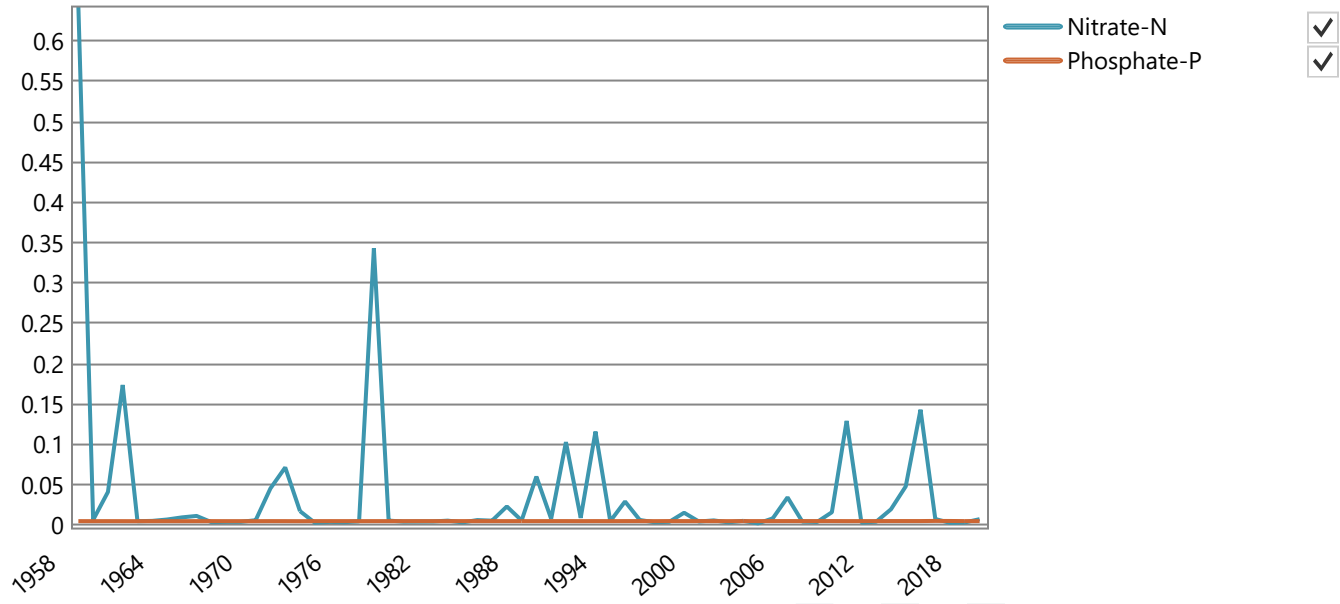
Land Performance - Soil Nutrient

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

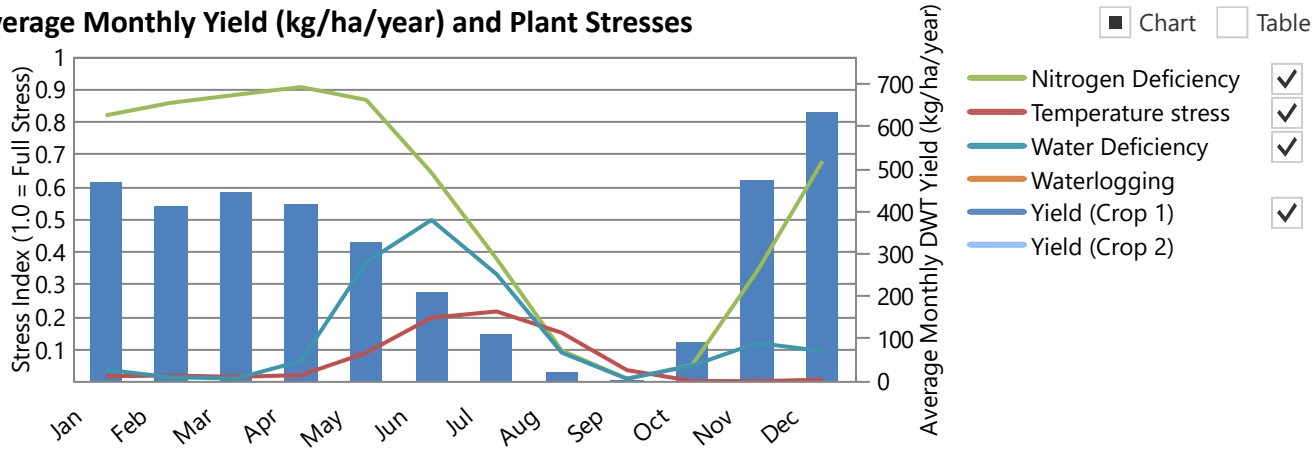
Plant: Continuous Forage Sorghum Pasture

