Graphinex – Esmeralda Graphite Project Environmental Impact Statement

Appendix M – Land-based Effluent Disposal Assessment

GRAPHINEX

MEDLI ASSESSMENT

ESMERALDA GRAPHITE PROJECT



PREPARED FOR
GRAPHINEX

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Executive Summary

The Esmeralda Graphite Project proposes the development of an open-cut graphite mine with an associated accommodation village and sewage treatment plant (STP) to service a fly-in/fly-out workforce. Treated domestic wastewater generated by the accommodation village is proposed to be managed via land application through irrigation, which constitutes an Environmentally Relevant Activity (ERA 63) under the *Queensland Environmental Protection Regulation 2019*. Accordingly, an environmental assessment of effluent disposal sustainability has been undertaken using the Queensland Government's Model for Effluent Disposal using Land Irrigation (MEDLI).

This assessment evaluates the suitability of the proposed irrigation area, irrigation scheduling, wet-weather storage capacity, and potential environmental risks associated with nutrients, salinity, pathogens, and groundwater. MEDLI modelling was undertaken using site-specific soil data, long-term climate data, conservative effluent quality assumptions consistent with ERA 63 eligibility criteria, and vegetation parameters representing a low-maintenance, non-harvested land application area. Irrigation area sizes of 3 hectares (ha) and 4 ha were assessed, along with alternative irrigation scheduling approaches and a sensitivity analysis using a high-uptake pasture species.

Results demonstrate that both the 3 ha and 4 ha irrigation configurations achieve near-complete effluent reuse, stable soil water balance, and effective wet-weather storage operation. Increasing the irrigation area from 3 ha to 4 ha reduces per-hectare hydraulic and nutrient loading; however, this does not result in a material reduction in total deep drainage volumes, nutrient leaching risk, or overall environmental performance. Model outputs indicate that drainage processes are primarily governed by climate and inherent soil properties, with wet-season rainfall driving the majority of downward water flux independently of irrigation area or scheduling.

Nitrogen and phosphorus behaviour was assessed using both the operational vegetation scenario and a Rhodes grass pasture sensitivity analysis. Model outputs indicate that nutrient uptake is highly efficient and that less than 0.1% of applied nitrogen and less than 0.01% of applied phosphorus are lost via leaching. Flow-weighted nitrate-N concentrations in deep drainage are extremely low and converge to similar steady-state values under both irrigation area options. Salt modelling similarly demonstrates stable long-term conditions, with no accumulation in the root zone and salinity levels remaining well below agronomic and environmental thresholds.

Groundwater context further reduces environmental risk, with a substantial unsaturated zone beneath the irrigation area and regional groundwater flow directed toward the mine pit, which will operate as a long-term hydraulic sink due to active dewatering. Consequently, the likelihood of offsite groundwater impacts from effluent irrigation is considered very low.

Overall, the MEDLI assessment demonstrates that a 3 ha irrigation area, operated using a simple fixed daily design irrigation rate and supported by a 60-day wet-weather storage capacity, provides robust and environmentally sustainable effluent disposal performance. The 4 ha option does not materially improve compliance, risk reduction, or operational resilience and would increase land disturbance and management requirements without delivering a proportional environmental benefit. On this basis, the 3 ha irrigation area is considered the most appropriate and proportionate design for the Project.

1 Introduction

The Esmeralda Project is a proposed open cut graphite mine, located on light grazing land approximately 70 km south of Croydon, Queensland, Australia (Figure 1). The Project proposes mining of the Esmeralda Granite unit and on-site concentration of graphite ore. The Project will mine up to 3.5 million tonnes per annum (Mtpa) of Run-of-Mine (ROM) ore over a mine life of approximately 65 years, including 2 years construction, 53 years operation, and 10 years of rehabilitation. Due to the remote nature of the proposed mine site, a fly-in/ fly-out style workforce is required to construct and operate the mine. To facilitate this workforce an accommodation camp and associated sewage treatment plant are proposed. This camp would have capacity for approximately 192 workers during construction and operation.

During operation, domestic wastewater will be generated from the on-site workers village and associated facilities (Figure 2). The wastewater will include that which is generated from the use of toilets (often classed as black water) as well as wastewater produced from showers, kitchen facilities and laundry (often classed as grey water). The wastewater from these sources will need to be treated and disposed of in a manner which is economical, practical and environmentally sustainable. In this case, the most feasible method will involve a basic level of treatment followed by land-based disposal. It is important to distinguish this domestic wastewater does not include Mine Water or Sediment Water which will be stored and handled in a separate manner.

Operating a sewage treatment plant, and disposing of effluent through irrigation, for a plant with a peak design capacity of more than 21 Equivalent Persons (EP), is considered as an Environmentally Relevant Activity (ERA 63) under Schedule 2 the Queensland *Environmental Protection Regulation 2019*. As such the activity requires an environmental assessment. This is supported by undertaking modelling using the Model for Effluent Disposal using Land Irrigation (MEDLI).

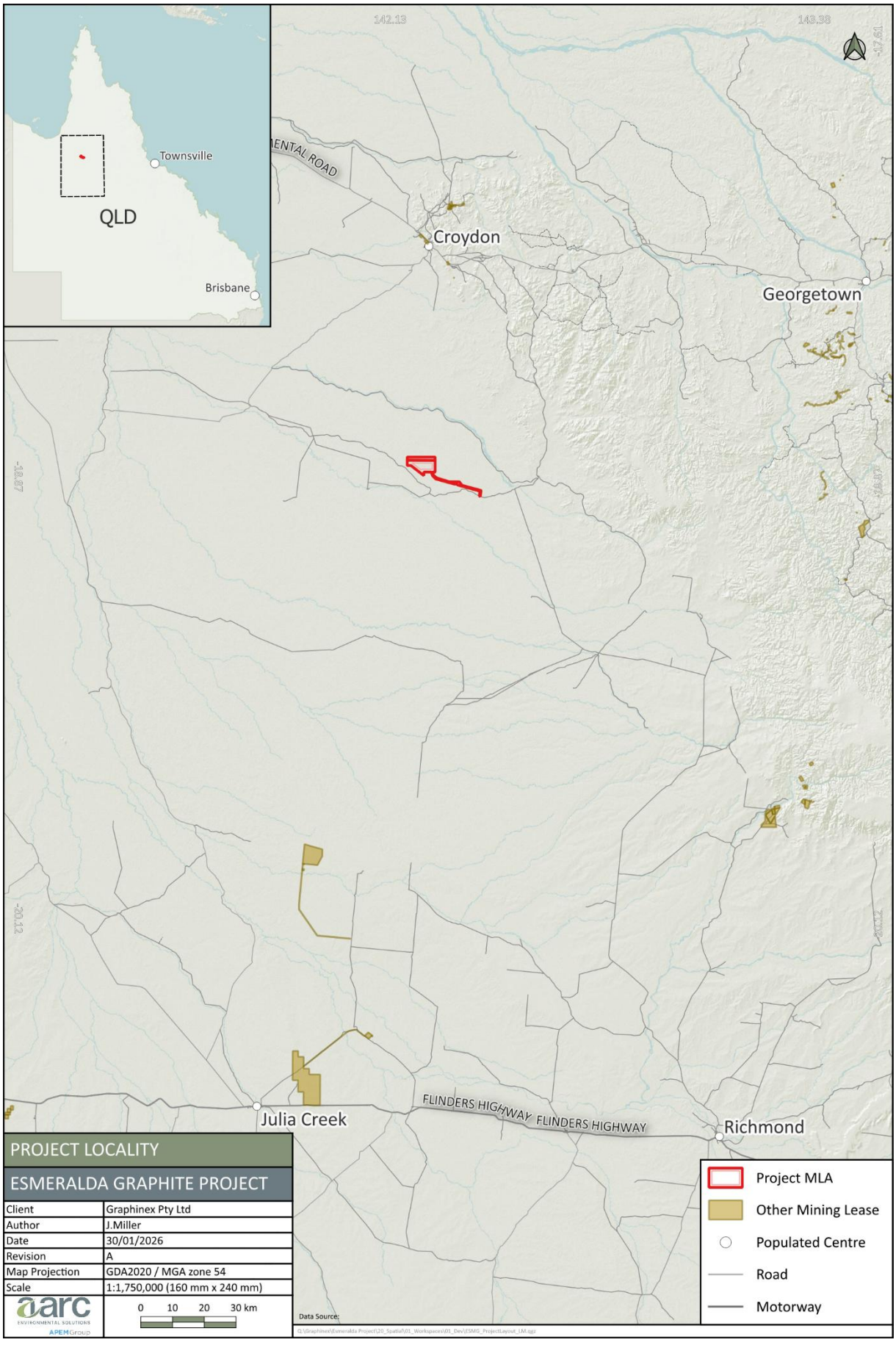


Figure 1: Project location

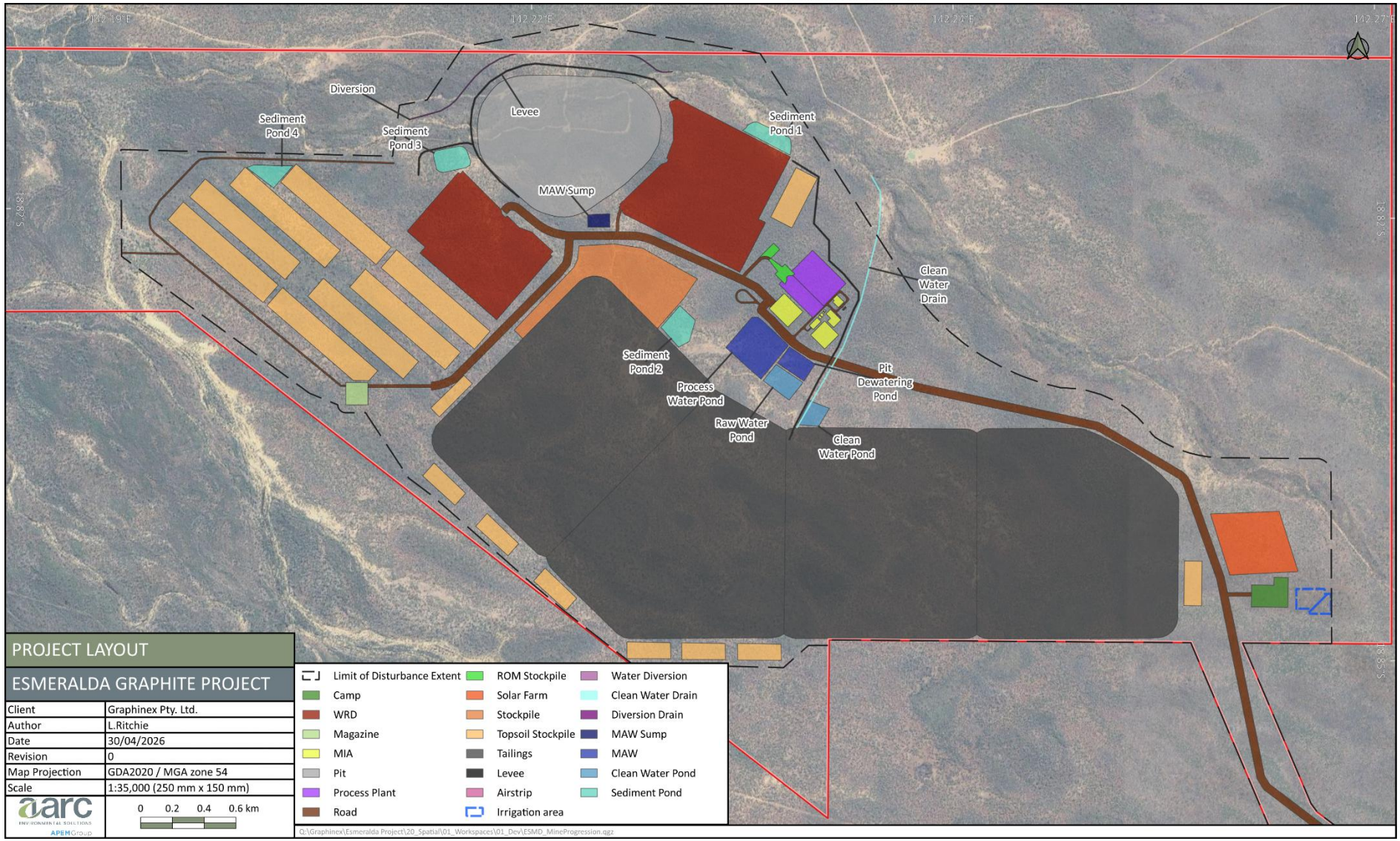


Figure 2: Project infrastructure layout

1.1 Site Description

The Project area is located immediately north of Warrigal Creek and the Borer River within the Norman River Drainage Basin of the Gulf Drainage Division. The site is traversed by unnamed tributaries of Warrigal Creek that drain from south-east to north-west. Regional topography is very flat, contributing to widespread flooding and hydraulic interaction between the main waterways during significant wet-season events. Within the Project area, the landform is flat to gently undulating, with elevations ranging between 120 m and 140 m AHD.

The Project is situated on an existing pastoral property within the Gulf Savannah Natural Resource Management region and is zoned 'Rural' under the *Croydon Shire Planning Scheme 2019*. Existing land use is low-intensity cattle grazing of native vegetation, and paperbark open woodland was recorded at the soil investigation site. The mapped soil class is a Brown Tenosol formed on Claraville geology. Surface conditions comprise a hard-setting soil with no coarse fragments, no rock outcrops and no evidence of erosion. Access to the site is via Esmeralda Prospect Road, which forms the southern boundary of the mining lease areas.

The Warrigal Creek catchment flows into the Borer River, then the Clara River, and ultimately the Norman River before discharging to the Gulf of Carpentaria. Flow within this system is largely restricted to the wet season (December to March). Several seasonal wetlands occur around the study area, with two ephemeral wetlands mapped within the Project boundary. There are no protected areas or areas zoned for future residential development intersecting or adjacent to the Project area. The land is mapped as Agricultural Land Class C2 (pasture land: native pastures), and no Important Agricultural Areas occur within 80 km of the site.

There is one unnamed waterway within the Project's ML boundary (Figure 3). The stream order 3 waterway tracks north westerly through the central line of the ML. The waterway is defined as a watercourse under the Water Act 2000 and has a total catchment area of 115 km2. The waterway is ephemeral with flow occurring immediately following rainfall events.

Groundwater investigations undertaken for the Project indicate that groundwater beneath the site occurs at a consistent depth and is hosted within the Gilbert River Formation. Monitoring bore data and groundwater modelling show that:

- The depth to groundwater across the Project area is generally between 8 and 10 metres below ground level (mbGL); and
- The shallow Tertiary sediments are consistently dry and unsaturated, with no persistent shallow groundwater table present.

As a result, a substantial unsaturated zone exists beneath the irrigation area, providing vertical separation between irrigated soils and the regional groundwater table. The groundwater table does not intersect the ground surface within the irrigation area or adjacent drainage features, and does not contribute baseflow to local creeks or waterways.

Groundwater flow direction has been defined based on assessed groundwater elevations, monitoring bore hydrographs, and groundwater contour mapping. These data indicate that:

- Regional groundwater elevations decline from approximately 120–125 mAHD in the east–southeast to approximately 100–105 mAHD in the west–northwest; and
- Groundwater flow is consistently directed from east-southeast toward west-northwest, broadly following surface topography and regional drainage patterns toward the Gulf of Carpentaria.

This flow direction is stable across seasonal conditions and is reflected in both observed groundwater levels and the calibrated numerical groundwater model.

The effluent irrigation area is located within the broader Project footprint and overlies the same regional hydrogeological setting assessed for the mine. The mine pit is located down-gradient of the irrigation area, in the direction of the regional groundwater flow path.

2 Methodology

2.1 Site Suitability Assessment/ Soil Quality Data

Soil sampling was undertaken in December 2025, by GT Environmental as part of the Soil and Land Suitability technical study. This sampling program included a range of sampling locations and a detailed site assessment at D10 in the soil type of the proposed irrigation area (Figure 3). Samples were analysed at Eurofins APAL Pty Ltd and Environmental Analysis Laboratory (EAL) who are accredited by the National Association of Testing Authority (NATA) and certified by the Australasian Soil and Plant Analysis Council (ASPAC).

GT Environmental also undertook a site suitability assessment collecting the following information:

- Slope (flat, steep slope, slightly undulating, sloped towards drainage lines etc.);
- Vegetation type and condition (native woodlands, grasses, pasture or planted grasses, pasture or crops, full coverage or brown and bare spots etc.);
- Surrounding Environmental Features and Land Use (closest waterways or drainage paths, potential GDE's etc.); and
- Soil conditions (dry cracked earth, spongy earth etc.).

These data were used to inform the suitability of the site for wastewater disposal and were necessary variables for consideration when applying the modelling scenarios.

The site and soil description for D10 provided by GT Environmental as well as the laboratory results for the soil analysis are provided in Appendix A. This data formed the basis of this assessment.

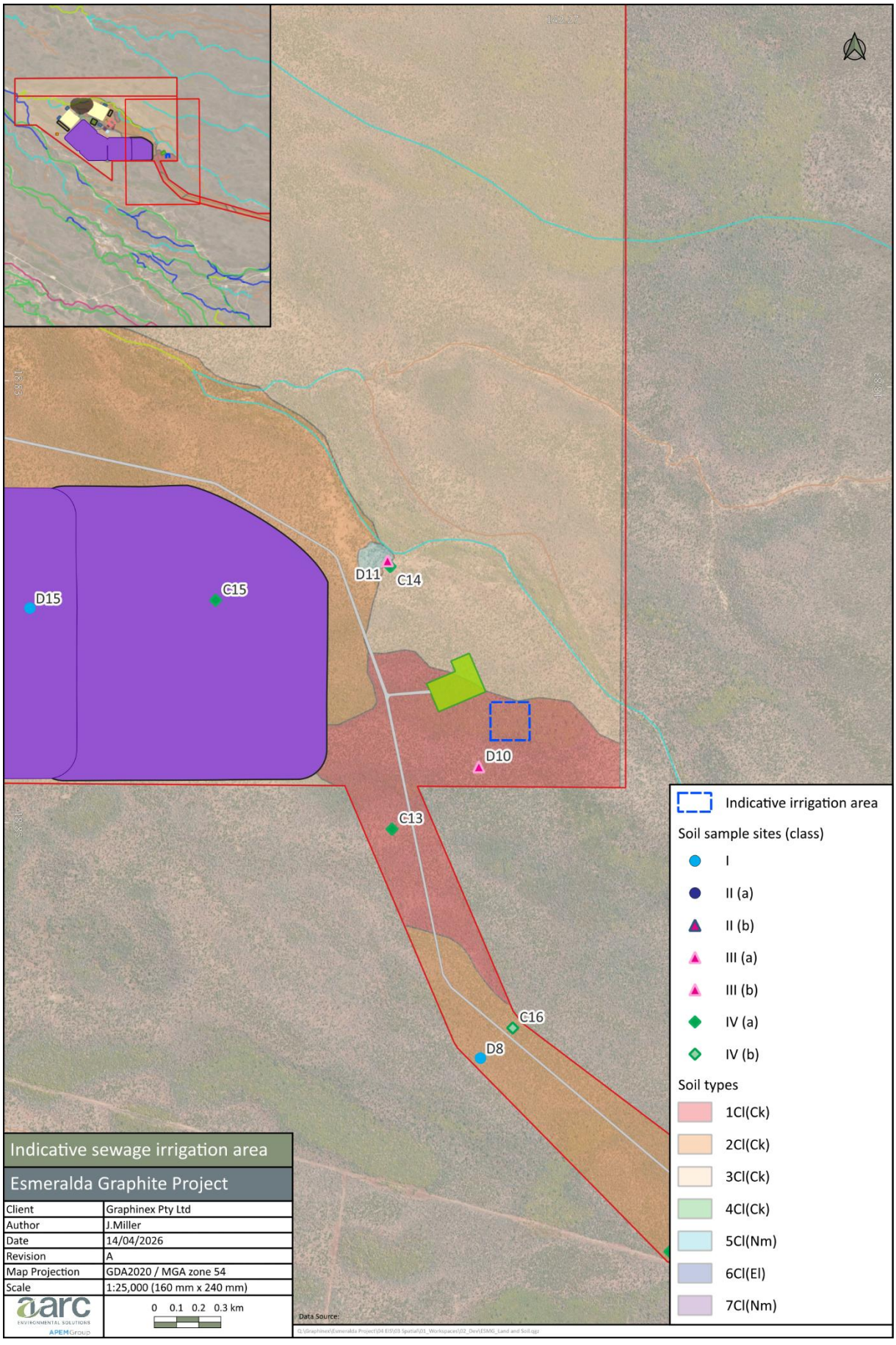


Figure 3: Indicative sewage irrigation area

2.2 Wastewater Data

The MEDLI model required the following wastewater data inputs to effectively assess the sustainability of the model, appropriate irrigation area size, and appropriate wet weather storage sizes.