Average annual shoot dry matter yield (kg/ha/year)	3658.96 (2603.38 - 4599.28)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.41 (0.00 - 0.78)
Average monthly root depth (mm) (minimum - maximum)	838.65 (17.66 - 1529.88)

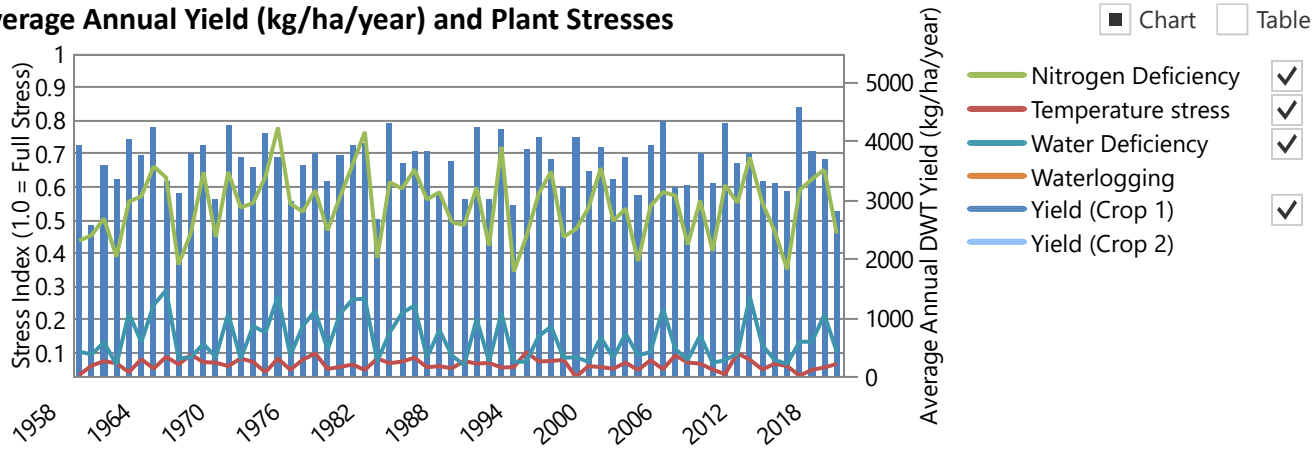
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	34.16 (25.98 - 41.08)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	5.60 (0.11 - 9.84)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.001 (0.000 - 0.002)

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 0.68 (normal), 1.00 (forced by crop death due to nitrogen stress (0.03), water stress (0.97))

No. days without crop/year (days/year): 118.02 due to water stress (118.02)

PERFORMANCE

Land Performance

Paddock: Stage 2 irrigation, 100 ha **Soil Type**: Lambells

Plant: Continuous Forage Sorghum Pasture

Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11
No. years assumed for leaching to reach steady-state (years)	10.00

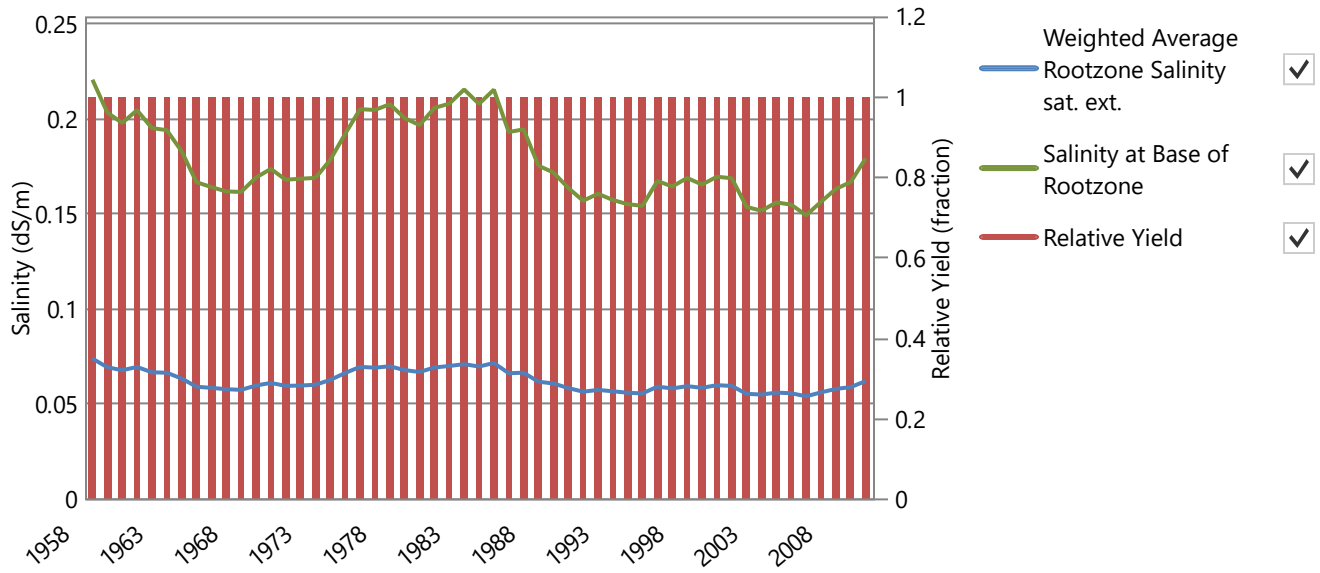
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.07
Salt added by rainfall (kg/ha/year)	290.81
Average annual effluent salt added & leached at steady state (kg/ha/year)	892.29
Average leaching fraction based on 10 year running averages (fraction)	0.53
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.06
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.18
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



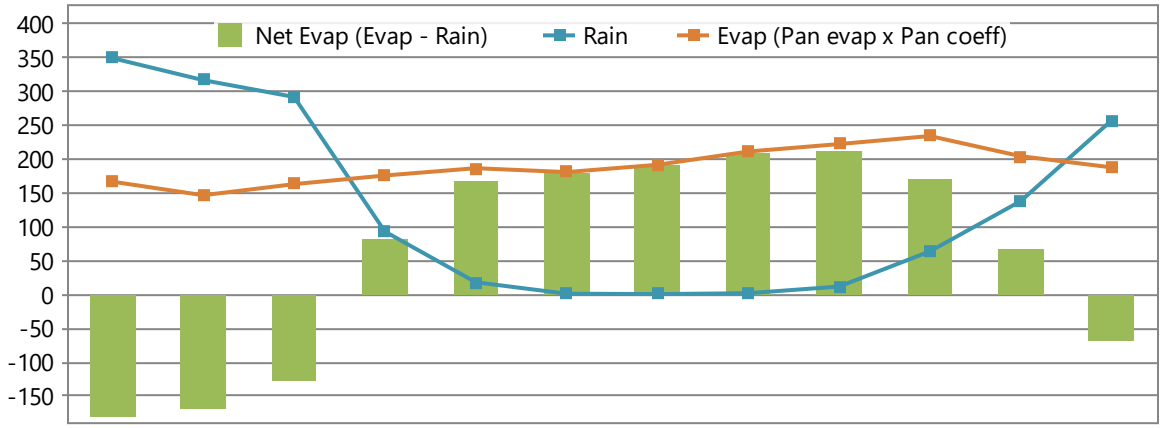
DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Averaged Historical Climate Data Used in Simulation (mm)