- Wastewater Volume kL/day;
- Total Nitrogen mg/L;
- Total Phosphorus mg/L; and
- Electrical Conductivity dS/m.

The water quality data for the treated wastewater are based on the long-term limits established in the Eligibility Criteria and Standard Conditions for Sewage Treatment Works (ERA 63) – Version 2. These limits also align with the quality which would be expected from a basic sewage treatment plant as per Table A3.2 of the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1).

The wastewater volumes were estimated based on a maximum daily workforce capacity provided by Graphinex.

2.3 MEDLI Modelling

MEDLI is a computer model for design and analysis of effluent disposal schemes for a wide range of rural and industrial sites. It was developed jointly by the CRC for Waste Management and Pollution Control, the Queensland Department of Natural Resources and the Queensland Department of Primary Industries. It is now managed by the Department of Environment, Tourism, Science, and Innovation (DETSI).

MEDLI Version 2 was used to assess the long-term sustainability of the proposed treated wastewater irrigation scheme for the Project. The model was applied as a decision-support tool to evaluate whether the proposed land application system can reliably manage effluent volumes while protecting soil, surface water, and groundwater values under the full range of expected climatic conditions.

MEDLI simulates daily water and nutrient balances within the soil–plant system, accounting for rainfall, irrigation, evapotranspiration, runoff, soil storage, and drainage below the root zone. The model also tracks the fate of nitrogen, phosphorus, and soluble salts, enabling assessment of potential accumulation within the soil profile and losses via deep drainage.

For this assessment, MEDLI was used to:

- Confirm the suitability of the site for effluent irrigation;
- Test alternative irrigation area sizes and irrigation scheduling approaches;
- Assess the adequacy of wet-weather storage capacity; and
- Evaluate potential environmental risks associated with nutrients and salinity.

The model was parameterised using site-specific soil data, long-term regional climate data, and conservative effluent quality and quantity assumptions consistent with Queensland regulatory guidance. Scenarios were developed to reflect realistic operational management of the irrigation area, with additional sensitivity analysis undertaken to test nutrient behaviour under higher plant uptake conditions.

Model outputs were interpreted in the context of the Project's climatic setting, soil characteristics, and hydrogeological environment, with emphasis placed on long-term trends and steady-state behaviour rather than isolated short-term responses. Detailed descriptions of model inputs and assumptions are provided in Section 4, and modelling results are presented and discussed in Section 5.

2.3.1 Limitations and Assumptions of MEDLI V2

MEDLI V2 is not suitable for use in modelling subsurface lateral flow of water (i.e. groundwater). It is developed to model the soil water interaction within the root zone to a depth of 2.0 m. The model assumes that chemicals passed below this depth may impact on groundwater. MEDLI V2 also assumes that harvesting removes the biomass from the system, i.e. mowing turf with no catcher where the grass clippings remain in the irrigation area is not accounted for in the model.

The model is also limited in that it can only predict the volume of surface runoff and not the quality. However, it does have the ability to determine if surface runoff is from rainfall or a result of irrigation.

The MEDLI model is dependent upon the inherent limitations of the model as discussed above and the accuracy or representativeness of data collected or supplied for input. As the scope of this Project only allowed for a single test pit location, the soil data had to be taken as representative of soil conditions in the disposal area.

2.3.2 Considerations

Although MEDLI does not utilise soil pH, salinity or sodicity as input parameters, these aspects must be considered for the site and inform how the model and wastewater disposal may be undertaken. Soil pH can affect the availability of nutrients or cause nutrients to be available at toxic levels. Salinity levels can impair plant growth and may inform the crop selection based on salt tolerance. Sodicity can impact on the hydraulic properties of the soil and soil amelioration may be required before the area is suitable for wastewater disposal.

3 Site Suitability

The suitability of the site for wastewater disposal and the need for additional considerations in applying modelling scenarios, are considered in the following sections. Consideration of these factors is required as part of the MEDLI assessment, although they do not act as direct inputs to the model.

Relevant to the MEDLI Modelling Assessment, the site of interest (D10) falls within the Brown Tenosol soil classification and is underlain by geology associated with the Claraville Formation. A detailed field survey using an auger method was undertaken for profile description and the soil suitability assessment.

The site is positioned on a level plain exhibiting a flat landform element with slopes of less than one per cent (%). The surrounding landscape supports paperbark open woodland, with no microrelief features present. No significant disturbance was evident apart from minor impacts associated with hoofed grazing animals. Erosion was not observed, and the land surface appears stable under current land use.

The site is currently utilised for grazing, with no apparent soil degradation, bare scalds, or vegetation dieback. The vegetation community remains intact and reflective of natural conditions for this geomorphic setting.

The ground surface at Site D10 is hard setting, with no coarse fragments and no rock outcrop observed. Surface materials indicate stable conditions, with no evidence of compaction impacts beyond what would be expected under light to moderate grazing use.

No indicators of actual or potential acid sulfate soils (ASS) were found, with observations confirming that the pH was not below critical thresholds, no jarosite, sulfurous odours, or corrected shell material were found, and no low lying-scaled, bare, or dying vegetation zones present. As such, no further ASS investigations were required.

3.1 Soil Profile Characteristics

Soil characterisation for the site is informed by multiple investigation locations, including Site D10 and additional D- and C-series observations across the Project area (Figure 3). These investigations consistently indicated shallow soil profiles, with depths to refusal typically between approximately 0.5 m and 0.8 m, underlain by a cemented or indurated layer. Soil textures are broadly consistent across sites, comprising sandy to loamy surface horizons transitioning to more clay-influenced subsoils. This profile is consistent with the regional Claraville (Tertiary) sediments described in the Groundwater Impact Assessment, which are laterally continuous across the site and characterised by low permeability and unsaturated conditions.

The proposed irrigation area is

The detailed site investigation at D10 within the proposed irrigation area included a full auger profile to 0.82 m, with refusal encountered at a cemented pan immediately below this depth. The profile consisted of:

- A Horizon (0.00–0.30 m)

  The A horizon comprises two sublayers (A1 and A2), both described as loamy sand, massive, and loose in structure. Colours range from 10YR 4/2 to 10YR 6/4, with no mottles or bleaching present. The surface and upper subsoil horizons are dry and rapidly drained, containing few fine roots. Field pH measured 6.5 throughout these layers.

- B Horizon (0.30–0.82 m)

  The B horizon consists of clayey sand with a massive, loose structure and uniform 10YR 5/4 colouration. Drainage is well-drained, and fine roots are present, though sparse. Dispersion testing indicated:

  - 0.30–0.55 m: slight dispersion after 10 minutes; complete slaking
  - 0.55–0.82 m: moderate dispersion after 10 minutes; complete slaking
  - Field pH transitions from 6.5 in the upper B21 layer to 7.5 at depth.

While the detailed soil description at Site D10 extends to 0.82 m due to refusal on the cemented pan, the presence of this limiting layer is consistently observed across the site and is considered representative of the broader irrigation area. Accordingly, the D10 profile is considered a suitable basis for defining soil hydraulic behaviour in the MEDLI model. The parameterisation of soil water properties reflects these observed conditions and does not rely on assumptions of deep or unconstrained drainage.

The presence of a cemented or indurated layer at approximately 0.8 m depth is acknowledged as a potential constraint on vertical water movement within the soil profile. This layer may locally reduce vertical permeability and could, in principle, promote temporary perching of soil moisture and lateral redistribution of water above the pan under high soil moisture conditions. This is however, considered unlikely given the broader site context and hydrogeological setting.

The laboratory soil results are presented in Appendix A. The results of the tests for each soil layer are presented in Table 1 and Figure 4 illustrates the soil profile.

Table 1: Onsite Soil Parameters

Depth	Layer	Texture	Colour
A Horizon – 0.00 – 0.10 m	A1	Loamy sand	Dark greyish brown 10YR4/2 No mottles or bleaching
A Horizon – 0.10 – 0.30 m	A2	Loamy sand	Light yellowish brown 10YR6/4 No mottles or bleaching
B Horizon – 0.30 – 0.55 m	B1	Clayey sand	Yellowish brown 10YR5/4 No mottles or bleaching
B Horizon – 0.55 – 0.82 m	B2a		
C Horizon	The auger encountered refusal on a cemented pan		



Figure 4: Soil profile

3.2 pH and Conductivity

The Australian Standard Soils for Gardening and Landscape Use (AS4419) provides recommended ranges for pH and conductivity. This standard recommends a pH range from 5.5 to 7.5 for optimum plant growth. The A and B Horizon samples returned pH readings within this range.

Another interpretation of soil pH is provided by the resource (Hazelton, 2007), which defines a set of ratings for soil pH and nutrient availability for plants, as outlined in Table 2. These ratings indicate that the pH of the A Horizon and the shallow B Horizon is mildly acidic, and the pH of the deeper layer of Horizon B (B21a) is neutral.

Based on the pH values at the sample location, the availability of nutrients within the soil profile to plants should not be limited.

Table 2: Soil pH Ratings

pH	Ratings	Nutrient Availability	Site Specific Soil Samples
>9.0	Very Strongly Alkaline		
9.0 – 8.5	Strongly Alkaline	Iron, Copper and Zinc may become poorly available – Sodicity may become an issue.	
8.4 – 7.9	Moderately Alkaline*	Some elements will begin to be less available	
7.8 – 7.4	Mildly Alkaline		
7.3 – 6.6	Neutral		B Horizon (B21a)
6.5 – 6.1	Slightly Acidic		A Horizon B Horizon (B21)
6.0 – 5.6	Moderately Acidic		
5.5 – 5.1	Strongly Acidic	Phosphorus, Calcium and Magnesium will become poorly available. Aluminium, and Manganese may be available at toxic levels for plants	
5.0 – 4.5	Very Strongly Acidic**		

*Iron and Zinc may be deficient.
**With increasing acidity exchangeable aluminium increases to toxic levels, cadmium and heavy metals become available and molybdenum becomes increasingly unavailable

3.3 Exchangeable Sodium Percentage

The Exchangeable Sodium Percentage (ESP) is a measure of the sodium ions present in the soil expressed as a percentage of all the exchangeable cations present in a soil. The ESP provides an indication of the sodicity of the soil profile at the sample location. A soil with an ESP greater than six is generally regarded as being sodic soil in Australia (Skene & Northcote, 1972). The ratings for soil sodicity are listed in Table 3 below.

Table 3: ESP Ratings

Exchangeable Sodium Percentage	Soil Classification	Site Specific Soil Samples
<6.0	Non-Sodic	A Horizon B Horizon (B21)
6.0 – 10	Sodic	B Horizon (B21a)

Exchangeable Sodium Percentage	Soil Classification	Site Specific Soil Samples
11 – 15	Moderately Sodic	
16 – 25	Strongly Sodic	
>25	Very Strongly Sodic	

The topsoil and Horizon A returned an ESP ranging from 0.2% to 0.5%, which indicates these layers are not sodic. Soil Horizon B returned an ESP ranging between 0.8% and 7.6% indicating that this layer is overall considered to be sodic. However, the sodicity was found at the deeper layer of the B Horizon (B21a). This ESP is not unusual for Australian subsoils, due to their higher clay content. Based on these results, wastewater disposal methods do not need to account for soil sodicity.

3.4 Nutrients: Nitrogen and Phosphorus

Nutrients are essential for plant growth and include nitrogen and phosphorus and their compounds, however at high concentrations the presence of their compounds can be harmful to plants. In the soil, nutrients which plants can uptake are in the forms of nitrate and phosphate. High concentrations of these nutrients can cause toxicity in some Australian native plants as well as eutrophication of nearby surface and ground waters. The Australian and New Zealand standard (AS/NZS 1547:2012) for on-site domestic wastewater management provides an informative section on the impact of nutrient levels in effluent that is disposed of via land application.

The availability of phosphorus in the soil is dependent on the absorptive capability of the soil, which varies significantly based on site specific conditions. As phosphorus, in the form of phosphate, has a negative charge, it can be removed from pore water by adsorption to the soil particles and making it unavailable for plant uptake.

Typically, native plants in Australia, including turf grasses, take up less phosphorus than is contributed to the soil profile by irrigation. Therefore, sustainable irrigation relies on the ability of the soil to store and adsorb phosphorus. If the phosphorus adsorption capacity of the soil is exceeded than the application of wastewater for disposal may result in leaching of phosphorus to groundwater and high concentrations of phosphorus in surface runoff (DEC, 2004).

4 MEDLI Inputs

The model requires a series of user inputs based on local climatic conditions, effluent quality and volume from the STP, or waste stream, the sizing of the wet weather storage, sizing of the irrigation area, soil profiles within the irrigation area, and plant type.

4.1 Climate Data

MEDLI utilises daily rainfall, temperature, pan evaporation, and solar radiation. Data for a period greater than 40 years is required in order to account for climatic variability.

Climate data has been acquired from the Queensland Government's SILO climate data database for a patched grid location in Croydon, Queensland (-18.2S, 142.24E- BoM Station Number 029012) for a 49-year period, 1976 to 2025. This location has an average annual rainfall of 774.7 mm and temperatures ranging from a low of 14.2°C to a high of 37.6°C (mean monthly maximum and minimum).

This dataset captures a wide range of climatic variability, including extended wet-season periods, above-average rainfall years. The dataset includes multiple high-intensity rainfall seasons associated with tropical systems that have historically impacted the North West Minerals Province. Notable events within this period include Cyclones Ted (1976), Joy (1990–91), Justin (1997), Abigail (2001), Monica (2006), Yasi (2011), Ita (2014), Debbie (2017), and Trevor (2019). These events are associated with prolonged and high-intensity rainfall and are represented within the daily rainfall time series used in the MEDLI model. These events are inherently incorporated into the modelling through the daily rainfall time series, ensuring that storage performance is assessed against realistic extreme and cumulative wet-season conditions rather than simplified design assumptions.

4.2 Effluent Quality

The treated wastewater (used as effluent) parameters used in the model are presented in Table 4. This water quality data is based on the long-term limits established in the Eligibility Criteria and Standard Conditions for Sewage Treatment Works (ERA 63) – Version 2 (Department of Environment and Heritage Protection, 2015). These limits also align with the quality which would be expected from a basic sewage treatment plant as per Table A3.2 of the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, & Australian Health Ministers' Conference., 2006).

Based on the proposed package sewage treatment plant configuration, the system is expected to achieve a minimum of secondary treatment consistent with a Class C recycled water standard under the Queensland Public Health Regulation 2018 (E. coli <1000 cfu/100 mL). This level of treatment is typical of modular STP systems used in remote accommodation settings.

Table 4: Effluent Quality

Parameter	Units	Effluent Quality
pH		5.0 – 8.5
Conductivity	µs/cm	1600
Total Nitrogen	mg/L	30
Total Phosphorous	mg/L	10
Total Residual Chlorine (if used for disinfection)	mg/L	1
E.coli	Cfu/100 mL	<1000

4.3 Effluent Quantity

The wastewater quantity is based on a workforce of 200 persons. For the purpose of the modelling, it has been conservatively assumed that all 200 personnel are present on site at all times, and that each individual generates wastewater equivalent to one Equivalent Person (EP). The *Environmental Protection Regulation 2019* defines 1 EP as 200 L/day of effluent; therefore, the total daily wastewater volume is conservatively estimated at 40,000 L/day.

This assumption represents a conservative upper-bound scenario. During construction, the workforce is expected to be approximately 100 personnel, and during operations approximately 192 personnel, with actual occupancy further reduced by workforce rostering. Accordingly, the modelled wastewater volume represents a credible worst-case design scenario for sizing and performance assessment of the irrigation system.

4.4 Soil Profile

The soil hydraulic and nutrient parameters used in the MEDLI model were derived from a combination of site-specific field measurements, laboratory analyses, and established Queensland and international guidance for soil water and nutrient modelling.

Four layers are designated within the model. The topsoil has been split into two layers. The first layer (Layer 1) is set to a depth of 100 mm to simulate the portion of the soil profile subject to evaporation (air dry moisture content). The second layer is the remaining depth of the A horizon (Layer 2). Layers 3 and 4 are a split of the identified B Horizon (Table 1).

The adopted soil profile used within the model is presented in Table 5.

Table 5: Soil Input Parameters

Parameter	Layer 1	Layer 2	Layer 3	Layer 4
Soil Layer Thickness (mm)	100	200	250	270
Air Dry (% v/v)	0.2			
~Lower Storage Limit (% v/v)	5	5	8	9
^Drained Upper Limit (% v/v)	12	13	17	18
*Plant Available Water Capacity (mm)	7	16	22.5	24.3
Saturated Water Content (% v/v)	32	35	44	47
Bulk Density (g/cc)	1.59	1.51	1.28	1.16
*Porosity (%)	40	43.02	51.7	56.23
Saturated Hydraulic Conductivity (mm/hr)	3	1.4	0.12	0.01
Initial Soil Phosphorus (mg/kg)	5	5	5	5
Adsorption Coefficient	180	220	300	350
Adsorption Exponent	0.4	0.43	0.5	0.55

Parameter	Layer 1	Layer 2	Layer 3	Layer 4
Desorption Exponent	0.38	0.41	0.48	0.52
Nitrate N (mg/kg)	1			

The parameters specifically drawn from literature, rather than direct soil analysis, justified below are:

- Lower Storage Limit (LL)
- Drained Upper Limit (DUL)
- Saturated Water Content (SWC)
- Phosphorus adsorption and desorption coefficients (exponents)

4.4.1 Lower Storage Limit (LSL)

The Lower Storage Limit (LSL) represents the minimum soil water content at which plants can no longer extract water (conceptually equivalent to permanent wilting point). In MEDLI, LSL defines the **l**ower bound of plant-available water (DSITI, 2016), directly influencing:

- Root water uptake
- Evapotranspiration partitioning
- Soil water deficit triggering

The LSL values adopted for the model were derived from the site-specific soil texture and bulk density data, consistent with standard Australian soil characterisation practices for plant available water capacity (PAWC).

Queensland guidance explicitly recognises that LSL is most robustly estimated using texture-based relationships unless long-term crop extraction trials are available. This approach is consistent with the national PAWC methodology developed by CSIRO and GRDC, which underpins MEDLI and APSIM soil modules (Tennakoon & Ramsay, 2020) (Burk & Dalgliesh, 2013).

Internationally, LSL is routinely defined as the 15-bar soil water content and is treated as a soil-specific constant that varies primarily with texture rather than short-term land use (Foley, 2017) (Dalgliesh, Hochman, Huth, & Holzworth, 2015) (Dalgliesh & Foale, 1998)

The LSL values selected:

- Fall within published ranges for Brown Tenosols / sandy loam to sandy clay loam soils
- Slightly over-estimate residual water availability, which marginally reduces modelled drainage and nitrate leaching, consistent with conservative environmental assessment

4.4.2 Drained Upper Limit (DUL)

The Drained Upper Limit (DUL) represents soil water content after free drainage has ceased (commonly referred to as field capacity). In MEDLI, DUL governs:

- Soil water storage capacity
- Onset of drainage
- Irrigation triggering and cessation

Laboratory field capacity values often overestimate true DUL due to soil disturbance and loss of macropore structure during sample preparation (Burk & Dalgliesh, 2013). Site specific laboratory or field measurements were not undertaken for the irrigation area, and instead were derived from literature and standard MEDLI parameter ranges for the identified soil textures and bulk density. Accordingly, DUL was calculated using:

- Measured bulk density
- Particle density of 2.65 g/cm³ (which is preset in the MEDLI Model)
- Texture-appropriate drainage assumptions

This approach is supported by Queensland's *Disposal of Effluent Using Irrigation Technical Guideline* (Tennakoon & Ramsay, 2020), and is consistent with common practice in MEDLI applications, where literature-based values are used in the absence of site-specific measurements. Published soil water characteristic data were used to select values that are physically realistic and internally consistent (i.e. LSL < DUL < SWC) across all soil layers. International soil modelling frameworks (APSIM, DSSAT) apply the same principle, treating DUL as a model-ready parameter rather than a literal laboratory output (Foley, 2017) (Dalgliesh, Hochman, Huth, & Holzworth, 2015) (Dalgliesh & Foale, 1998).