Location: Lambells Lagoon, -12.55°, 131.25°

Run Period: 01/01/1958 to 31/12/2019 62 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Evap	166.8	146.7	163.1	175.9	186.7	180.9	191.7	211.3	222.3	234.2	204.4	188.0	2272.1
Net Evap	-182.6	-170.1	-128.9	82.9	168.6	179.7	191.1	209.4	210.6	170.5	66.3	-69.4	728.1
Net Evap/day	-5.9	-6.0	-4.2	2.8	5.4	6.0	6.2	6.8	7.0	5.5	2.2	-2.2	2.0

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Pond System: 1 facultative, aerobic or storage pond

New Generic System - 394710.92 m3/year or 1080.68 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	8.76 (6.00 - 13.00)	3457.43 (3456.46 - 3460.48)
Total Phosphorus	2.00 (0.70 - 4.00)	789.76 (789.65 - 790.12)
Total Dissolved Salts	153.00 (153.00 - 153.00)	60390.77 (60365.98 - 60468.45)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	500.00 (500.00 - 500.00)	197355.46 (197274.45 - 197609.30)

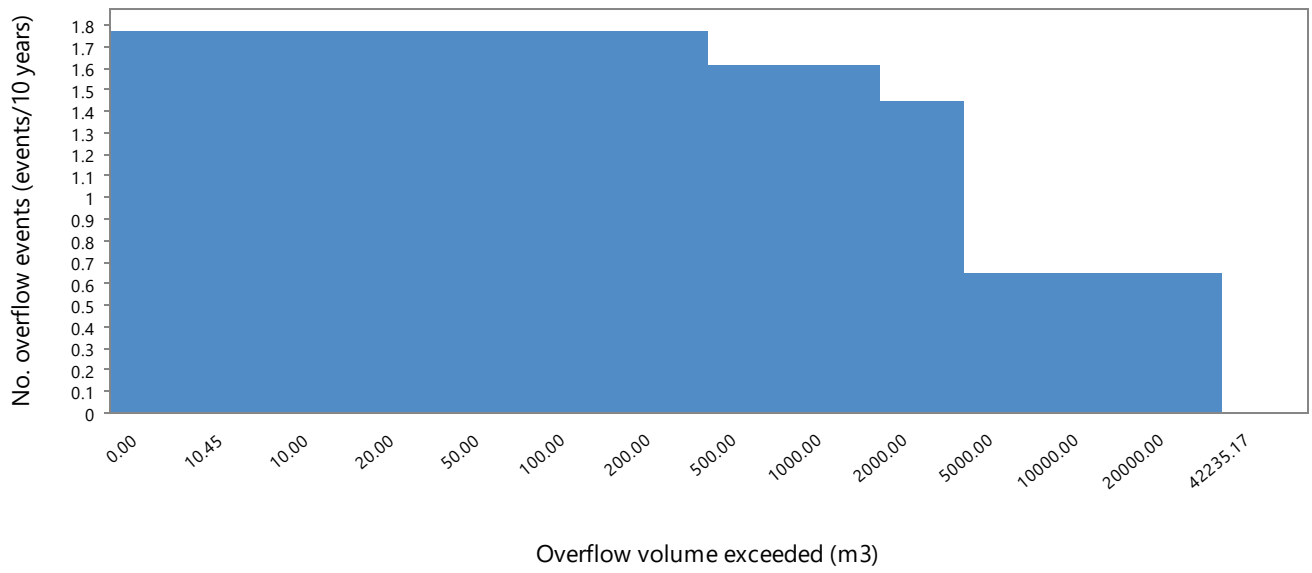
Last pond (Wet weather store): 60000.00 m3

Theoretical hydraulic retention time (days)	55.52
Average volume of overflow (m3/year)	2224.32
No. overflow events per year exceeding threshold* of 10.45 m3 (no./year)	0.18
Average duration of overflow (days)	12.73
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.99
Probability of at least 90% effluent reuse (fraction)	0.98
Average salinity of last pond (dS/m)	0.18
Salinity of last pond on final day of simulation (dS/m)	0.18
Ammonia loss from pond system water area (kg/m2/year)	0.00