The adopted parameters reflect moderate permeability soils consistent with the observed sandy to clay-influenced soil profile, and provide a suitable basis for simulating soil water behaviour and drainage processes for the purposes of this assessment.

Table 6: Literature Derived Ranges for LSL and DUL based on Soil Texture.

Soil texture	Lower Storage Limit (LL) (% v/v)	Drained Upper Limit (DUL) (% v/v)	Indicative PAWC
Sand	2 – 5	8 – 12	Very low
Loamy sand	4 – 7	12 – 18	Low
Sandy loam	6 – 10	18 – 25	Moderate
Loam	8 – 12	25 – 32	Moderate–high
Sandy clay loam	10 – 15	28 – 36	Moderate
Clay loam	12 – 18	32 – 40	High
Light clay	15 – 22	35 – 45	High
Medium–heavy clay	18 – 25	40 – 50	Moderate–high

4.4.3 Saturated Water Content (SWC)

Saturated water content (SWC) defines the maximum volumetric water content of the soil and controls:

- Perched saturation behaviour
- Drainage rates above DUL
- Upper hydraulic boundary conditions

SAT values were calculated from measured bulk density using:

$$SWC = Porosity - Entrapped\ Air\ Fraction$$

An entrapped air fraction of approximately 3% was assumed, consistent with CSIRO guidance for light-textured Australian soils. This approach is routinely applied within Australian soil water databases (APSoil) and is consistent with APSIM soil parameterisation standards. (Dalgliesh & Foale, Soil Matters: Monitoring Soil Water and Nutrients in Dryland Farming, 1998) (Verburg, 2016).

Queensland MEDLI guidance requires that SWC must be greater than DUL and less than total porosity, and physically plausible for the defined soil profile (Tennakoon & Ramsay, 2020). These conditions were satisfied following recalculation.

By reducing laboratory porosity by an entrapped air allowance:

- Saturated water contents are slightly lower
- This limits transient saturation storage and promotes more conservative drainage behaviour

4.4.4 Phosphorus Adsorption and Desorption Coefficients

MEDLI models phosphorus attenuation using empirical adsorption and desorption exponents, representing the soil's capacity to retain phosphorus through sorption to mineral surfaces. These exponents are conceptually equivalent to simplified Freundlich-type relationships, rather than full Langmuir isotherm expressions (Louhar, Gaur, Yadav, Dhaker, & Jadhav, 2019) (DSITI, 2016) (Dar, Nair, Harris, & Mylavarapu, 2015) (He, 1999).

Phosphorus adsorption behaviour in the MEDLI model was represented using literature-derived parameters appropriate to the identified soil textures. No site-specific adsorption isotherm testing was undertaken as part of this study. The adopted parameters are consistent with published values for sandy loam to clay-influenced soils and provide a suitable basis for assessing phosphorus transport at the scale of this investigation.

International literature confirms that:

- Sandy and weakly weathered soils often exhibit low or negligible P sorption capacity;
- Freundlich exponents approaching zero indicate rapid breakthrough and minimal buffering (He, 1999), (DSITI, 2016) (Dar, Nair, Harris, & Mylavarapu, 2015); and
- Using low, positive coefficients is more conservative than assuming infinite P retention (Louhar, Gaur, Yadav, Dhaker, & Jadhav, 2019) (DSITI, 2016).

The adopted coefficients:

- Minimise soil P retention
- Promote faster phosphorus movement to deep drainage
- Provide a worst-credible-case representation of long-term P behaviour under irrigation

4.5 Crop Species

The Monthly Green Covers – Deciduous Forest planting option was adopted in the MEDLI model to represent the existing vegetation cover and potential minimal site management regime for the effluent disposal area during operation of the sewage treatment plant (STP).

Testing whether the irrigation area could not be managed as an intensively harvested or grazed pasture, but instead, as a low-disturbance, non-productive land application area, maintained primarily for treated effluent disposal and environmental protection rather than agricultural production. The deciduous forest monthly green cover option provides a reasonable and pragmatic proxy for representing the existing site condition, and possible management intent.

Within MEDLI, the Monthly Green Covers – Deciduous Forest option is characterised by:

- Seasonally variable green cover, reflecting natural vegetation responses to climate rather than managed pasture cycles
- Absence of biomass harvesting or grazing, consistent with the proposed site management
- Moderate to low transpiration demand relative to purpose-managed pasture systems
- Persistent root presence without active agronomic optimisation

These characteristics align with the possible conditions of the effluent disposal area, which will be:

- Lightly managed
- Ungrazed and non-harvested
- Maintained primarily for hydraulic and nutrient assimilation rather than yield

As such, the deciduous forest option was selected as the most representative vegetation parameterisation available within MEDLI for the operating scenario.

The deciduous forest monthly green cover option provides a realistic representation of water balance processes under passive vegetation management by:

- Allowing soil moisture to respond primarily to rainfall and irrigation inputs, rather than aggressive plant extraction
- Producing representative transpiration rates for a passive, non-managed vegetation system, without relying on elevated evapotranspiration associated with intensively managed pasture.
- Avoiding artificial inflation of evapotranspiration associated with highly productive pasture crops

This supports simulation of deep drainage behaviour that is consistent with expected field performance, rather than optimised agronomic outcomes that would not be achieved or maintained on site.

It is acknowledged that the native vegetation at the site comprises Gulf savannah paperbark open woodland, which is not directly represented by any available vegetation class within the MEDLI model. The “Monthly Green Covers – Deciduous Forest” option was therefore selected as a pragmatic proxy to simulate seasonal vegetation dynamics and evapotranspiration behaviour.

While this proxy does not replicate the exact structural and physiological characteristics of the native woodland, the key drivers of the soil water balance at the site are climatic, with high evaporation rates significantly exceeding rainfall for most of the year. As such, vegetation type is considered a secondary control on long-term evapotranspiration and drainage processes within the model.

To account for uncertainty in vegetation representation, a Rhodes grass pasture scenario was also modelled as a sensitivity analysis. This provides a higher transpiration and nutrient uptake option and demonstrates that modelled drainage and nutrient outcomes are not highly sensitive to vegetation parameterisation. Accordingly, the adopted vegetation proxy is considered appropriate for the purposes of a fit-for-purpose, screening-level MEDLI assessment.

Under this potential land use:

- No systematic removal of above-ground biomass is proposed
- Nutrients taken up by vegetation are largely cycled back to the soil through litter fall and senescence
- Net nutrient export from the system via harvesting is not expected

The Monthly Green Covers – Deciduous Forest option appropriately reflects these conditions by limiting permanent nutrient removal, thereby providing a realistic assessment of nutrient accumulation and leaching potential under operational management.

This avoids relying on optimistic assumptions regarding nutrient export that would not occur in practice.

4.6 Modelling Scenarios

The model was run to investigate different irrigation scheduling options. The only difference in model inputs for the two scenarios were the scheduling trigger and the application rate of wastewater being irrigated. A third scenario as a sensitivity analysis for the nutrient leaching was also run.

- Scenario 1 - DUL

  This scenario triggers irrigation to occur every day until the Drained Upper Limit (DUL) or field capacity of the soil layer is reached.

- Scenario 2 - DIR

  The second scenario triggers irrigation to occur every day to a fixed depth, based on a design irrigation rate provided in AS/NZS 1547:2012 for the soil texture identified, in this case a Design Irrigation Rate (DIR) of 3.5 was selected to match a soil category 4.

- Scenario 3 - Sensitivity Analysis

  A Rhodes grass pasture option was modelled separately as a sensitivity analysis, representing a deliberately high nitrogen-uptake and high-transpiration endmember. This scenario was included to test:

  - The influence of enhanced biological uptake on nutrient leaching outcomes
  - Whether conclusions regarding irrigation area sizing and groundwater risk were dependent on vegetation optimisation

4.7 Wet Weather Storage Size

Wet-weather effluent storage has been provided with a usable capacity equivalent to approximately 60 days of Average Dry Weather Flow (ADWF). This storage duration has been adopted to account for the monsoonal rainfall regime of north-west Queensland (as discussed in Section 4.1), where prolonged wet-season conditions can significantly restrict irrigation opportunities and result in extended periods during which land application is not practicable. A 60-day storage allowance represents a conservative and commonly applied design assumption for mine accommodation facilities in remote northern Queensland and is considered appropriate to ensure continuous operation of the sewage treatment system without uncontrolled release during sustained wet weather.

For the purposes of MEDLI modelling, the wet-weather storage has been represented as a fully enclosed (closed) storage tank. Accordingly, the storage has been modelled as a vertical-sided structure with a fixed plan area and depth, and with no rainfall input, evaporation loss, or seepage, such that the modelled behaviour reflects a closed hydraulic system. This approach ensures that the storage volume assessed in MEDLI accurately represents the available operational storage and does not artificially benefit from climatic gains or losses that would be associated with an open pond. The adequacy of the adopted storage capacity has been evaluated through MEDLI outputs for storage utilisation and irrigation opportunity.

5 MEDLI Outputs

As discussed, several scenarios were run to test the irrigation scheduling, and undertake sensitivity analysis. The multirun feature of MEDLI v2 was used to run sizing options from 1.0 to 5.0 ha, at 1 ha intervals, and test the wet weather storage size increasing from 60 to 90 days storage, at 10 day intervals.

The models outputs determined that the 60 day wet weather storage option was appropriate with no significant decrease in overtopping with increases in storage size. The optimal irrigation area is 3 to 4 ha, with minimal benefits gained from increasing to 4 ha.

MEDLI Output reports for each scenario are provided in Appendix B, with a summary of key parameters provided in Table 7.

Table 7: MEDLI Summary

Parameter	Units	Scenario 1 – DUL – 3 ha	Scenario 2a – DIR – 3 ha	Scenario 2b – DIR – 4 ha	Rhodes Grass Sensitivity Analysis – 3 ha	Rhodes Grass Sensitivity Analysis – 4 ha
Irrigation Area	ha	3	3	4	3	4
Wet Weather Storage Volume	kL	2,400	2,400	2,400	2,400	2.400
Irrigation Control		Every 1 day to 0mm beyond DUL (Excl. rainfall days)	Every 1 day to 3.5 mm (Excl. rainfall days)	Every 1 day to 3.5 mm (Excl. rainfall days)	Every 1 day to 3.5 mm (Excl. rainfall days)	Every 1 day to 3.5 mm (Excl. rainfall days)
Pond Inflow	kL/year	15,704	15,704	15.704	15,704	15,704
Irrigation Volume	kL/year	15,477	15,685	15,687	15,685	15,687
Overflow Volume	kL/10 years	2,104	5.54	0	5.54	0
No. of Days Overflow	Days/10 years	41.2	0.2	0	0.2	0
Overall Reuse	%	99	100	100	100	100
Rainfall	mm/year	775	775	775	775	775
Irrigation Applied	mm/year	516	523	392	523	392
Soil Evaporation	mm/year	353	353	296	5.9	11.1
Transpiration	mm/year	710	704	642	912	810
Rain Runoff	mm/year	21.7	26.4	24.7	52.9	49.4
Irrigation Runoff	mm/year	0	0	0	0	0
Drainage	mm/year	205	213	202	325	295
Plant Species		Monthly Green Covers – Deciduous Forest Cover	Monthly Green Covers – Deciduous Forest Cover	Monthly Green Covers – Deciduous Forest Cover	Rhodes Grass Pasture	Rhodes Grass Pasture
No. of Plant Harvests		N/A	N/A	N/A	2.28	1.76

Parameter	Units	Scenario 1 – DUL – 3 ha	Scenario 2a – DIR – 3 ha	Scenario 2b – DIR – 4 ha	Rhodes Grass Sensitivity Analysis – 3 ha	Rhodes Grass Sensitivity Analysis – 4 ha
Salinity of Soil Solution at Base of Rootzone	dS/m	4.27	4.17	3.33	2.63	2.23
Average Nitrate Conc. Of Deep Drainage	mg/L	N/A	N/A	N/A	0.03	0.04
Average Phosphorus Conc. Of deep drainage	Mg/L	N/A	N/A	N/A	0.0011	0.0009
Design Soil Profile Storage Life for Phosphorus	years	N/A	N/A	N/A	407	499
Nitrogen Irrigated	kg/ha/year	144	145	109	145	109
Nitrogen Uptake		N/A	N/A	N/A	151	114
Phosphorus Irrigated	kg/ha/year	49	49	36	49	36
Phosphorus Uptake		N/A	N/A	N/A	34.2	26

5.1 Wet Weather Storage Sizing

The selection of 60-day wet weather storage has been assessed within a long-term, climate-driven modelling framework using 50 years of daily climate data (1976–2025), including periods representative of both average and above-average wet seasons. The modelling explicitly accounts for extended wet-season conditions through the use of continuous daily climate inputs, rather than relying on fixed design storm assumptions.

Sensitivity testing of wet weather storage volumes from 60 to 90 days indicates that increases in storage capacity do not materially change overtopping frequency or volume, which is already modelled. This reflects the dominant influence of rainfall-driven water inputs and limited irrigation opportunities during the wet season, rather than storage capacity alone. Accordingly, the 60-day storage configuration is considered appropriate and proportionate for the site conditions.

5.2 Comparison of Irrigation Scheduling

Review of the irrigation diagnostics and paddock water balance outputs indicates that there is little practical difference between Scenario 1 and Scenario 2 in terms of irrigation application frequency, total annual irrigation volume, and overall soil water behaviour.

This similarity is explained by the interaction between:

- Daily triggering logic;
- Rainfall-based irrigation exclusion;
- Climatic dominance of the water balance; and
- Moderate daily design irrigation depth.

In both scenarios, irrigation was not applied on days with measurable rainfall (>0 mm). The output files show that approximately the same number of days per year were excluded from irrigation in both cases due to rainfall events. As a result:

- Irrigation was suspended during wet periods regardless of the scheduling method;
- The soil profile frequently approached or exceeded DUL due to rainfall alone; and
- The opportunity for irrigation to "top up" to DUL in Scenario 1 was often pre-empted by rainfall.

This indicates that rainfall controls the majority of irrigation interruptions and significantly limits divergence between the two approaches. Although Scenario 1 theoretically allows variable daily application volumes up to DUL, the output files demonstrate that the fixed irrigation rate of 3.5 mm/day closely approximates the average DUL based requirement based on the following results:

- On most irrigated days, the soil water deficit relative to DUL was small;
- The 3.5 mm/day design rate was generally sufficient to partially or fully replenish this deficit; and
- On days where the soil was already near DUL, both scenarios resulted in:
    - Either minimal irrigation;
    - Or no effective change in soil water status.

Consequently, the fixed-rate approach naturally converges toward the same long-term irrigation volume as the DUL-targeted approach.

The MEDLI irrigation summaries show that annual irrigation totals are effectively identical, based on the total annual irrigation volumes, which differ only marginally between Scenario 1 and Scenario 2. The differences are considered to be well within inter-annual climatic variability. Additionally, both scenarios achieve near-complete effluent reuse. This indicates that the design irrigation rate has been appropriately set, and that Scenario 2 is not under- or over-irrigating relative to soil capacity.

The paddock water balance results show that the soil water balance outcomes are comparable between the two scenarios due to:

- Similar annual transpiration totals;
- Only marginal differences in Deep drainage magnitudes; and
- The same seasonal patterns for the soil moisture dynamics.

These results confirm that soil water movement is governed far more strongly by climate and soil properties than by minor differences in daily irrigation logic.

While Scenario 1 (DUL-based scheduling) provides a theoretically optimised soil water control mechanism, in practice the daily irrigation triggering, rainfall-based exclusion of irrigation, and the moderate irrigation depths mean that both approaches produce functionally equivalent outcomes over the long term. Scenario 2 therefore provides a simpler and more operationally realistic irrigation rule, with no material change to environmental performance indicators.

5.3 Comparison of Irrigation Area Size – 3 ha vs 4 ha

Reviewing the multirun outputs for irrigation area size, demonstrated that 3 to 4 ha was the most appropriate option. A smaller irrigation area, resulted in a significant volume of overtopping from the wet weather storage, and a larger area, provided no benefit.

At the system scale, MEDLI outputs indicate that both options perform equivalently with respect to what is considered as core compliance metrics as follows:

- Effluent reuse
  Both scenarios achieve essentially 100% reuse;
- Pond performance
  No meaningful difference in overflow frequency, duration, or volume;
- Irrigation operation
  Similar number of irrigated days and total applied volume; and
- Runoff
  Irrigation runoff remains negligible in both cases.

These results demonstrate that irrigation area is not a limiting factor for system operability or effluent disposal reliability within the assessed range. Increasing the area from 3 ha to 4 ha does not resolve any operational constraint present in the 3 ha scenario, as none are observed within the results for hydraulic performance and deep drainage, and the per-hectare versus total drainage response. Increasing the irrigation area from 3 ha to 4 ha did result in:

- A reduction in irrigation depth per hectare, and
- A modest reduction in deep drainage depth (mm/yr) per hectare.

However, because the total irrigated area increases, the total volume of deep drainage (m^3/yr) is slightly higher in the 4 ha scenario. This illustrates a key outcome of the modelling, where drainage behaviour is governed primarily by climate and soil properties, not irrigation area. Additionally the wet-season rainfall drives many drainage events independent of irrigation scheduling.

As a result, the additional hectare produces only a minor redistribution of drainage, not a step change in hydraulic risk.

As expected, the larger irrigation area reduces per-hectare nitrogen loading. However:

- Plant uptake scales proportionally with applied nitrogen;
- Soil nitrogen balances in both scenarios indicate high uptake efficiency; and
- Residual soil nitrogen remains low in both cases.

The reduction in per-hectare loading does not translate into a commensurate reduction in leaching risk, because leaching is driven by water movement rather than nutrient supply under the rates modelled.

With respect to nitrogen leaching, it is noted that the Monthly Green Covers vegetation option used to represent the operational land use does not explicitly calculate nitrate-N concentrations in deep drainage within MEDLI. Accordingly, direct comparison of leaching concentrations between the 3 ha and 4 ha scenarios is undertaken based on the Rhodes grass pasture sensitivity analysis, which enables reporting of nitrate concentrations. Results from the Rhodes grass sensitivity analysis indicate that:

- Long-term nitrate-N concentrations in deep drainage converge to the same very low values under both the 3 ha and 4 ha irrigation area scenarios;
- Differences between the scenarios are limited to short-term or transient behaviour and do not persist under steady-state conditions; and
- Steady-state nitrate-N concentrations are effectively indistinguishable between the two irrigation areas.

Given that the Rhodes grass scenario represents a high nitrogen uptake and high transpiration endmember, these results demonstrate that increasing the irrigation area does not materially alter nitrogen leaching risk under conditions favourable to plant uptake. When considered alongside the Monthly Green Covers scenario, which represents the intended non-harvested operational land use and yields comparable soil water balance and drainage behaviour, it can be concluded that irrigation area (3 ha versus 4 ha) does not materially influence the nitrogen leaching risk profile for the site.

In relation to salinity and phosphorus both irrigation area sizes exhibit a very low rootzone and deep drainage salinity with negligible phosphorus leaching and no indication of long-term soil degradation. The 4 ha scenario marginally reduces per-hectare salt loading, but the 3 ha scenario is already well below any agronomic or environmental threshold. As such, the additional area does not unlock any new benefit with respect to salinity or phosphorus management.

The modelling demonstrates that the incremental benefit of an additional hectare is small and largely limited to a numerical reduction in per-hectare loading. However, this benefit:

- Does not change system compliance;
- Does not materially reduce leaching concentrations or mass;
- Does not alter groundwater risk conclusions; and
- Does not improve operational resilience.

In contrast, increasing the irrigation area introduces:

- Additional land disturbance;
- Greater infrastructure footprint; and
- Larger management and monitoring area

without delivering a proportional environmental benefit.

Based on the MEDLI outputs and the intended operational context, the 3 ha irrigation area is determined to be the most appropriate and proportionate option, because it:

- Achieves all performance objectives for effluent reuse, soil protection, and water balance;
- Is robust to vegetation and irrigation scheduling sensitivity analysis;
- Avoids unnecessary expansion of the land application footprint; and
- Represents a balanced, conservative, and efficient design.