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Irrigation Information

Irrigation: 100 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	391226.74	3912.27
Total nitrogen applied (kg)	3358.27	33.58
Total phosphorus applied (kg)	788.65	7.89
Total salts applied (kg)	60148.09	601.48

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.13
Proportion of Days water demand is too small to trigger irrigation (fraction)	0.14
Proportion of Days irrigation occurs (fraction)	0.73

DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Paddock Land: Stage 2 irrigation: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Irrigation triggered when soil water deficit reaches 5.00 mm and rainfall is less than or equal to 10.00 mm
Irrigate a fixed amount of 5.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Lambells, 99.05 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	349.3	316.8	292.0	93.0	18.1	1.2	0.6	1.9	11.8	63.8	138.2	257.3	1544.0
Irrigation	19.3	16.1	27.0	52.6	40.1	35.4	36.3	36.0	34.7	36.4	36.2	21.1	391.2
Soil Evap	75.4	56.7	50.0	39.1	29.2	24.6	29.7	35.9	40.7	62.7	91.5	91.0	626.6
Transpn.	67.4	70.5	89.0	100.0	67.3	20.8	8.7	1.8	0.3	3.3	25.5	56.2	510.8
Rain Runoff	7.1	4.2	4.8	1.0	0.0	0.0	0.0	0.0	0.0	0.8	1.6	9.8	29.4
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	193.9	209.2	195.3	47.1	4.6	0.0	0.0	0.0	0.0	1.0	17.8	100.7	769.6
Delta	24.9	-7.7	-20.2	-41.6	-42.9	-8.8	-1.5	0.2	5.5	32.3	37.9	20.7	-1.1

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	33.58
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	34.16
Average annual soil nitrogen removed by denitrification (kg/ha/year)	4.22E-03
Average annual soil nitrogen leached (kg/ha/year)	0.22
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.22
Soil organic-N kg/ha (Initial - Final)	6.41 - 37.25
	23.77 - 0.07
Average nitrate-N concentration of deep drainage (mg/L)	0.03
Max. annual nitrate-N concentration of deep drainage (mg/L)	0.64

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	7.89
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	5.60
Average annual soil phosphorus leached (kg/ha/year)	0.04
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.01
Adsorbed phosphorus (kg/ha) (Initial - Final)	449.15 - 594.34
Average phosphate-P concentration in rootzone (mg/L)	0.01
Average phosphate-P concentration of deep drainage (mg/L)	4.77E-03
Max. annual phosphate-P concentration of deep drainage (mg/L)	5.00E-03
Design soil profile storage life based on average infiltrated water phosphorus concn. of 0.41 mg/L (years)	264.88