The 4 ha option, while technically viable, does not materially improve environmental performance relative to the 3 ha scenario and therefore does not represent a meaningful refinement of the design.

5.4 Nutrient Loading

Under the 3 ha irrigation scenario using the Monthly Green Covers vegetation and a daily design irrigation rate of 3.5 mm (with irrigation not triggered on days with >0 mm rainfall), MEDLI outputs indicate:

- Total irrigation volume: approximately 15,685 m^3/year
- Average irrigation depth: approximately 5,230 m^3/ha/year (≈ 523 mm/year)

Based on the modelled effluent quality, the applied nutrient and salt loads are presented in Table 8.

Table 8: Nutrient Loading

Constituent	Total applied load (kg/year)	Applied load (kg/ha/year)
Total Nitrogen (TN)	~437 kg/year	~146 kg/ha/year
Total Phosphorus (TP)	~146 kg/year	~49 kg/ha/year
Total Dissolved Salts	~14,900 kg/year	~5,000 kg/ha/year

These values represent the maximum annual nutrient and salt inputs to the land application area.

The Monthly Green Covers vegetation option represents a proposed low maintenance operational land use, under which:

- Above-ground biomass is not harvested or removed;
- Nutrients taken up by vegetation are largely recycled within the soil–plant system through litter fall and decomposition; and
- The soil profile functions as the primary nutrient buffering medium.

MEDLI soil nutrient balance outputs indicate that, despite the absence of harvested nutrient removal, there is no progressive accumulation of nitrogen or phosphorus within the soil profile over the simulation period. This reflects the combined influence of:

- Moderate application rates,
- Seasonal plant uptake,
- Soil adsorption processes (particularly for phosphorus), and
- Climate-controlled drainage behaviour.

For the Monthly Green Covers, 3 ha scenario, MEDLI outputs indicate that deep drainage occurs predominantly during wet-season rainfall events, rather than as a direct consequence of irrigation. Additionally, irrigation contributes a relatively small proportion of total annual downward water flux. The annual deep drainage volumes are broadly comparable to those observed in the equivalent pasture-based simulations (Rhodes Grass Sensitivity Analysis), confirming that drainage behaviour is driven primarily by climate and soil hydraulic properties. This is consistent with the irrigation regime, under which irrigation is curtailed on rainfall days and applied at a moderate fixed rate.

5.4.1 Nitrogen Leaching Behaviour

It is noted that the Monthly Green Covers – Deciduous Forest vegetation option used to represent the operational land use does not explicitly report nitrate-N concentrations in deep drainage within MEDLI. Consequently, quantitative assessment of nitrogen leaching concentrations is informed by the Rhodes grass pasture scenario, which enables reporting of both nitrogen mass leached and nitrate-N concentrations.

The Rhodes grass scenario was applied using the same irrigation area, irrigation scheduling, and effluent loading as the operational scenario, and therefore provides a like-for-like assessment of nitrogen behaviour under identical hydraulic conditions, differing only in vegetation uptake and management assumptions. For the 3 ha irrigation area, MEDLI outputs indicate:

- Total nitrogen applied: approximately 146 kg N/ha/year; and
- Nitrogen leached: approximately 0.10 kg N/ha/year.

This corresponds to less than 0.1% of the applied nitrogen load being lost via leaching. Flow-weighted nitrate-N concentrations in deep drainage are presented in Table 9.

Table 9 Flow Weighted Nitrate Concentrations

Metric	Modelled value
Average nitrate-N concentration (all years)	0.03 mg/L
Average nitrate-N concentration (excluding first year)	0.01 mg/L
Maximum annual nitrate-N concentration	0.94 mg/L

The higher transient concentrations occur during early simulation years, and following periods of elevated drainage associated with wet-season rainfall. These values do not persist under steady-state conditions. These outcomes indicate that nitrogen leaching behaviour is controlled primarily by drainage dynamics driven by climate and soil properties.

While the Monthly Green Covers scenario does not report nitrate-N concentrations directly, MEDLI outputs show that:

- Deep drainage volumes are comparable to those simulated under the Rhodes grass scenario;
- Residual soil nitrogen remains low and stable over time; and
- There is no indication of progressive nitrogen accumulation in the soil profile.

The Rhodes grass pasture does not represent a worst-case nitrogen leaching scenario in all respects; rather, it represents a bounding case for nitrate concentration reporting under identical hydraulic loading. The key relevance of the pasture results is that even when nitrate concentrations are explicitly modelled, long-term values remain very low and are insensitive to irrigation area.

Accordingly, the Rhodes grass results provide quantitative confirmation that nitrogen leaching risk is low under the applied loading regime and does not materially differ between the 3 ha and 4 ha options.

5.4.2 Phosphorus Leaching Behaviour

Under the Monthly Green Covers – Deciduous Forest, 3 ha irrigation scenario with a design irrigation rate of 3.5 mm/day, the applied phosphorus load is approximately:

- Total phosphorus applied: ~146 kg P/year
- Area-normalised load: ~49 kg P/ha/year

MEDLI soil phosphorus balance outputs for this operational vegetation scenario indicate that the majority of applied phosphorus is retained within the soil profile through adsorption and incorporation into soil phosphorus pools. No progressive increase in dissolved or mobile phosphorus is evident over the simulation period.

Because the Monthly Green Covers vegetation option does not explicitly report phosphorus concentrations in deep drainage, quantitative assessment of phosphorus leaching is informed by the Rhodes grass pasture scenario, which uses identical hydraulic and effluent loading assumptions.

For the Rhodes grass, 3 ha irrigation area, MEDLI outputs indicate:

- Average phosphorus leached: approximately 0.0036 kg P/ha/year; and
- Proportion of applied phosphorus leached: less than 0.01%.

These values confirm that phosphorus leaching is negligible under both irrigation areas and that soil adsorption capacity effectively immobilises applied phosphorus. The absence of increasing leached mass over time indicates that phosphorus retention mechanisms remain effective at steady state.

Given that the Monthly Green Covers operational scenario exhibits comparable drainage behaviour and is not subject to biomass removal, these pasture-based results provide quantitative support for the conclusion that phosphorus leaching potential under operational conditions is extremely low.

5.4.3 Salt Behaviour

Salinity modelling shows that salt behaviour is characterised by effective leaching sufficient to prevent accumulation in the rootzone, while maintaining stable long-term conditions.

Quantitative salt leaching behaviour is consistent across vegetation scenarios. For the Rhodes grass pasture sensitivity analysis, MEDLI outputs indicate:

- Average annual salt added and leached at steady state: approximately 5,110 kg/ha/year; and
- Average rootzone salinity (ECe): approximately 0.63 dS/m.

This demonstrates that rootzone salinity remains well below crop tolerance thresholds. The leaching fractions are considered to be sufficient to prevent salt accumulation within the soil profile. There is no upward trend in soil salinity observed over the simulation period, indication that the irrigation scheme would be well within acceptable salinity limits, and does not present an environmental risk.

5.5 Drainage and Potential for Lateral Subsurface Flow

The groundwater assessment demonstrates that the regional groundwater table lies at approximately 8–10 m below ground level across the Project area. Additionally, the shallow Tertiary sediments (within which the irrigation soils occur) are unsaturated across the site with no shallow or perched groundwater system identified in the investigation data.

This provides a minimum vertical separation of approximately 7–9 m between the base of the soil profile and the regional groundwater table. Which implies that even where the cemented pan is present at ~0.8 m any perched water is temporary and limited to the soil profile, and there remains a substantial unsaturated zone available for storage, redistribution, and attenuation of infiltrating water.

The MEDLI modelling explicitly simulates the oil water storage, drainage volume, and episodic deep percolation driven by climate (particularly wet-season rainfall). The model outputs show that drainage events are infrequent and climate-controlled, with no sustained saturation of the soil profile. The soil water content regularly returns below the DUL, indicating that perched conditions are not persistent.

While the model assumes parameterised vertical drainage, the actual results demonstrate that the soil profile does not remain saturated for extended periods that would promote sustained lateral subsurface flow.

The presence of a cemented pan may allow short-term lateral movement of water during periods of high soil moisture. However, several site characteristics limit this process:

a) Landscape position

- The irrigation area is located on a level to very gently sloping plain (<1%)
- Limited hydraulic gradient reduces the driving force for lateral flow

b) Soil structure

- Subsoils are massive and include clay fractions, which:
    i. Reduce lateral permeability, and
    ii. Limit preferential flow pathways

c) Climatic regime

- High evaporation relative to rainfall for most of the year
- Wet-season driven drainage that occurs in pulses rather than sustained saturation

d) Surface Water and Groundwater

- The primary downgradient feature is an unnamed tributary located approximately 300 m from the edge of the irrigation area.
- The groundwater table lies ~10 m below the base of drainage features, and
- There is no groundwater–surface water interaction or baseflow connection in the Project area.
- There is no evidence of seepage zones, springs, or wet areas between the irrigation area and the tributary;
- Surface drainage is dominated by episodic overland flow during rainfall events.

Any lateral flow above the pan would be localised and short-lived, highly dependent on wet-season rainfall, and insufficient to create a consistent subsurface transport pathway.

The presence of a cemented layer at shallow depth may locally influence vertical drainage and result in temporary perching of soil water following rainfall or irrigation. However, this effect is limited by the low gradient of the site, the soil structure, and the highly seasonal climate. There is no evidence of persistent perched water or lateral seepage within the irrigation area. Surface water features are separated from the irrigation area by approximately 300 m and are not hydraulically connected to the soil profile or groundwater system. Accordingly, the presence of the cemented layer does not result in a credible pathway for off-site transport of nutrients or contaminants.

The MEDLI model applied in this assessment simulates vertical soil water movement, plant uptake, and drainage processes using a one-dimensional soil water balance framework. This approach is consistent with the intended application of MEDLI for land application system assessment and reflects the dominant water movement processes for the site conditions.

Explicit modelling of lateral subsurface flow was not undertaken. This is considered appropriate based on both the capability of the modelling framework and the site-specific hydrogeological and landscape conditions, which indicate that lateral flow is not a dominant or persistent transport pathway at this site.

Even if lateral flow were explicitly modelled, the governing constraints (low gradient, soil structure, unsaturated zone, receptor separation) mean that lateral flux would be of a very low magnitude, over a short distance, and intermittent. It would not materially alter the deep drainage volumes, nutrient loading outcomes, or the environmental risk conclusions.

5.6 Groundwater Interception

Given the hydrogeological setting any groundwater recharge or downward flux originating beneath the irrigation area would migrate toward the mine pit. Additionally, there is no groundwater flow pathway from the irrigation area toward off-site receptors or external groundwater users. The irrigation area lies hydraulically up-gradient of the mine pit within the Gilbert River Formation aquifer system.

The proposed open-cut mine is excavated well below the groundwater table, intersecting the Gilbert River Formation at approximately 10 mbGL, and extending to a final pit depth of approximately 250 mbGL. As a result, groundwater inflows to the mine pit will occur and require active dewatering. The mine pit therefore functions as a long-term hydraulic sink, actively intercepting groundwater that would otherwise flow through the Project area.

The groundwater assessment demonstrates that the irrigation area operates within a controlled hydrogeological environment. Groundwater depth, flow direction toward the mine pit, and active groundwater interception and management provide strong containment of any potential downward drainage. As a result, the risk of off-site groundwater impact from nutrient or salt leaching associated with effluent irrigation is considered very low under operational conditions.

The identification of the mine pit as a hydraulic sink is appropriate for assessing potential groundwater pathways; however, the likelihood, magnitude, and relevance of effluent-derived constituents reaching groundwater and subsequently being captured within the mine water management system are very low when considered in the context of soil, hydrogeological and modelling evidence.

In addition to soil profile processes, further attenuation is expected within the unsaturated zone beneath the irrigation area. This zone comprises approximately 7–9 m of unsaturated Tertiary sediments, which are characterised by low permeability and limited vertical connectivity. As water moves through this zone, additional processes including adsorption, dispersion, and microbial transformation are expected to further reduce nutrient concentrations prior to reaching the water table. This provides a secondary barrier that is not explicitly represented in the MEDLI model but is inherent to the site hydrogeology.

Even in the unlikely event that drainage reaches the groundwater table, the resulting contribution to groundwater loading would be negligible relative to the overall groundwater flux intercepted by the mine pit. Groundwater modelling indicates average inflows to the pit of approximately 640 ML/year, with peak inflows of up to approximately 2963 ML in year 5. By comparison, potential drainage derived from the irrigation area represents a very small component of the overall groundwater budget. Any constituents entering groundwater would therefore be subject to significant dilution within the regional groundwater flow system prior to interception by the pit.

Groundwater captured within the mine pit is managed as part of the site's mine water management system, which is designed to contain, reuse, and treat water in accordance with environmental authority conditions. The minor and highly diluted contribution of any irrigation-derived constituents does not materially change the quality or management requirements of mine water, which is already subject to monitoring and control. Accordingly, the interception of groundwater by the pit provides a containment mechanism for any potential migration pathways, without creating a material additional burden on the mine water management system.

6 Aerosols, Pathogens, Odour and Toxins

6.1 Aerosols and Pathogens

A spray irrigation system is the most cost effective and practical method of irrigation for this site. Spray irrigation systems disperse effluent through the air, which can result in a fine mist. The aerosols can contain pathogens which can be carried for some distance on the wind.

There are a range of measures which can be put into effect to minimise the exposure risk to mine workers from exposure to aerosols. The *National Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006* contain guidance based on achieving pathogen hazard log reduction targets. If these hazard reduction targets can be achieved for the given scenario, the human health risk is considered to be negligible. The appropriate targets for a STP system such as the one proposed for this project have been extracted and presented below in Table 10 below. The reduction targets are as follows:

- Viruses – 5.0 log reductions.
- Protozoa – 3.5 log reductions.
- Bacteria – 4.0 log reductions.

Hazard log reduction targets can be achieved via treatment alone, or in combination with exposure reduction measures. These are discussed in further detail in Section 8.1 and Section 8.2.

Table 10: Pathogen reduction targets for priority uses of recycled water from treated sewage

Activity	Route of exposure	Exposure (litres) x freq (per year)	Log reduction		
			Cryptosporidium	Rotavirus	Campylobacter
Dual reticulation					
Garden irrigation	Ingestion of sprays Ingestion – Low – High **Total**	0.0001 x 90 0.001 x 90 0.1 x 1 0.2	**4.4**	**5.8**	**4.6**
Internal uses					
Toilet flushing	Ingestion of sprays	0.00001 x 1100	3.1	4.5	3.3
Washing machine	Ingestion of sprays	0.00001 x 100	2.1	3.5	2.3
Cross-connections	Ingestion	1 x 0.365	4.7	6.1	4.8
Total internal use (no garden use)		0.38	4.7	6.1	4.8
Total residential use (garden + internal)		0.67	4.9	6.3	5.1
Municipal Irrigation	Ingestion of sprays	0.001 x 50	3.7	5.2	4.0
Dual reticulation plus municipal irrigation	Ingestion water and sprays	0.72	5.0	6.4	5.1
Fire fighting	Ingestion water and sprays	0.02 x 50	5.1	6.5	5.3

Log reduction calculations:

Cryptosporidium = Log (number of organisms in sewage x exposure (L) x frequency / 1.6×10^{-2})

Rotavirus = Log (number of organisms in sewage x exposure (L) x frequency / 2.5×10^{-3})

Campylobacter = Log (number of organisms in sewage x exposure (L) x frequency / 3.8×10^{-2})

6.1.1 Recommended Combination of Treatment and Exposure Reduction

The *National Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006* provide examples of how log reductions using treatment (Section 9.2) and exposure control (Section 9.3) can be achieved. The three examples which are relative to municipal irrigation are provided below in **Table 11**. The options are presented in order of highest level of treatment, to lowest level of treatment. The lower the level of treatment, the higher the level of exposure reductions measures are required.

It is recommended that the sewage treatment plant be designed to achieve a minimum Class C recycled water standard (E. coli <1000 cfu/100 mL), consistent with secondary treatment systems commonly used in remote accommodation settings. In accordance with the National Guidelines for Water Recycling, pathogen risk should be managed through a combination of treatment performance and exposure reduction measures.

The irrigation area is located approximately 55 m from accommodation and is separated by retained native vegetation, which is recommended to be maintained as a physical barrier to intercept spray drift and aerosols. Additional controls should include the use of low-trajectory irrigation systems, operational restrictions to avoid irrigation during adverse wind conditions, and controlled access to the irrigation area during and after irrigation events.

This approach is consistent with the “municipal irrigation with enhanced access restrictions” framework, under which Class C recycled water can be considered appropriate when supported by effective exposure controls. Collectively, these measures are expected to reduce pathogen exposure risk to workers to an acceptable level.

6.2 Odour

Odour can be released by the sewage treatment plant and the irrigation field. Odour is spread in a similar manner to that of aerosols and can be dealt with in a similar manner.

Odour can be reduced by aiming for a higher level of treatment. Otherwise, setback distances tend to be highly effective in addition to aerosol reduction measures (i.e. using aerosol limiting spray methods). Timing also plays a part in minimising odour drift, such as avoiding irrigation when the prevalent wind direction is towards nearby accommodation facilities. Irrigation can also be best timed during the day when staff are at work. Avoid irrigating in periods such as cold still winter nights when temperature inversions commonly occur and “trap” odours towards the ground.

6.3 Toxins

Aside from nutrients and pathogens, wastewater can contain other toxins. Domestic sources of wastewater can contain heavy metals, pesticides and pharmaceuticals. These tend to only pose a direct risk to humans if the treated wastewater is intended for re-use to supplement a drinking water supply. In such cases, the wastewater must be treated to an extremely high level to address these risks.

In this case, the only risk posed by toxins is via aerosol exposure which could result in dermal contact or inhalation. This would generally need to occur over a prolonged period to result in any noticeable effects. The most effective way to minimise health risks from toxins is to reduce the production of aerosols during irrigation, implement access restrictions to the irrigation area, and ensure buffer zones are implemented.

Table 11: Examples of how pathogen log reduction targets can be achieved for Municipal Irrigation systems

Log reduction targets (Virus, Protozoa, Bacteria) [a]	Indicative treatment process	Log reductions achievable by treatment (Virus, Protozoa, Bacteria)	On-site preventative measures	Exposure reduction [b]	Water quality objectives [c]
Municipal use – open use, sports grounds, golf courses, dust suppression, etc *or* unrestricted access and application					
5.0 3.5 4.0	Advanced treatment required; for example: Secondary, coagulation, filtration and disinfection Secondary, membrane filtration, UV light	5.0 (V) 3.5 (P) 4.0 (B)	No specific measures		To be determined on case-by-case basis depending on technologies Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) *E. coli* < 1 per 100ml
Municipal use, with restricted access and application					
5.0 3.5 4.0	Secondary treatment with disinfection	2.0 - 3.0 (V) 1.0 (P) >6.0 (B)	Restrict public access during irrigation and one of the following: No access after irrigation, until dry (1-4 hours) Minimum 25-30m buffer to nearest point of public access Spray drift control; for example, through low-throw sprinklers (180º inward throw), vegetation screening, or anemometer switching	2.0 1.0 1.0 1.0	BOD < 20mg/L[d] SS < 30mg/L[d] Disinfectant residual (e.g. minimum chlorine residual) or UV dose[e] *E. coli* < 100cfu/100mL
Municipal use, with enhanced restrictions on access and application					

Log reduction targets (Virus, Protozoa, Bacteria) [a]	Indicative treatment process	Log reductions achievable by treatment (Virus, Protozoa, Bacteria)	On-site preventative measures	Exposure reduction [b]	Water quality objectives [c]
5.0 3.5 4.0	Secondary treatment with > 25 days lagoon detention or primary treatment with > 50 days lagoon detention Secondary treatment	1.0 – 3.0 (V) 1.0 – 3.0 (P) 3.0 – 4.0 (B) 0.5 – 2.0 (V) 0.5 – 1.0 (P) 1.0 – 3.0 (B)	Restrict public access during irrigation and combinations of: No access after irrigation, until dry (1-4 hours) Minimum 25-30m buffer to nearest point of public access Spray drift control, e.g. through low throw sprinklers (180º inward throw), vegetation screening or anemometer switching	2.0 1.0 1.0 1.0	BOD < 20mg/L[d] SS < 30mg/L[d] *E. coli* < 1000 cfu/100mL (disinfection may be required to achieve this concentration)

B = enteric bacteria; BOD = biochemical oxygen demand; cfu = colony forming unit; Ct = disinfectant concentration x time; P = enteric protozoa; SS = suspended solid; V = enteric virus; UV = ultraviolet.

a Log reduction targets are minimum reductions required from raw sewage based on 95th percentiles from Table 3.7 of guideline.

b Exposure reductions are those achievable by on-site measures as listed in Table 3.3 of guideline.

c Water quality objectives represent medians for numbers of *E. coli* and means for other parameters.

d BOD and SS are an indication of secondary treatment effectiveness.

e Aim is to demonstrate reliability of disinfection and ability to consistently achieve microbial quality.

f Log reductions for public in the vicinity of commercial food crop irrigation areas should comply with total log reductions required for municipal use.