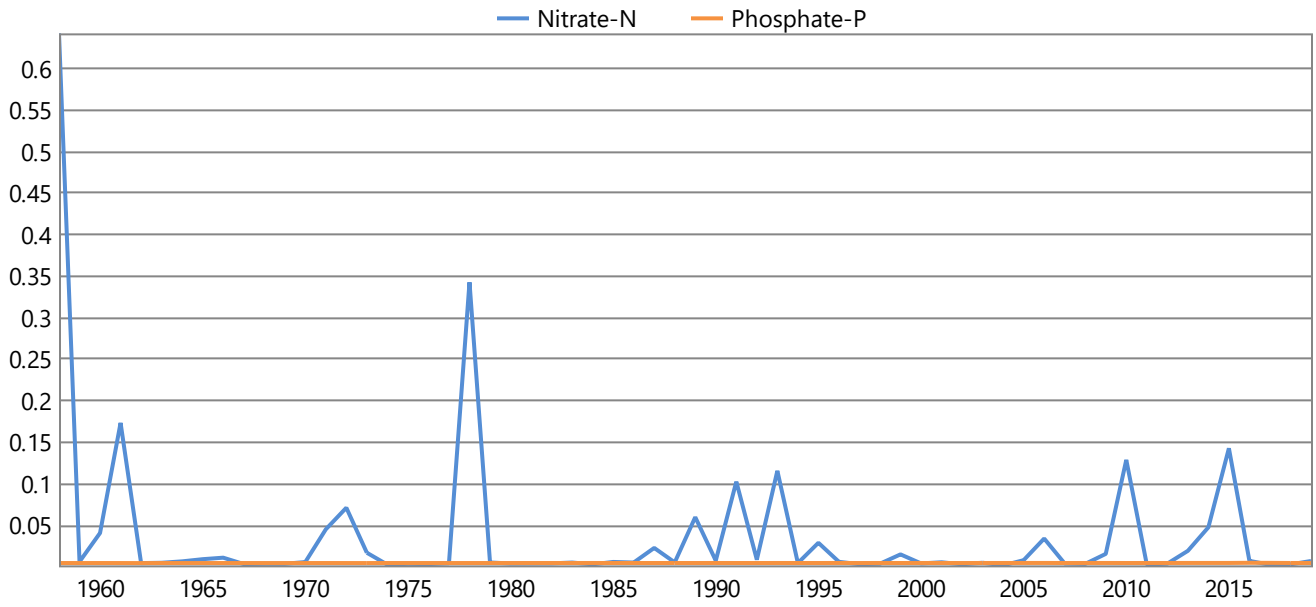
DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

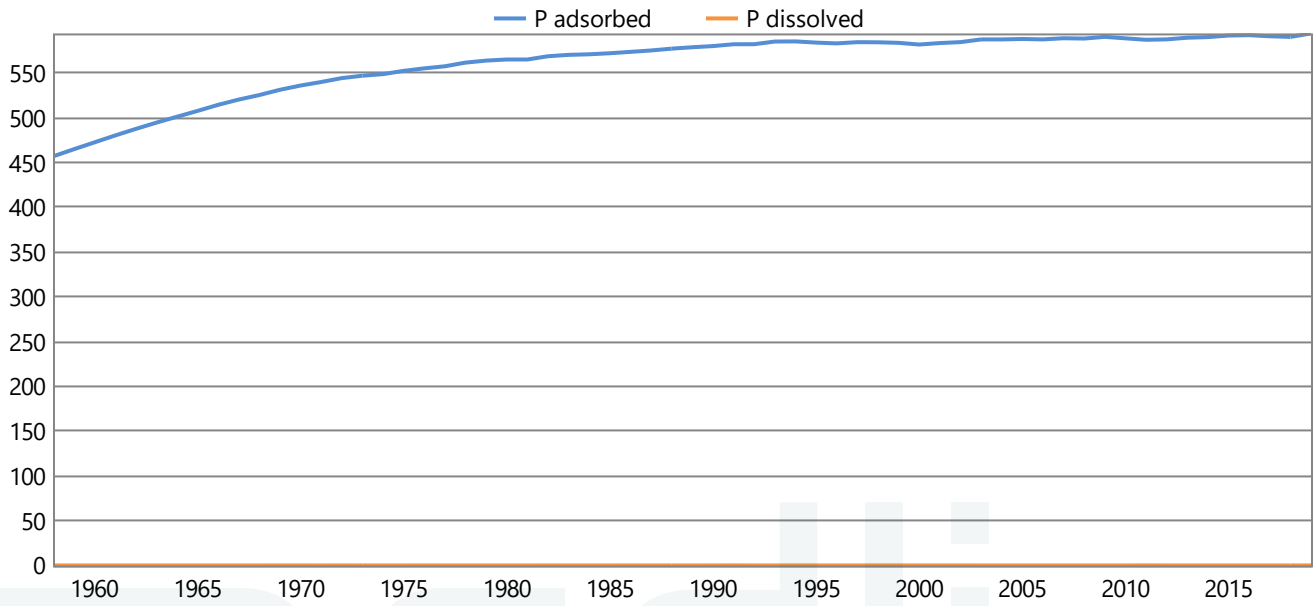
Paddock Land: Stage 2 irrigation: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: MARPU - Lambells Lagoon Crocodile Farm