7 Set Out and Management of Irrigation Area

7.1 Spray Irrigation Specifications

The irrigation system will adopt recommendations from AS/NZS 1547:2012 as determined to be appropriate. Key considerations are outlined in the following sections.

7.1.1 Designated Disposal Area

The designated irrigation area:

- is not be used for purposes that compromise the effectiveness of the system or access for future maintenance purposes;
- is to be used only for effluent application;
- will have boundaries clearly delineated and not accessible to livestock to minimise damage;
- will be constructed to capture run-off and seepage of effluent beyond the designated area; and
- will have appropriate buffer areas maintained.

7.1.2 Irrigation System

The spray-irrigation system will be designed to:

- distribute effluent evenly in the designated area;
- control the droplet size, throw and plume height so that the risk of aerosol dispersion and the likelihood of wind draft distributing any effluent beyond the designated area is negligible;
- restrict access and manage as a controlled operational zone with warnings complying with AS 1319 or AS/NZS 1319, at the boundaries of the designated area, clearly visible to mine workers, with wording such as “Recycled Water – Avoid Contact – DO NOT DRINK”;
- have a buffer area to ensure that any potential spray drift is adsorbed within appropriate setback distances; and
- schedule irrigation during periods when accommodation occupancy exposure is lowest (e.g. daytime work hours).

7.2 Buffer Distances

The QLD Government *Technical Guideline for Disposal of Effluent via Irrigation* provide the following distances for reducing the risk associated with land disposal schemes using effluent irrigation:

- Natural waterways: >100 m
    - The edge of the irrigation area is approximately 300 m from the unnamed tributary which runs through the ML.
- Residential facility or public amenities: >50 m
    - The separation distance between the irrigation area and accommodation is approximately 55 m. The National Guidelines for Water Recycling specifically allow for reduced treatment standards (e.g. Class C) where exposure risks are mitigated through a combination of physical controls, operational measures, and restricted access conditions.

- Domestic water bore: > 250 m
- Drinking water catchment and aquatic ecosystems with high ecological value: > 250 m
- Town water supply bore: > 1000m
- Groundwater bore used for potable water supply: >250 m; and
- Groundwater table at a depth: >3 m.

It is recognised that the public buffer of 50 m is greater than that suggested in Table 11. As a conservative measure, it is recommended to implement a 50 m buffer.

7.3 Monitoring Program

A monitoring program will be designed in accordance with the DETSI *Technical Guideline Disposal of Effluent Using Irrigation* and can be adopted into the Irrigation Management Plan. The monitoring program may include periodic monitoring of soil, groundwater, plant tissue, and any available surface water in close proximity to the irrigation area. Often such monitoring programs include 6 monthly or annual monitoring for nutrients, salts, sodicity and contaminants such as metals/metalloids and pesticides.

8 Recommendations

Based on the outcomes of the site suitability assessment, MEDLI modelling results, and evaluation of potential environmental risks, the following recommendations are provided for implementation of the treated wastewater irrigation scheme at the Esmeralda Graphite Project:

- **Irrigation Area Size**
  Adopt a 3 hectare irrigation area for treated effluent disposal. Modelling demonstrates that this configuration achieves equivalent environmental performance to a 4 ha area in terms of hydraulic behaviour, nutrient fate, salinity, and groundwater protection, while avoiding unnecessary expansion of the land application footprint.
- **Irrigation Scheduling and Application Rate**
  Operate the irrigation system using a fixed daily design irrigation rate of approximately 3.5 mm/day, consistent with AS/NZS 1547:2012 for the site soil category. Irrigation should not occur on days with measurable rainfall (>0 mm). This approach provides operational simplicity and delivers outcomes equivalent to more complex soil-moisture-triggered scheduling.
- **Wet-Weather Storage Capacity**
  Provide 60 days of wet-weather effluent storage, based on Average Dry Weather Flow. This capacity is sufficient to manage prolonged wet-season conditions typical of north-west Queensland and prevents uncontrolled discharges during periods when irrigation is not practicable.
- **Vegetation and Land Management**
  Maintain the irrigation area as a non-harvested, low-maintenance land application area, with vegetation cover representative of existing conditions. No reliance should be placed on biomass harvesting for nutrient removal. Vegetation should be managed to maintain soil cover and promote stable evapotranspiration without intensive agronomic intervention.
- **Irrigation System Design**
  Design and operate the spray irrigation system to:
  - Minimise aerosol generation and spray drift through:
    1. Use of low-trajectory or low-pressure sprinklers,
    2. Control of droplet size and throw distance,
    3. Inward-facing irrigation patterns, and
  - Avoidance of high plume or misting systems.
  - Comply with signage and public safety requirements in accordance with AS 1319 / AS/NZS 1319; and
  - Ensure runoff beyond the designated irrigation area does not occur.
- **Buffer Distances**
  Implement buffer distances in accordance with Queensland Government technical guidelines, including:
  - ≥100 m to natural waterways;
  - ≥50 m to accommodation or public access areas (as a conservative measure);
  - ≥250 m to domestic water bores; and

- Maintain a minimum groundwater separation of ≥3 m.

- **Pathogen and Aerosol Risk Management**
  Achieve pathogen hazard log-reduction targets appropriate for spray irrigation through a combination of:
  - Secondary treatment consistent with Class C recycled water quality and
  - Exposure reduction measures such as restricted access during irrigation, buffer distances, spray drift controls, vegetation screening, and irrigation timing to avoid adverse wind conditions.

- **Monitoring and Management Planning**
  Develop and implement an Irrigation Management Plan (IMP) consistent with the DETSI Technical Guideline for Disposal of Effluent Using Irrigation. The monitoring program should include periodic soil and (where practicable) groundwater monitoring for nutrients, salinity, and sodicity, with review frequencies appropriate to operational risk.

- **Adaptive Management**
  Review irrigation performance, monitoring results, and operational practices periodically, and update management measures if required to ensure ongoing compliance with licence conditions and environmental objectives.

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Appendix A. Soil Data

Site D10	Location (mE/mS GDA2020 ZONE 55) / Method, Accuracy: 632931 7915554 / GPS <3.00m	Map Unit / Australian Soil Class: Brown Tenosol	Geology (Dominant): Claraville	Soil Survey Type / Observation Class / Method: Free, detailed, auger	Survey Date / Described by: 26/12/2025 / MCCR

Land use / Landform Pattern / Element / Slope (% slope, clinometer)	Vegetation / Microrelief / Disturbance	Surface condition / surface rock / Rock outcrop	Soil Profile Description								
			Horizon / Depth (m) / Boundary	Field Texture	Structure / Strength / Pedality / Slickensides	Coarse fragments / Segregations	Colour / Mottle / Bleaching	Soil water status / Drainage	Roots Size / Abundance	Depth (m) / Field pH / Dispersion Field Test	Sample (m) / Observations
Grazing Level plain Plain Flat <1.0 / <1.0 ASS Attributes pH < 5 <4: No Presence of corroded mollusc shell: No Jarositic horizons: No Sulfurous smell: No Dead, dying, stunted vegetation, scalded or bare low-lying areas: No Further Assessment: No	Paperbark Open woodland No microrelief No effective disturbance; hoofed animals No erosion	Hard setting No coarse fragments No rock outcrop	A11 0.00-0.10 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	10YR4/2 No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	6.5 / n/a	0.00-0.10 0.20-0.30 0.40-0.50 0.70-0.80
			A12 0.10-0.30 Clear 20-50mm	Loamy sand	Massive Loose	No inclusions or segregations	10YR6/4 No mottles or bleaching	Dry Rapidly drained	Fine 1-2mm Few	6.5 / n/a	
			B21 0.30-0.55 Clear 20-50mm	Clayey sand	Massive Loose	No inclusions or segregations	10YR5/4 No mottles or bleaching	Dry Well drained	Fine 1-2mm Few	6.5 Slight Dispersion after 10 minutes Complete slaking	
			B21 0.55-0.82 End of Borehole	Clayey sand	Massive Loose	No inclusions or segregations	10YR5/4 No mottles or bleaching	Dry Well drained	Fine 1-2mm Few	7.5 Moderate dispersion after 10 minutes Complete slaking	
			C Refusal on cemented pan								

Landscape



Surface



Soil Profile



ESSA /EAL(ASPAC)

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email:e.s.s.a@bigpond.net.au

Date Received: 21/01/2026
Date Completed: 30/01/2026

FINAL REPORT

Project: ESM

All results in this report relate only to the items tested. Results are expressed on an "as received basis".

Client Name: GTE

Contact: Dennis Baker BSc CPSS

Sample Type: Soil

Number of samples: 4 Selected GSM D10

ESSA (EAL)Pty Ltd

Soil Analysis Report

Reference: 26000668 ESSA 267965

R

Rep

Client: GTE GSM

				D10 - 0.00 - 0.10m	D10 - 0.20 - 0.30m
Wet Bulk Density	kg/L	** AS4419 Appendix B	---	1.61	1.55
Dry Bulk Density	kg/L	** AS4419 Appendix B	---	1.59	1.51
Moisture Content 105Â°C	%	** AS4454:2012 Appendix I	<0.1	1	2.6

tecd 21/01/2026

orted 30/01/2026

D10 - 0.40 - 0.50m	D10 - 0.70 - 0.80m
1.35	1.24
1.28	1.16
5.3	6.4

ESSA Pty Ltd/ EAL

METHOD DESCRIPTIONS

Soil

Reference:26000668 ESSA 267965

Methods used to Analyse Samples

Analyte	ALHS*	Uncertainty %	LOQ	Unit	Name	Method Description
pH	4A1	1.1	0.1	pH	pH	1:5 water extr, pH meter
EC	3A1	5.4	0.01	dS/m	Electrical conductivity	1:5 water extr, EC meter
Cl	5A2	10.0	10.0	mg/kg	Chloride	1:5 water extr, (AA) colorimetric
NO3-N	7C2	6.7	1.0	mg/kg	Nitrate-nitrogen	1:5 water extr, (AA) colorimetric
NH4-N	7C2	7.8	0.6	mg/kg	Ammonium-nitrogen	1M KCl extr, (AA) colorimetric
Bicarb.P	9B2	16.8	1.0	mg/kg	Bicarb.ext.phosphorus	0.5M NaHCO3 @ pH 8.5, (AA) colorimetric
TN	7A2	12.9	0.01	%	Total Kjeldahl Nitrogen	Sulphuric acid digest, (AA) colorimetric
OC	8B1	9.7	0.02	%	Organic Carbon	Walkley & Black, (H2SO4/K2Cr2O7), titr.
Ca (Neut)	15A1	10.3	0.10	meq/100g	Exchangeable calcium	1M NH4Cl @ pH 7.0 shake, AAS
Mg (Neut)	15A1	6.6	0.10	meq/100g	Exchangeable magnesium	1M NH4Cl @ pH 7.0 shake, AAS
Na (Neut)	15A1	7.3	0.03	meq/100g	Exchangeable sodium	1M NH4Cl @ pH 7.0 shake, AAS
K (Neut)	15A1	3.9	0.02	meq/100g	Exchangeable potassium	1M NH4Cl @ pH 7.0 shake, AAS
ECEC	15J1	5.0	1	meq/100g	Effective cation ex.capacity	Sum of exchangeable cations
ESP	15N1	5.0	3	%	Exchangeable Na%	(Exchangeable Na/sum of exch.cations)%
Sand	no ref	22.1	1.0	%	Particle size, sand	Hydrometer, gravimetric
Silt	no ref	16.6	1.0	%	Particle size, silt	Hydrometer, gravimetric
Clay	no ref	12.7	1.0	%	Particle size, clay	Hydrometer, gravimetric
Bulk Density					BD AS4419	AS4419
15 Bar					Pressure Plate	

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992 /2011)**

For Manager Analytical Services: **D E Baker BSc MASSSI**

Director and Principal Soil Scientist – ESSA Pty Ltd



Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.

Soluble Salts included in Exchangeable Cations - Except PRE-WASHED (if EC>0.3dS/m).

Adjunct Professional Fellow Southern Cross University
Chief Soil Chemistry Trainer Soil Science Australia (National & Qld)
Hon. Life Member Soil Science Australia (National & Qld)
Certified Professional Practicing Soil Scientist CPSS

Analyte	ALHS*	Uncertainty %	LOQ	Unit	Name	Method Description
Ca (Alc)	15C1	7.2	0.18	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
Mg (Alc)	15C1	4.7	0.31	meq/100g	Exchangeable magnesium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
Na (Alc)	15C1	9.6	0.09	meq/100g	Exchangeable sodium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
K (Alc)	15C1	4.8	0.02	meq/100g	Exchangeable potassium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
CEC	15I3	5.7	1.0	meq/100g	Cation Exchange Capacity	KNO3 + Ca(NO3)2 extr, (AA) colorimetric
DTPA-Cu	12A1	17.1	0.26	mg/kg	DTPA ext. copper	DTPA extraction, AAS
DTPA-Zn	12A1	16.4	0.10	mg/kg	DTPA ext. zinc	DTPA extraction, AAS
DTPA-Mn	12A1	9.0	0.32	mg/kg	DTPA ext. manganese	DTPA extraction, AAS
DTPA-Fe	12A1	13.0	0.23	mg/kg	DTPA ext. iron	DTPA extraction, AAS
ADMC	2A1	11.9	0.4	%	Air Dried Moisture Content	Gravimetric oven dry @ 105C
R1	NA	20.2	NA		Dispersion Ratio	Ratio [Aqueous dispersible (Silt + Clay):Total (Silt + Clay)]
SO4-S	10B3	11.5	0.6	mg/kg	Sulfate sulfur	Ca(H2PO4)2 @ pH 4.0 extractable sulfate-sulfur, ICPOES
Al	15G1	NA	NA	meq/100g	Exchangeable Aluminium	Exch. Hydrogen and Aluminium by 1M KCl
H+	15G1	NA	NA	meq/100g	Exchangeable Acidity	Exch. Hydrogen and Aluminium by 1M KCl
15 Bar		NA	NA		15 Bar Analysis	Pressure Plate/Gravimetric oven dry @ 105C
1/3 Bar		NA	NA		15 Bar Analysis	Pressure Plate/Gravimetric oven dry @ 105C

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

For Manager
Analytical Services: _____

ESSA Pty Ltd/EAL

QUALITY CONTROL DATA

Reference:26000668 ESSA 267965

Soil

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

Test Method	Units		Actual Value	Acceptance Criteria [Range]
pH	pH	r118		9.7 - 10.1
EC	dS/m	r118		.301 - .334
Cl	mg/kg	r118		28 -40
NO3-N	mg/kg	rv		3 - 8
NH4-N	mg/kg	B		80-96
Olsen P	mg/kg	rv		15 - 20
Total Kjeldahl N	%	32-13		.329 - .485
Total P	%	aspac 111		.040 - .052
Organic Carbon	%	rv		1.82 - 2.3
Ca (Exch. cations)pH7	meq/100g	B		6.96 - 8.04
Mg (Exch. cations)pH7	meq/100g	B		1.88 - 2.22
Na (Exch. cations)pH7	meq/100g	B		.057 - .182
K (Exch. cations)pH7	meq/100g	B		1.21 - 1.41
Exch. Acidity	meq/100g			NA
ECEC	meq/100g	A		NA
CEC	meq/100g	S12		58 - 73
ESP	%	A		NA
Coarse sand	%	RD		29 -33
Fine Sand	%	RD		27 - 32
Silt	%	RD		10 - 16
Clay	%	RD		21 - 29
Bulk Density	Kg/L	NA		NA
R1		RD		.38 - .57

Test Method	Units	Test Soil	Actual Value	Acceptance Criteria [Range]
DTPA-Cu	mg/kg	112-09		1.52 - 1.82
DTPA-Zn	mg/kg	112-09		1.25 - 1.45
DTPA-Mn	mg/kg	112-09		148 - 178
DTPA-Fe	mg/kg	112-09		7.9 - 13.2
Suflate-sulfur	mg/kg	B		5 - 12
ADMC	%			NA
Bulk Density	Kg/L			NA
15 Bar	%	G	29, 29, 30, 31	23 - 32
0.33 Bar	%	G		36 - 52
Ca (Exch. cations)pH8.5	meq/100g	S12		27.7 - 37.4
Mg (Exch. cations)pH8.5	meq/100g	S12		22.6 - 26.5
Na (Exch. cations)pH8.5	meq/100g	S12		2.0 - 2.28
K (Exch. cations)pH8.5	meq/100g	S12		1.64 - 2.09

eurofins | APAL

Crop	Actual Crop	SubmissionID	SamplingDate	DateReceived	BatchID
		150293		2026-01-19	47754
		150293		2026-01-19	47754
		150293		2026-01-19	47754
		150293		2026-01-19	47754

Eurofins APAL Test Method Codes

Batch Position No.	AgentName	ClientName	SampleName	Barcode
7	GT Environmental - Reece McCann	GT Environmental	D10-0.00-0.10	111978310
9	GT Environmental - Reece McCann	GT Environmental	D10-0.20-0.30	111978311
8	GT Environmental - Reece McCann	GT Environmental	D10-0.40-0.50	111978312
6	GT Environmental - Reece McCann	GT Environmental	D10-0.70-0.80	111978313

				TMs-004A
SampleDepth	**Postcode**	**Transect GPS Start**	**Transect GPS Finish**	**pH 1:5 water**
				pH units
	4120	N/A	N/A	6.4
	4120	N/A	N/A	6.26
	4120	N/A	N/A	7.24
	4120	N/A	N/A	7.74

TMs-004B4	TMs-007NO3	TMs-007NH4	TMs-009B	TMs-015C1
pH CaCl2 (following 4A1)	**Nitrate - N (2M KCl)**	**Ammonium - N (2M KCl)**	**Colwell Phosphorus**	**Calcium (Ca) - prewash alc. pH 8.5 NH4Cl**
pH units	mg/kg	mg/kg	mg/kg	mg/kg
5.08	<1.0	<1.0	<5.0	120
4.98	<1.0	<1.0	<5.0	108
5.9	<1.0	<1.0	<5.0	194
6.3	<1.0	<1.0	<5.0	121

TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1
Magnesium (Mg) - prewash alc. pH 8.5 NH4Cl	**Potassium (K) - prewash alc. pH 8.5 NH4Cl**	**Sodium (Na) - prewash alc. pH 8.5 NH4Cl**	**Calcium (Ca) - prewash alc. pH 8.5 NH4Cl**	**Magnesium (Mg) - prewash alc. pH 8.5 NH4Cl**
mg/kg	mg/kg	mg/kg	cmol/kg	cmol/kg
14.8	46.8	<6.0	0.596	0.122
22.4	29.4	<6.0	0.54	0.184
62.3	25.4	<6.0	0.97	0.513
105	62.2	30.6	0.603	0.863

TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1
Potassium (K) - prewash alc. pH 8.5 NH4Cl	**Sodium (Na) - prewash alc. pH 8.5 NH4Cl**	**Ca:Mg ratio**	**K:Mg ratio**	**GTRI**
cmol/kg	cmol/kg			
0.12	<0.020	4.9	0.98	
0.075	<0.020	2.9	0.41	
0.065	<0.020	1.9	0.13	
0.159	0.133	0.7	0.18	

TMs-015C1	TMs-015G	TMs-015G	TMs-015G	TMs-Cal02
ECR	**Exchangeable acidity**	**Exchangeable aluminium**	**Exchangeable hydrogen**	**ECEC**
%	cmol/kg	cmol/kg	cmol/kg	cmol/kg
14	<0.02	<0.02	<0.02	0.84
9.9	<0.02	<0.02	<0.02	0.8
5	<0.02	<0.02	<0.02	1.56
17	<0.02	<0.02	<0.02	1.76

TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02
Calcium	**Magnesium**	**Potassium**	**Sodium**	**Aluminium**
%	%	%	%	%
71.2	14.5	14	<0.2	0
67.2	22.9	9.3	0.5	0
62.2	32.9	4.2	0.8	0
34.3	49.1	9	7.6	0

TMs-Cal02	TMs-005	TMs-003	TMs-007	TMs-003
Hydrogen	**Chloride**	**Salinity EC 1:5**	**Dumas Total Nitrogen**	**TDS**
%	mg/kg	dS/m	% dry wt	mg/L
0	<5	<0.010	<0.030	<6
0	6	<0.010	<0.030	6
0	10	0.023	<0.030	15
0	29	0.055	0.032	35

TMs-002A1	TMs-002A1
% Air-dry Moisture Content	S7 Gravimetric water content of air dried fine fraction (GWCad-ff)
% of dry wt	g/g
<0.1	<0.001
<0.1	<0.001
0.2	0.0017
0.2	0.0019

Appendix B. MEDLI Output Reports

General Information

SCENARIO REPORT: Full run

General information

Enterprise: Esmerelda Project - Run 3 with 2400.00 m3 storage pond volume and 3.00 ha irrigation area
Client: Graphinex
MEDLI user: APEM\Jenna.Huckenswager

Description:

Onsite Workers Camp STP - Scenario 1

Scenario details: Scenario 1 - DUL, 3 ha

Map of location:

Note: If the map above appears as a dark box, check that the network is accessible and that the coordinates are not for a location in the ocean.



Description

Climate information

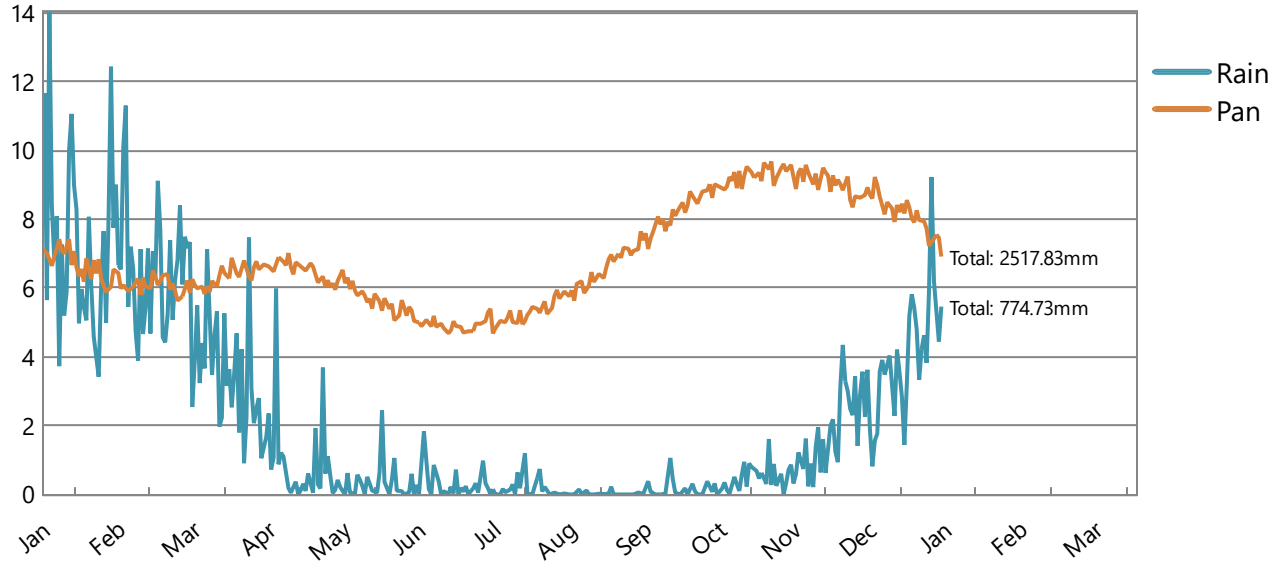
Climate Data Location: CroydonTownship_P51 File_29012, -18.2°, 142.24°
Run Period: 01/01/1976 to 31/12/2025 (50 years)

Climate statistics

	5th Percentile		50th Percentile		95th Percentile	
Rainfall (mm/year)	(Year 2013)	366.2	(Year 1977)	814.8	(Year 2006)	1129.4
Pan evaporation (mm/year)	(Year 1998)	2076.8	(Year 1992)	2545.6	(Year 1978)	2880.0

Climate data

Daily average across run period:



Description

Wastestream information

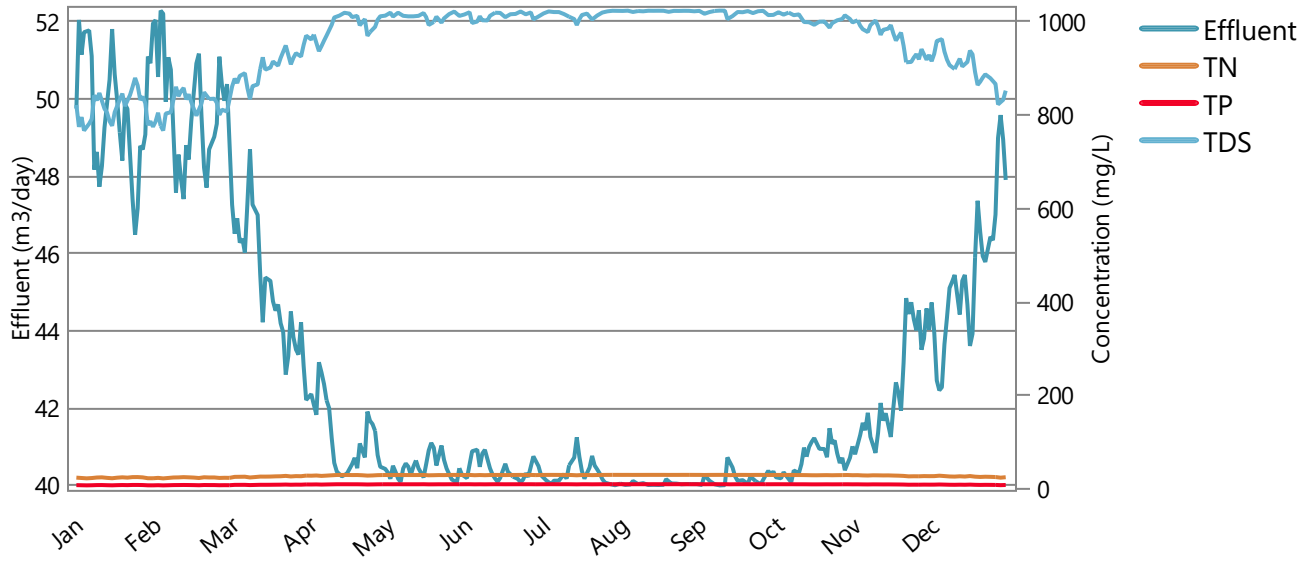
Wastestream Name: - New sewage treatment plant

Wastestream production description

New sewage treatment plant derived from a 200.0 EP (daily average) STP with a capacity of 2.00 times dry weather flow. The STP generates 14610.00 m3 effluent (average dry weather flow), and assumes Average infiltration into sewerage system during wet weather. Dry weather flow effluent quality is 30.00 mg/L total nitrogen, 10.00 mg/L total phosphorus and 1024.00 mg/L total dissoved salts. This wastestream is not separately pretreated.

Wastestream

Average Daily Quantity and Flow-Weighted Average Quality:



Wastestream

Effluent Quantity: 15703.61 m3/year or 42.99 m3/day (Min-Max 40.00 - 80.00)

Flow-Weighted Average (Min - Max) Daily Effluent Quality Entering the Pond System:

	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

STP bypass wastestream

Bypass Quantity: 93.33 m3_per_year (Min-Max: 0.00 - 126.08)

Flow-Weighted Average (Min - Max) Daily Bypass Flow Quality:

	Concentration (mg/L)	Load (tonnes/year)
Total nitrogen	24.25 (13.59 - 34.99)	2.26 (0.00 - 9.61)
Total phosphorus	17.32 (9.71 - 24.99)	1.62 (0.00 - 6.87)
Total dissolved salts	519.56 (291.15 - 749.84)	48.49 (0.00 - 205.98)

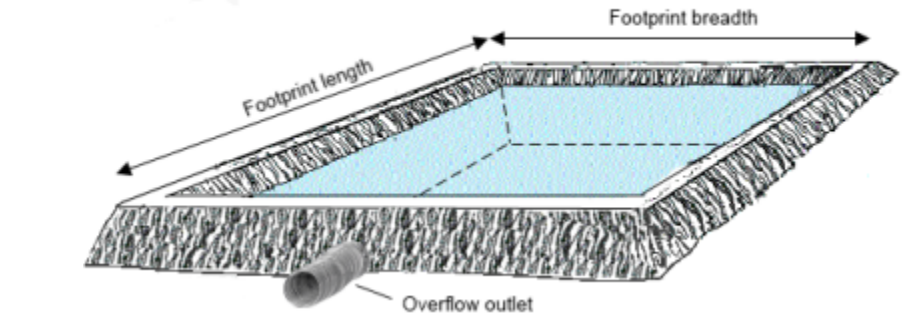
Description

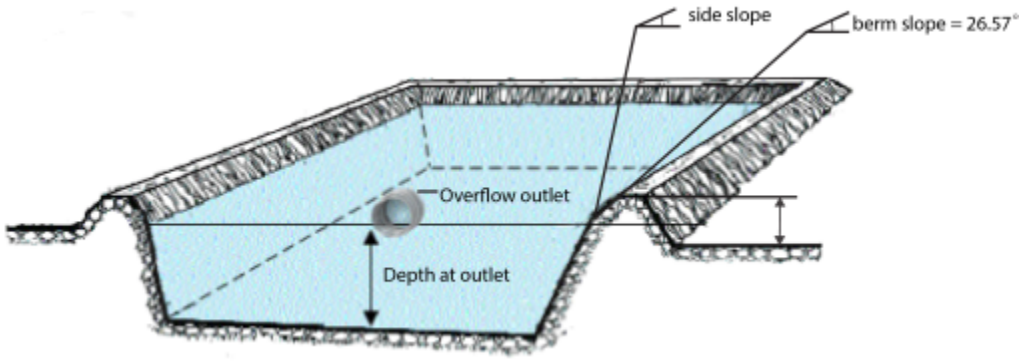
Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system details

	Pond 1
Maximum pond volume (m3)	2400.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	5.00
Maximum water surface area (m2)	480.00
Pond footprint length (m)	21.91
Pond footprint width (m)	21.91
Pond catchment area (m2)	480.00
Average active volume (m3)	128.57





Irrigation pump limits

Minimum pump rate limit (ML/day)	0.00
Maximum pump limit	As scheduled

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	No

Description

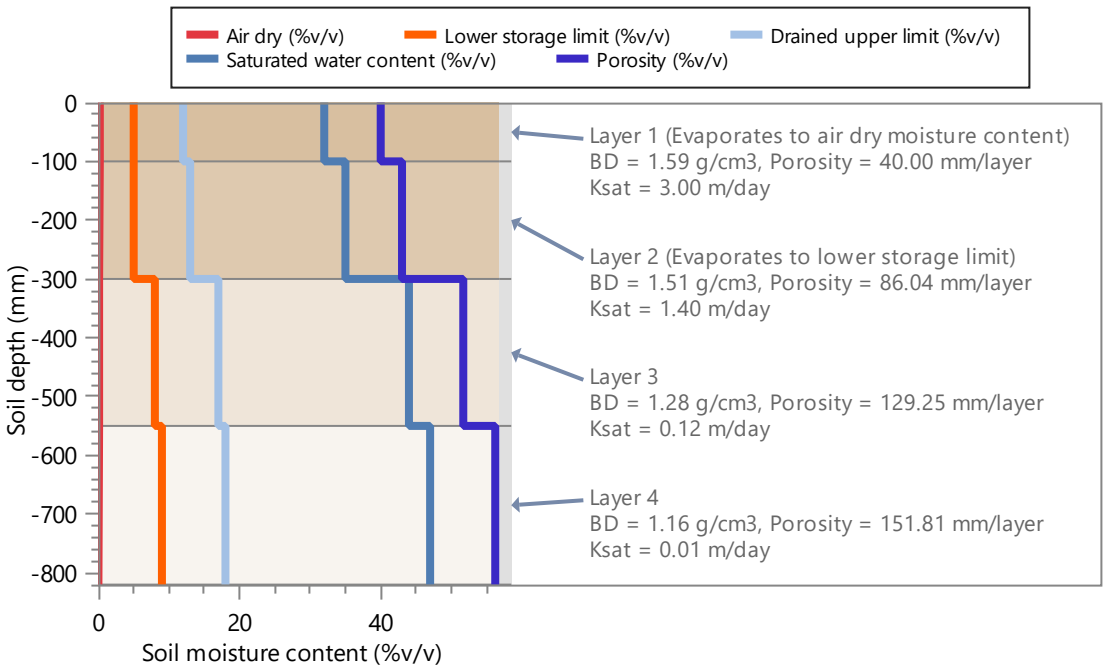
Paddock information

Paddock: New paddock, 3 ha

Soil type: Brown Tenosol - Site Specific, 820.00 mm defined profile depth

Profile porosity (mm)	407.09
Profile saturation water content (mm)	338.90
Profile drained upper limit (or field capacity) (mm)	129.10
Profile lower storage limit (or permanent wilting point) (mm)	59.30
Profile available water capacity (mm)	69.80
Profile limiting saturated hydraulic conductivity (m/day)	0.01
Surface saturated hydraulic conductivity (m/day)	3.00
Runoff curve number II (coefficient)	70.00
Soil evaporation U (mm)	9.50
Soil evaporation Cona (mm/sqrt day)	4.00

Profile



Planting regime: Monthly Green Covers - Deciduous forest cover

Average monthly cover (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 1 x Pan coefficient 1)	1.00
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	0.20
Potential rooting depth in defined soil profile (mm)	820.00
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	20.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.20

Irrigation rules: New irrigation method

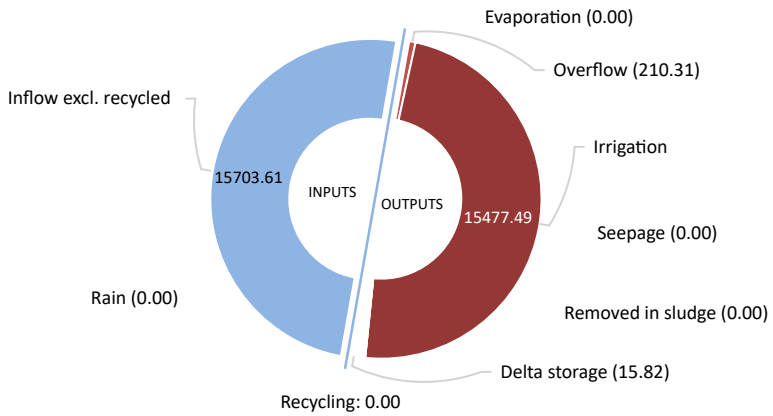
Rule 1. Irrigation triggered every 1 days and rainfall is less than or equal to 0.00 mm
Rule 2. Irrigate up to a soil water content of drained upper limit plus 0.00 mm
Rule 3. Irrigation window from 1/1 to 30/12 including the days specified
Rule 4. A minimum of 0 days must be skipped between irrigation events

Performance

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank (wet weather storage pond: 2400 m3)

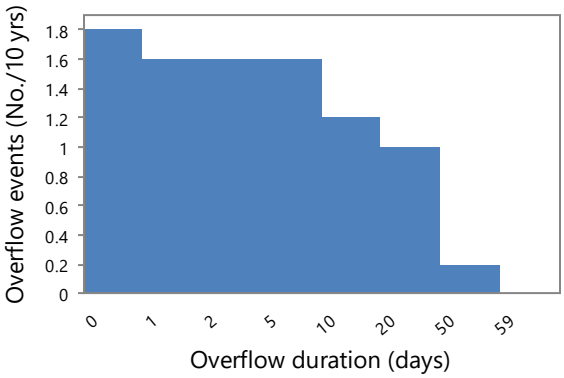
Pond system water balance (m3/year)

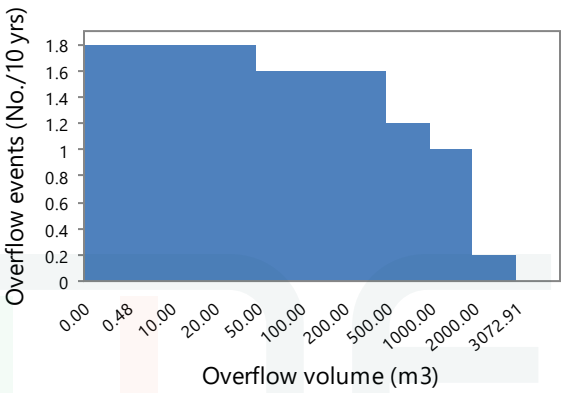


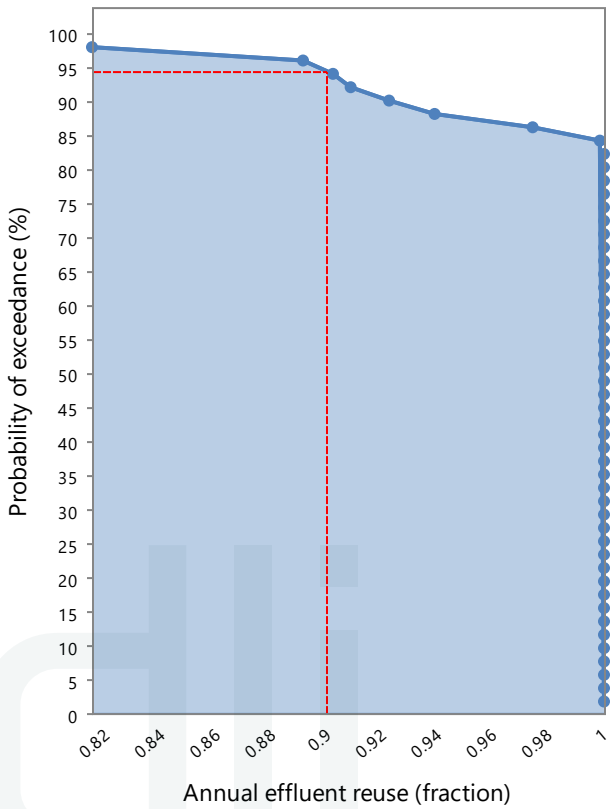
Name	Value
Rain	0.00
Inflow excl. recycled	15703.61
Recycled	0.00
Evaporation	0.00
Overflow	210.31
Irrigation	15477.49
Seepage	0.00
Removed in sludge	0.00
Delta storage	15.82

Overflow and reuse diagnostics

Metric	Value
Total volume of overflow (m3/10 years)	2103.08
Total number of overflow events (events/10 years)	1.80
Total number of pond overflow days (days/10 years)	41.20
Probability of at least 90% effluent reuse (%)	94.47
Effluent reuse (fraction)	0.99





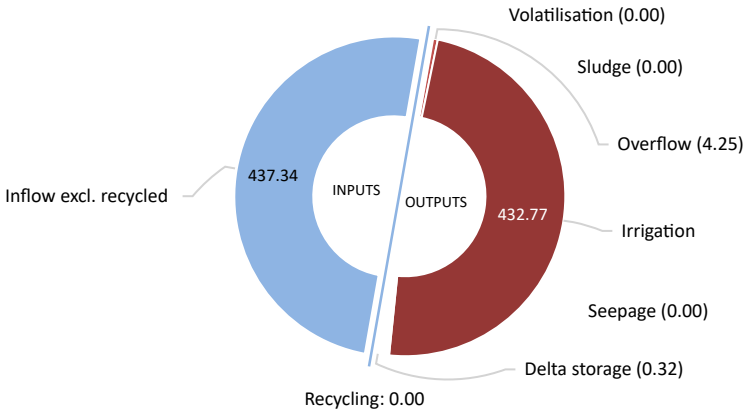


Performance

Pond system information

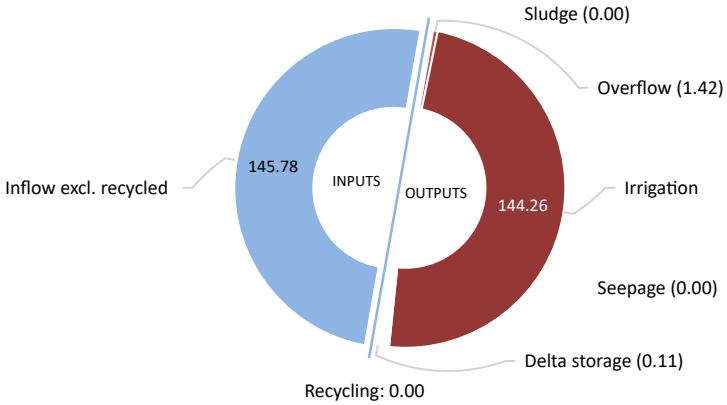
Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system nitrogen balance (kg/year)