Paddock Plant Performance: Stage 2 irrigation: 100 ha

Average Plant Performance (Minimum - Maximum): Continuous Forage Sorghum Pasture

Average annual shoot dry matter yield (kg/ha/year)	3658.96 (2603.38 - 4599.28)
Average monthly plant (green) cover (fraction)	0.41 (0.00 - 0.78)
Average monthly crop factor (fraction)	0.33 (0.00 - 0.62)
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Average monthly root depth (mm)	838.65 (17.66 - 1529.88)
Average number of normal harvests per year (no./year)	0.68 (0.00 - 1.00)
Average number of normal harvests for last five years only (no./year)	0.60
Average number of crop deaths per year (no./year)	1.00 (1.00 - 1.00)
Average number of crop deaths for last five years only (no./year)	1.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.54 (0.35 - 0.78)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.22 (0.07 - 0.37)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.14 (0.01 - 0.50)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	118.02

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.07
Salt added by rainfall (kg/ha/year)	290.81
Average annual effluent salt added & leached at steady state (kg/ha/year)	892.29
Average leaching fraction based on 10 year running averages (fraction)	0.53
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.06
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.18
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

APPENDIX D IRRIGATION PROCEDURES

Irrigation Procedures
Lambells Lagoon Crocodile Farm
PRI Farming Pty Ltd



DOCUMENT CONTROL RECORD

Job	EZ19095
Document ID	194932-2
Author(s)	Britanny Crescentino

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	Emma Lewis	Emma Lewis	PRI Farming	11/11/20

Recipients are responsible for eliminating all superseded documents in their possession.

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4.2 Procedure 6

Appendices

APPENDIX A VISUAL INSPECTION CHECKLIST

APPENDIX B IRRIGATION RECORDING SHEET

1 INTRODUCTION

This document lists procedures to be followed by PRI Farming management, staff and contractors to ensure that the reuse of wastewater via terrestrial irrigation is managed appropriately at the Lambells Lagoon Crocodile Farm (LLCF). This document has been developed in association with the Environmental Protection Licence (EPL) application and the Irrigation Management Plan (IMP). The EPL application for this project has been submitted to the Northern Territory Environmental Protection Authority (NT EPA), therefore the monitoring and trigger values for the irrigation activities will be conducted in accordance with the EPL application. These procedures will be updated once the EPL is issued, to the EPL conditions.

LLCF recognise the importance of finding a solution to wastewater management and preventing uncontrolled discharge of untreated wastewater offsite with the potential to impact the receiving environment. Sustainable wastewater management involves the selection of suitable irrigation infrastructure to the water and nutrient requirements of the crops, while also ensuring oversaturation does not occur, resulting in uncontrolled run off, damaging of the soil and unsustainable crops.

The list of procedures includes:

- Area of irrigation
- Timing of irrigation
- Application of irrigation
- Irrigation recording sheet

2 SELECTION OF AREA TO BE IRRIGATED PROCEDURE

2.1 Aim

The aim of this procedure is to ensure that suitable irrigation areas are selected for wastewater release, considering the factors important in minimising impact on surrounding neighbours and sensitive receptors in the environment. This is to be conducted daily and the Farm Manager is the responsible person. The important factors to consider are:

- Wind speed and direction
- Recent rainfall
- Soil saturation

2.2 Procedure

1) Check the daily weather forecast for wind speed and direction and potential rainfall in months December to March (when rain is more prevalent). Avoid irrigation activities being conducted when prevailing wind direction will carry any odours or off-spray towards surrounding neighbours and sensitive receptors.
2) Ensure daily visual inspections of potential irrigation areas are conducted as per daily visual inspection checklist (refer to Appendix A). Ensure area can adequately absorb the volume being applied as per irrigation rate. This can be achieved through digging a small hole and checking the soil moisture content or through soil moisture monitoring equipment such as a tensiometer.
3) Select appropriate location for irrigation activities.