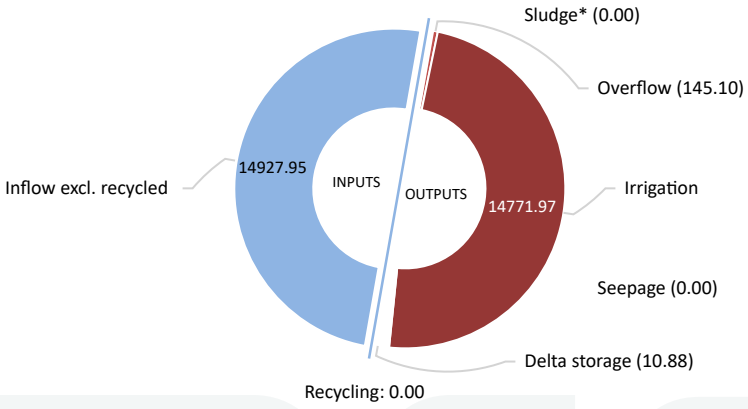
Name	Value
Inflow excl. recycled	437.34
Recycled	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	4.25
Irrigation	432.77
Seepage	0.00
Delta storage	0.32

Pond system phosphorus balance (kg/year)



Name	Value
Inflow excl. recycled	145.78
Recycled	0.00
Sludge	0.00
Overflow	1.42
Irrigation	144.26
Seepage	0.00
Delta storage	0.11

Pond system salt balance (kg/year)



Name	Value
Inflow excl. recycled	14927.95
Recycled	0.00
Sludge*	0.00
Overflow	145.10
Irrigation	14771.97
Seepage	0.00
Delta storage	10.88

* 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 information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond nutrient concentrations and salinity

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	20.58
Average phosphorus concentration of pond liquid (mg/L)	6.86
Average salinity of pond liquid (dS/m)	1.10

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	20.15
Final phosphorus concentration of pond liquid (mg/L)	6.72
Final salinity of pond liquid (dS/m)	1.07

Performance

Water use (assumes 100% irrigation efficiency)

Metric	Value
Pond water irrigated (m3/year)	15477.49
Average shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	15477.49
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

Metric	Value
Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	27.96
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	27.96
Average phosphorus concentration of irrigation water (mg/L)	9.32
Average salinity of irrigation water (dS/m)	1.49

Irrigation diagnostics

Metric	Value
No. periods/year without any irrigable effluent in the wet weather storage pond (periods/year)	0.00
Average length of such periods (days)	0.00

Irrigation triggering and application

No. Days without Irrigation Applied per Year: 67.80 (with rain exceeding specified rainfall threshold [53.70], water demand too small to trigger irrigation [13.10] and day outside of irrigation window [1.00])
No. Days without Irrigation Applied per Year: 67.80 (with not triggered [54.70] and no demand - no application [13.10])
No. Days with Irrigation Applied per Year: 297.46 (with supply limited - partial application [280.16] and full application [17.30])
No. Days with Irrigation Triggered per Year: 310.56

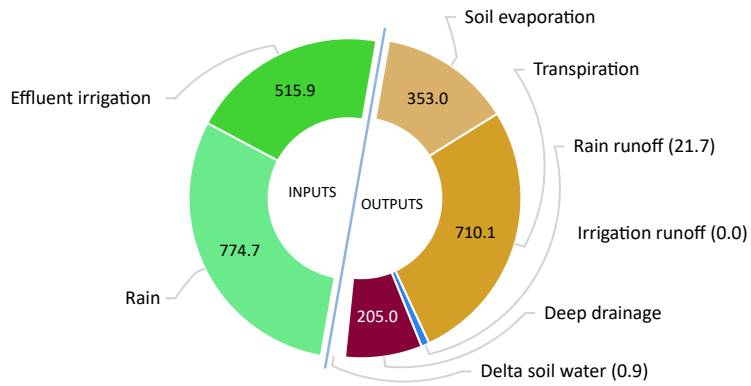
Performance

Paddock information

Paddock: New paddock, 3 ha

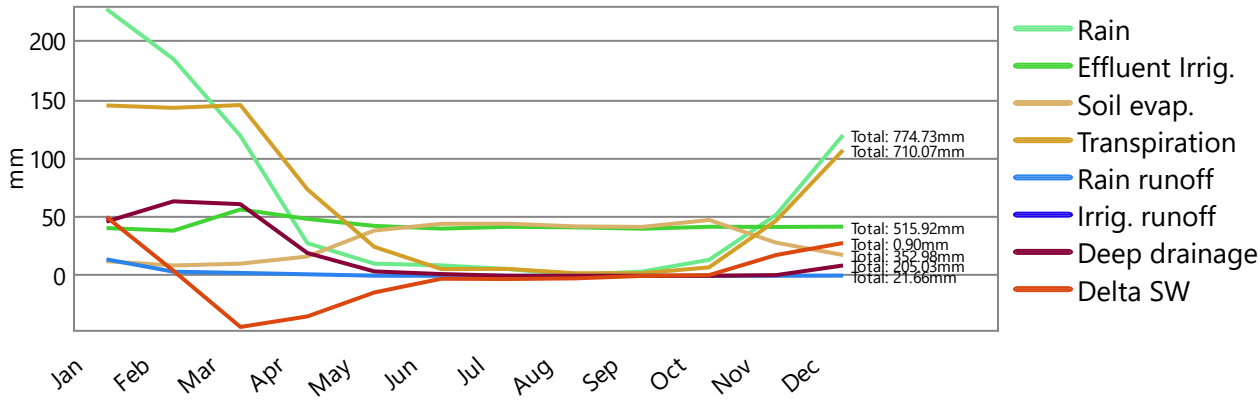
Soil Type: Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

Soil water balance (mm/year)

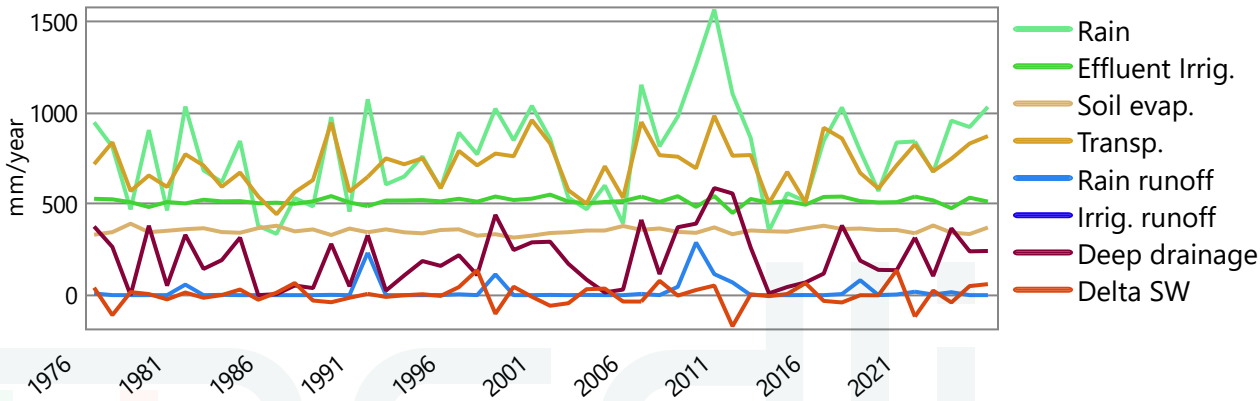


Name	Value
Rain	774.7
Effluent irrigation	515.9
Soil evaporation	353.0
Transpiration	710.1
Rain runoff	21.7
Irrigation runoff	0.0
Deep drainage	205.0
Delta soil water	0.9

Average monthly totals (mm)



Average annual totals (mm/year)



Performance

Paddock information

Paddock: New paddock, 3 ha
Soil Type: Brown Tenosol - Site Specific
Irrigation Ammonia-N Volatilisation Losses (kg/ha/year): 0.00
Proportion of Total Nitrogen in Irrigated Effluent as Ammonium-N (fraction): 0.40
Nitrogen Added by Irrigation: 144.26
Phosphorus Added by Irrigation: 48.09
Planting Regime: Monthly Green Covers - Deciduous forest cover

Plant salinity tolerance

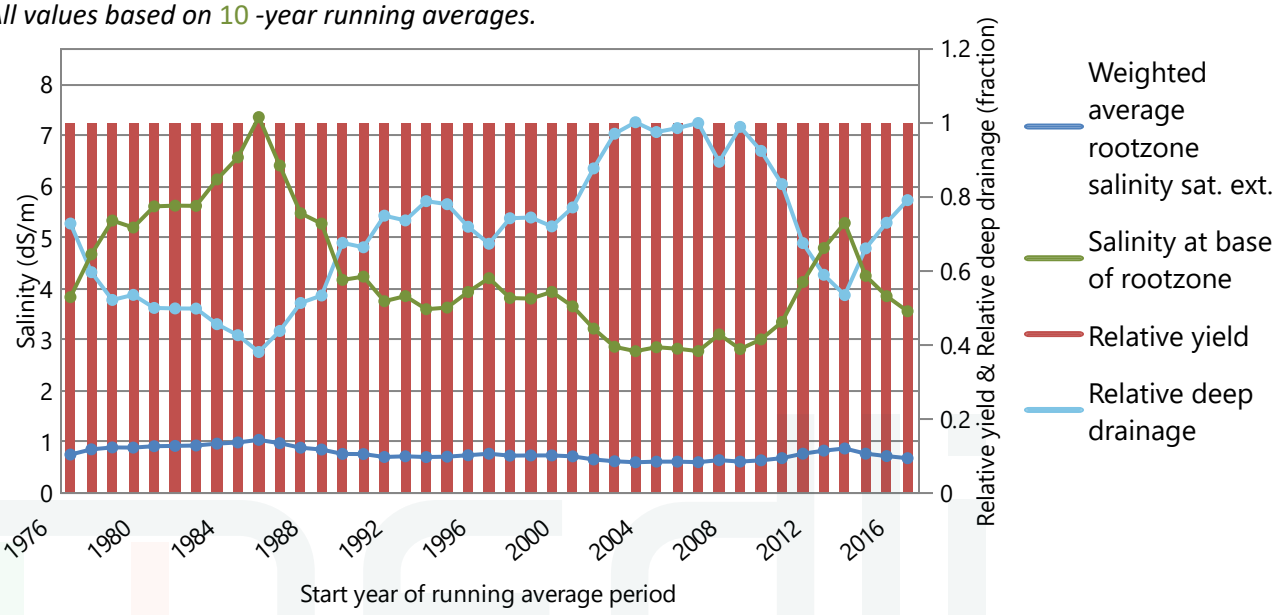
Metric	Value
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	20.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.20
No. years assumed for leaching to reach steady-state (years)	10.00

Soil salinity

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.63
Salt added by rainfall (kg/ha/year)	144.59
Average annual salt added & leached at steady state (kg/ha/year)	5068.58
Average leaching fraction based on 10 -year running averages (fraction)	0.38
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.77
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	4.27
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

All values based on 10 -year running averages.

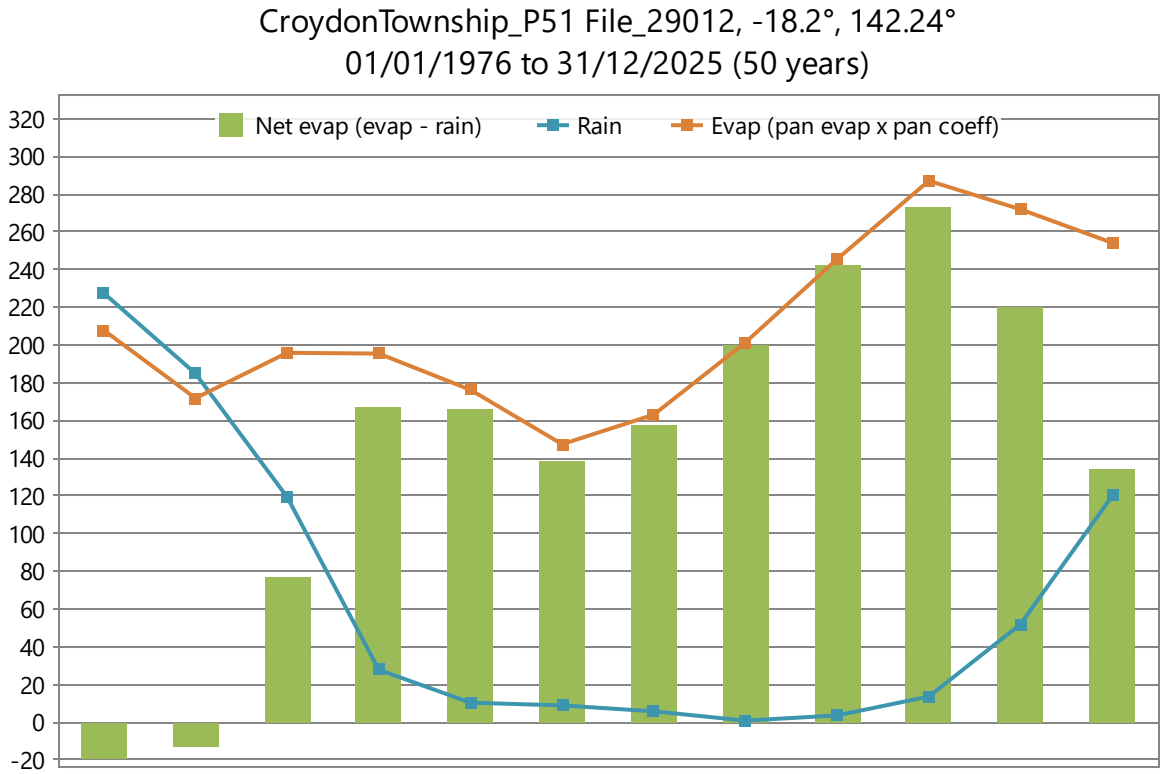


Diagnostics

Scenario information

Enterprise: Esmerelda Project

Climate long-term monthly averages (mm)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Evap	207.8	171.8	195.9	195.4	176.2	147.4	163.1	201.4	245.6	287.1	271.9	254.2	2517.8
Net evap	-19.7	-13.0	76.5	167.6	165.9	138.5	157.3	200.5	241.9	273.4	220.0	134.2	1743.1
Net evap/day	-0.6	-0.5	2.5	5.6	5.4	4.6	5.1	6.5	8.1	8.8	7.3	4.3	4.8

Diagnostics

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Effluent Type: - 15703.61 m3/year or 42.99 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.26 non-zero flow days/year.

Constituent	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

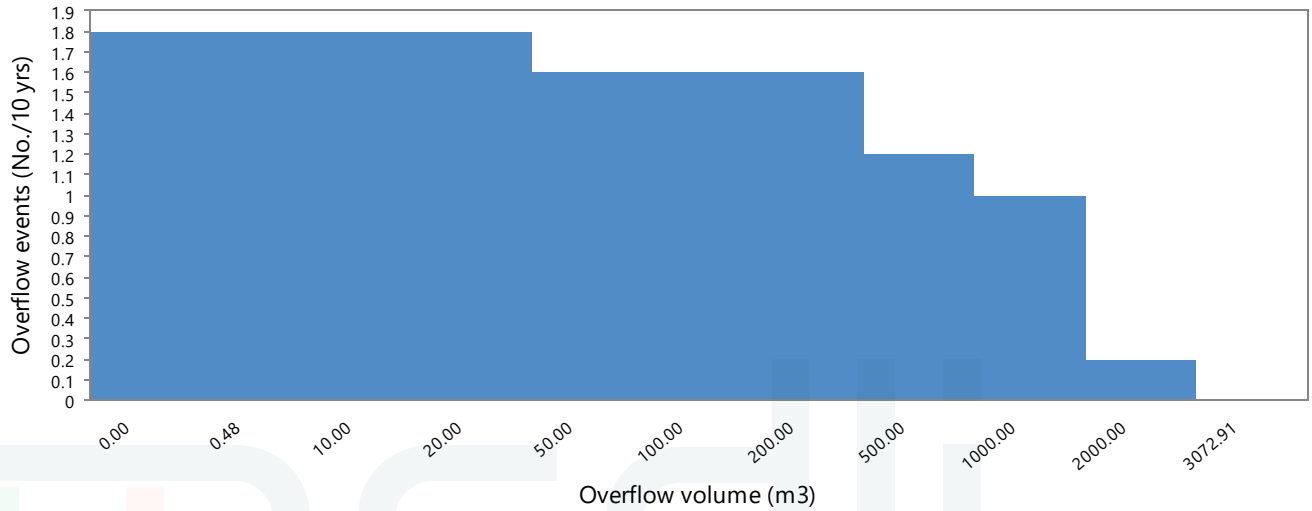
Ammonia-N loss from pond system water surface area: 0.00 kg/m2/year

Last pond (wet weather store): 2400.00 m3

Metric	Value
Theoretical hydraulic retention time (days)	55.82
Volume of overflow (m3/year) Average (minimum-maximum)	210.31 (0.00 - 3072.91)
Volume of overflow per day (m3/day) Average (minimum-maximum)	0.58 (0.00 - 80.00)
No overflow days - Average per year (Total in run period)	4.12 (206)
No. overflow events per 10 years exceeding threshold of 0.480 m3* (events/10 years)	1.80
Average overflow event recurrence interval (years)	5.56
Average duration of overflow (days)	22.89
Probability of at least 90% effluent reuse (%)	94.47
Effluent reuse (propn. of inflow + net rain gain that is irrigated/removed with sludge) (fraction)	0.99
Average salinity (dS/m)	1.10
Salinity on final day of simulation (dS/m)	1.07

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

Volume distribution of the overflow events



Diagnostics

Scenario information

Area irrigated: 3 ha total area

Loading to whole irrigation area: (assuming 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	15477.49	5159.16
Total nitrogen applied (kg)	432.77	144.26
Total phosphorus applied (kg)	144.26	48.09
Total salts applied (kg)	14771.97	4923.99

Shandying

Metric	Value
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)
Minimum shandy water is used	No

Irrigation issues

Metric	Value
Number of days without irrigation (days/year)	67.80

Diagnostics

Paddock information

Paddock: New paddock, 3 ha

Irrigation: New irrigation method with 0% ammonium loss during irrigation

Irrigation triggered every 1 days and when rainfall is less than or equal to 0.00 mm
Irrigate up to a soil water content of drained upper limit plus 0.00 mm
Irrigation window from 1/1 to 30/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil water balance (mm): Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Efflt. irrg.	40.7	38.5	56.6	48.6	42.6	40.3	41.8	41.3	40.2	41.8	41.7	41.9	515.9
Soil evap	12.4	8.8	10.4	16.5	38.6	44.4	44.4	42.2	41.7	47.6	28.3	17.8	353.0
Transpn.	145.2	143.2	145.6	73.8	24.7	5.8	5.9	2.2	2.2	7.2	47.0	107.2	710.1
Rain runoff	14.0	3.5	2.5	1.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	21.7
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	46.3	63.5	61.1	19.5	3.8	1.5	0.0	0.0	0.0	0.0	0.6	8.8	205.0
Delta SW	50.2	4.3	-43.6	-34.6	-14.2	-2.5	-2.7	-2.2	-0.1	0.6	17.7	28.0	0.9

Planting regime: Monthly Green Covers - Deciduous forest cover

Average monthly cover (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Average monthly crop factor (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	0.20
Average rooting depth in defined soil profile (mm)	820.00

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.