3 TIMING OF IRRIGATION PROCEDURE

3.1 Aim

The aim of this procedure is to ensure irrigation activities occur at an appropriate time and does not directly result in run-off and impacting on surrounding neighbours and sensitive receptors in the environment. The Farm Manager is the responsible person for this procedure.

3.2 Procedure

This procedure is to be implemented in conjunction with the selection of area to be irrigated procedure.

1) Check the daily weather forecast for potential rainfall. Irrigation activities are not to be conducted two hours prior to when heavy rainfall (>50mm) is forecasted, or at the time of rain events or high winds. Used as a preventative measure for surface water run-off.
2) When heavy rain (>50mm) has been received within the previous 24 hours, a daily visual inspection and moisture test (tensiometer) is to be conducted to ensure the irrigation area is not saturated prior to the commencement of irrigation activities. If saturated, delay irrigation until sufficiently dried out, or apply the minimum irrigation flow rate of 1mm/day.
3) If after rainfall, a daily visual inspection is conducted, and determines the irrigation area is unsaturated (without conducting a moisture test) the irrigation activities can commence as normal as per the application of irrigation procedure.

4 APPLICATION OF IRRIGATION

4.1 Aim

The aim of this procedure is to ensure that the application of the wastewater through irrigation activities is a controlled task, and does not cause any run-off or impacts to surrounding neighbours and sensitive receptors in the environment. The Farm Manager is the responsible person for this procedure. This procedure is to be applied after the use of the Selection of Area to be Irrigated Procedure and Timing of Irrigation Procedure.

4.2 Procedure

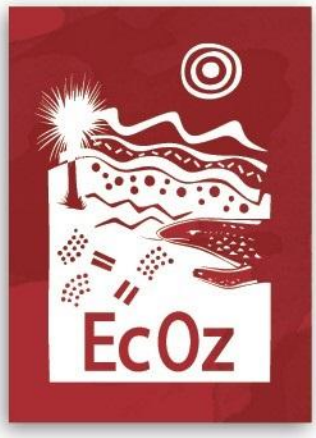
1) Conduct visual inspection and complete checklist (refer to Appendix A).
2) Record each irrigation event into irrigation recording sheet (refer to Appendix B).
3) Monitor the irrigation area during the irrigation application (every 1-2 hours), to ensure that surface ponding and runoff of wastewater does not occur.
4) If excess surface water ponding or run-off is identified, irrigation application is to cease immediately.
5) Control the surface ponding and run-off if there is potential for an uncontrolled release offsite, by installing diversion bunds where required and allowing the excess moisture to infiltrate or evaporate on-site.
6) Determine the likely cause of the surface water ponding or run-off (i.e. soil is too saturated or the correct irrigation application rate has not been set).
7) Review the irrigation application rate settings to determine if the correct irrigation rate was set. If the incorrect irrigation rate was set, adjust accordingly.
8) Using the Selection of Area to be Irrigated Procedure and Timing of Irrigation Procedure to identify if soil saturation is the likely cause.
9) Recommence irrigation application – and complete an irrigation recording sheet record (refer to Appendix B).

APPENDIX A VISUAL INSPECTION CHECKLIST

	Day: Date:	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	Comments
#	Visual inspection Items	Y/ N	Y/ N	Y/ N	Y/ N	Y/ N	Y/ N	Y/ N	
1.	Are there any areas too saturated for irrigation application?								
2.	Is there any water pondng? (if yes, cease application until soil moisture conditions are suitable)								
3.	Is there any odour present during irrigation application? (If yes, cease application and conduct wastewater sampling).								
4.	Is there any overspray/mist? (if yes, cease application and review weather forecast)								
5.	Is there any surface water run-off present? (if yes, cease application and review soil moisture content).								

APPENDIX B IRRIGATION RECORDING SHEET

Date	Approx. Area Irrigated (m^2)	Pumping time (mins)	Volume pumped (kL)	Application rate (mm)	Check for saturation, run-off or surface ponding	Weather observations (i.e. rainfall, wind direction/speed, sunny, cloudy etc).	Checked by:



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