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.63
Salt added by rainfall (kg/ha/year)	144.59
Average annual salt added & leached at steady state (kg/ha/year)	5068.58
Average leaching fraction based on 10 -year running averages (fraction)	0.38
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.77
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	4.27
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 information

Messages generated when the scenario was run
Monthly Green Covers plant option does not model soil nitrogen and soil phosphorus.
NOTE: Groundwater nitrate module cannot be run when Monthly Green Covers plant option is chosen
UNCONDITIONAL FINISH

General Information

SCENARIO REPORT: Full run

General information

Enterprise: Esmerelda Project - Run 3 with 2400.00 m3 storage pond volume and 3.00 ha irrigation area
Client: Graphinex
MEDLI user: APEM\Jenna.Huckenswager

Description:

Onsite Workers Camp STP - Scenario 2

Scenario details: Scenario 2 - DIR, 3 ha

Map of location:

Note: If the map above appears as a dark box, check that the network is accessible and that the coordinates are not for a location in the ocean.



Description

Climate information

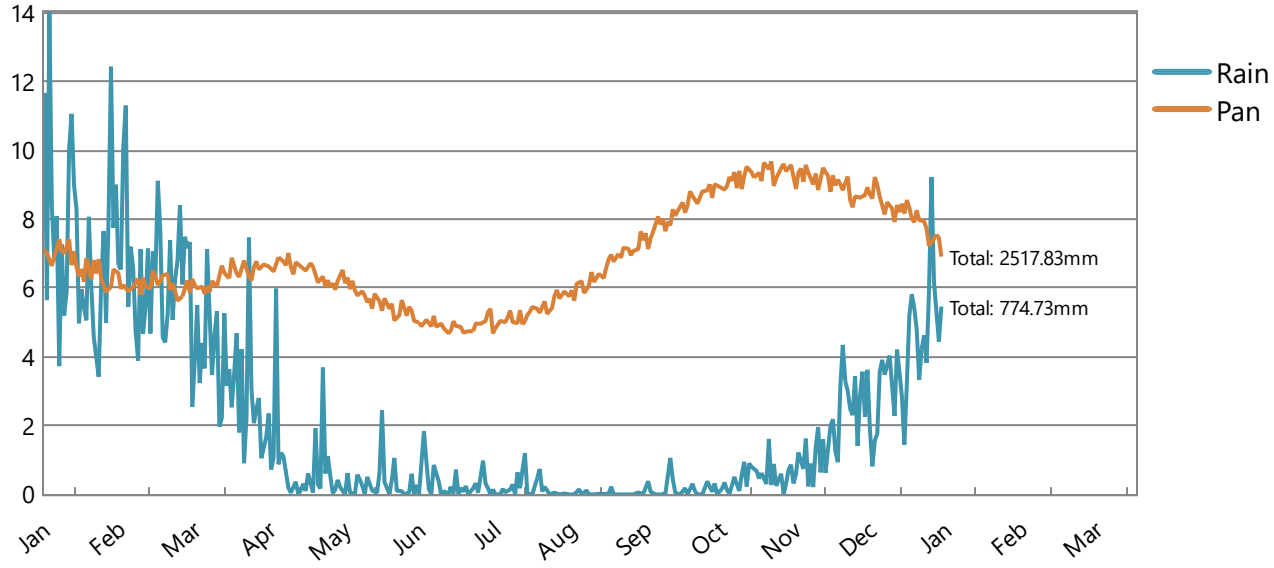
Climate Data Location: CroydonTownship_P51 File_29012, -18.2°, 142.24°
Run Period: 01/01/1976 to 31/12/2025 (50 years)

Climate statistics

	5th Percentile		50th Percentile		95th Percentile	
Rainfall (mm/year)	(Year 2013)	366.2	(Year 1977)	814.8	(Year 2006)	1129.4
Pan evaporation (mm/year)	(Year 1998)	2076.8	(Year 1992)	2545.6	(Year 1978)	2880.0

Climate data

Daily average across run period:



Description

Wastestream information

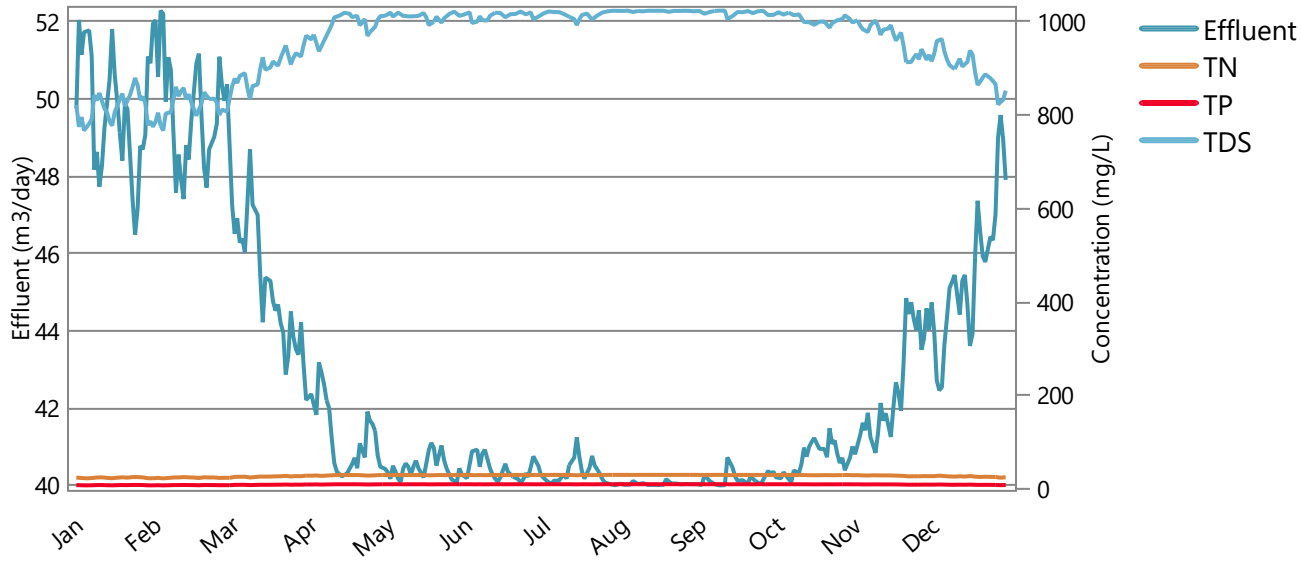
Wastestream Name: - New sewage treatment plant

Wastestream production description

New sewage treatment plant derived from a 200.0 EP (daily average) STP with a capacity of 2.00 times dry weather flow. The STP generates 14610.00 m3 effluent (average dry weather flow), and assumes Average infiltration into sewerage system during wet weather. Dry weather flow effluent quality is 30.00 mg/L total nitrogen, 10.00 mg/L total phosphorus and 1024.00 mg/L total dissoved salts. This wastestream is not separately pretreated.

Wastestream

Average Daily Quantity and Flow-Weighted Average Quality:



Wastestream

Effluent Quantity: 15703.61 m3/year or 42.99 m3/day (Min-Max 40.00 - 80.00)

Flow-Weighted Average (Min - Max) Daily Effluent Quality Entering the Pond System:

	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

STP bypass wastestream

Bypass Quantity: 93.33 m3_per_year (Min-Max: 0.00 - 126.08)

Flow-Weighted Average (Min - Max) Daily Bypass Flow Quality:

	Concentration (mg/L)	Load (tonnes/year)
Total nitrogen	24.25 (13.59 - 34.99)	2.26 (0.00 - 9.61)
Total phosphorus	17.32 (9.71 - 24.99)	1.62 (0.00 - 6.87)
Total dissolved salts	519.56 (291.15 - 749.84)	48.49 (0.00 - 205.98)

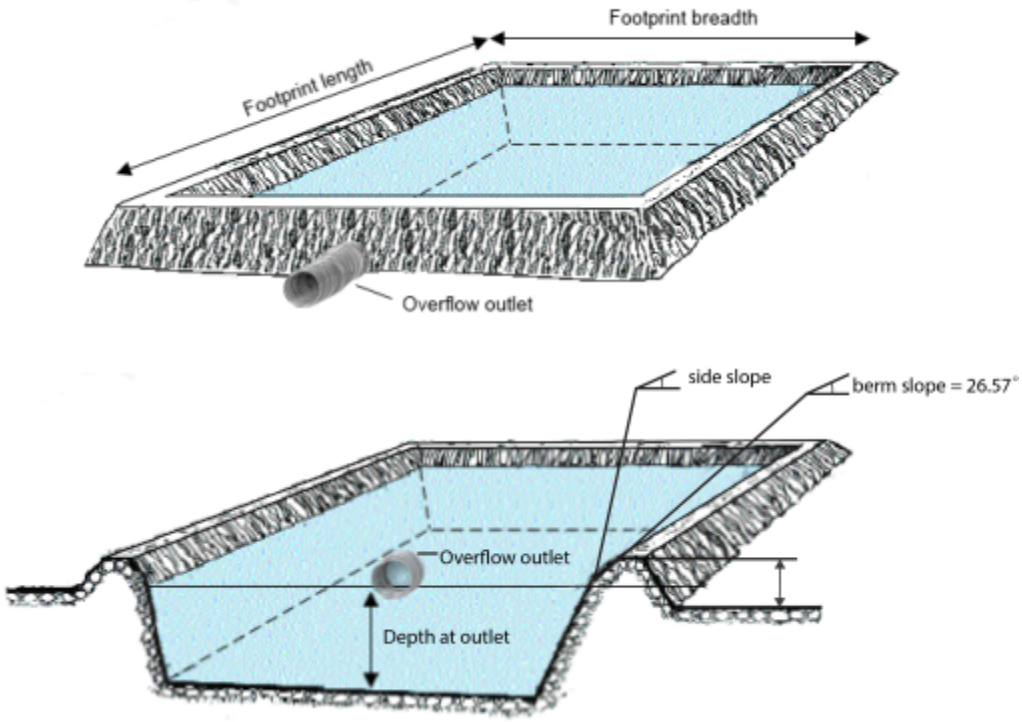
Description

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system details

	Pond 1
Maximum pond volume (m3)	2400.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	5.00
Maximum water surface area (m2)	480.00
Pond footprint length (m)	21.91
Pond footprint width (m)	21.91
Pond catchment area (m2)	480.00
Average active volume (m3)	85.53



Irrigation pump limits

Minimum pump rate limit (ML/day)	0.00
Maximum pump limit	As scheduled

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	No

Description

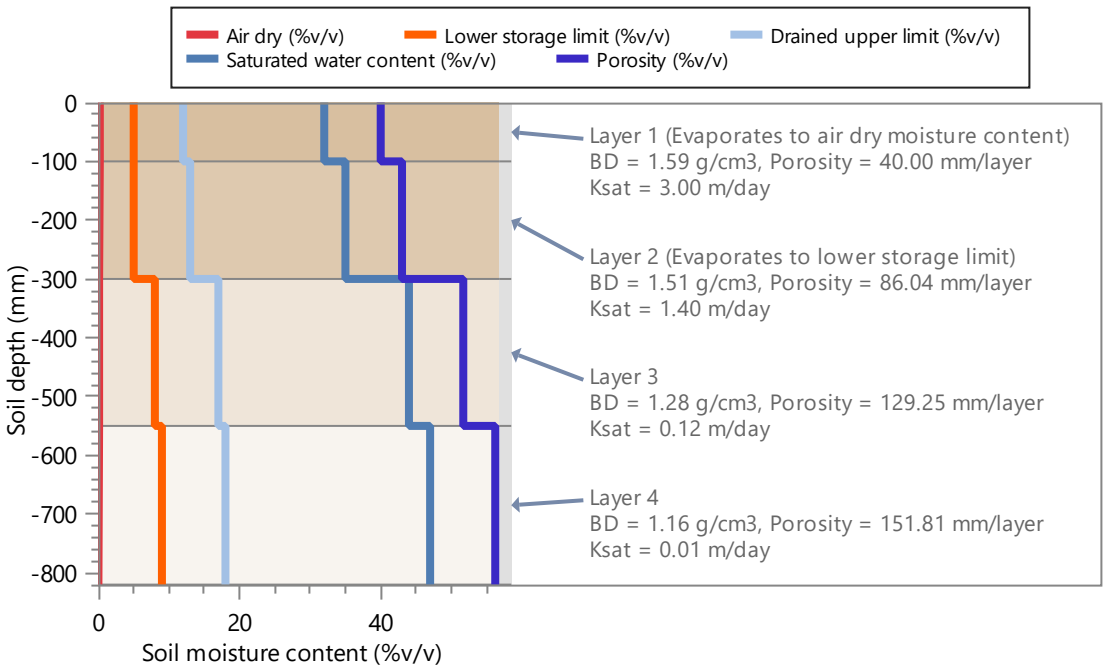
Paddock information

Paddock: New paddock, 3 ha

Soil type: Brown Tenosol - Site Specific, 820.00 mm defined profile depth

Profile porosity (mm)	407.09
Profile saturation water content (mm)	338.90
Profile drained upper limit (or field capacity) (mm)	129.10
Profile lower storage limit (or permanent wilting point) (mm)	59.30
Profile available water capacity (mm)	69.80
Profile limiting saturated hydraulic conductivity (m/day)	0.01
Surface saturated hydraulic conductivity (m/day)	3.00
Runoff curve number II (coefficient)	70.00
Soil evaporation U (mm)	9.50
Soil evaporation Cona (mm/sqrt day)	4.00

Profile



Planting regime: Monthly Green Covers - Deciduous forest cover

Average monthly cover (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 1 x Pan coefficient 1)	1.00
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	0.20
Potential rooting depth in defined soil profile (mm)	820.00
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	20.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.20

Irrigation rules: New irrigation method

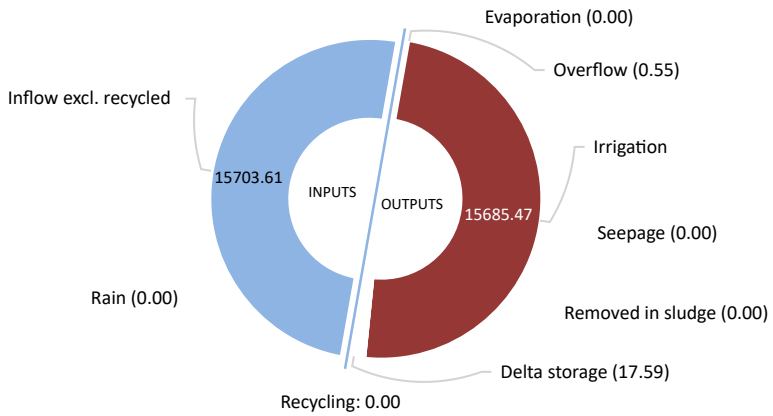
Rule 1. Irrigation triggered every 1 days and rainfall is less than or equal to 0.00 mm
Rule 2. Irrigate a fixed amount of 3.50 mm each day
Rule 3. Irrigation window from 1/1 to 30/12 including the days specified
Rule 4. A minimum of 0 days must be skipped between irrigation events

Performance

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank (wet weather storage pond: 2400 m3)

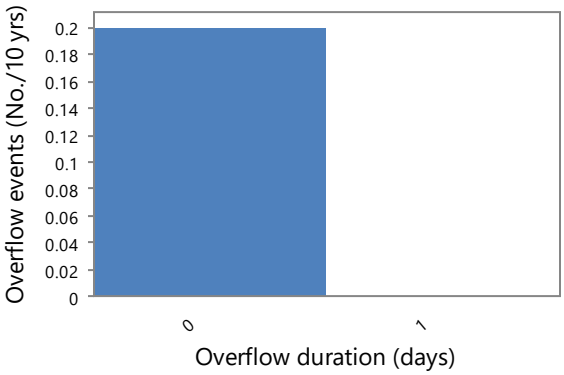
Pond system water balance (m3/year)

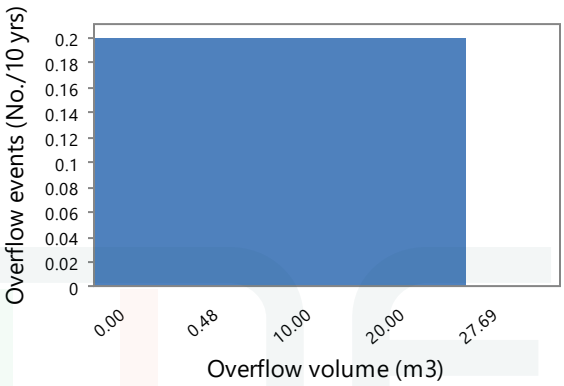


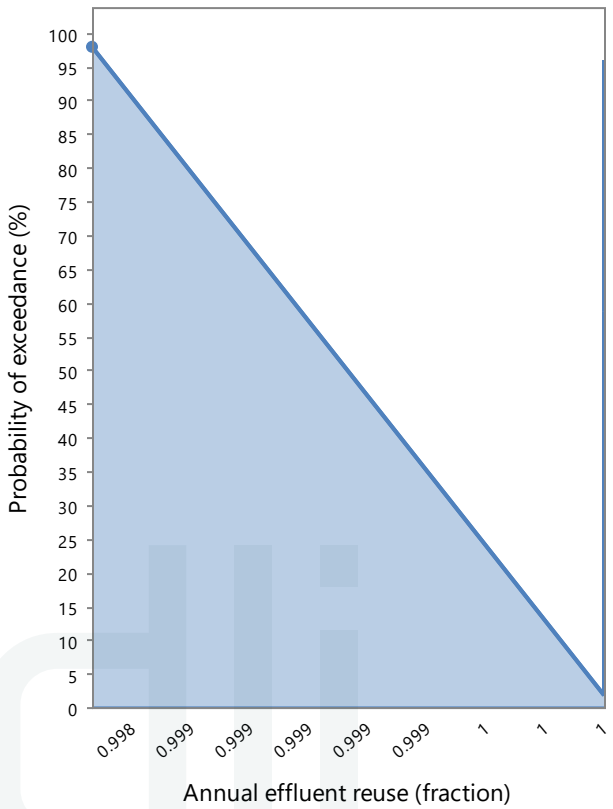
Name	Value
Rain	0.00
Inflow excl. recycled	15703.61
Recycled	0.00
Evaporation	0.00
Overflow	0.55
Irrigation	15685.47
Seepage	0.00
Removed in sludge	0.00
Delta storage	17.59

Overflow and reuse diagnostics

Metric	Value
Total volume of overflow (m3/10 years)	5.54
Total number of overflow events (events/10 years)	0.20
Total number of pond overflow days (days/10 years)	0.20
Probability of at least 90% effluent reuse (%)	100.00
Effluent reuse (fraction)	1.00





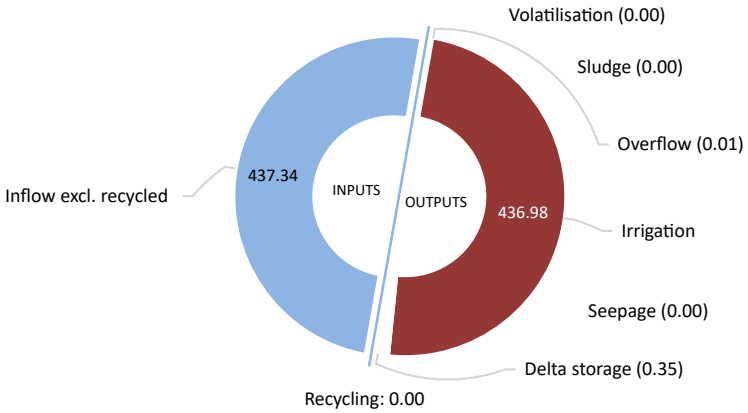


Performance

Pond system information

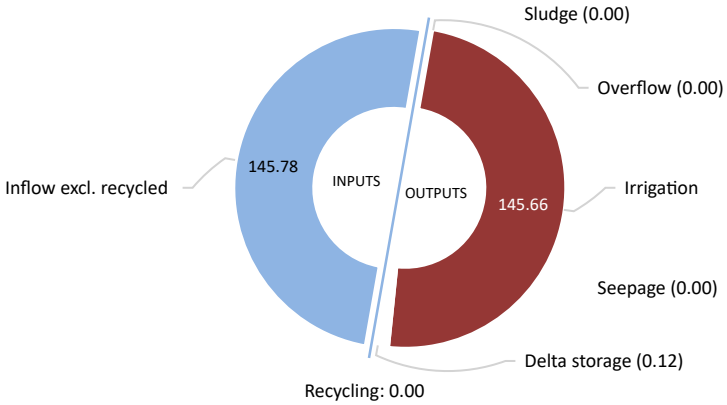
Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system nitrogen balance (kg/year)



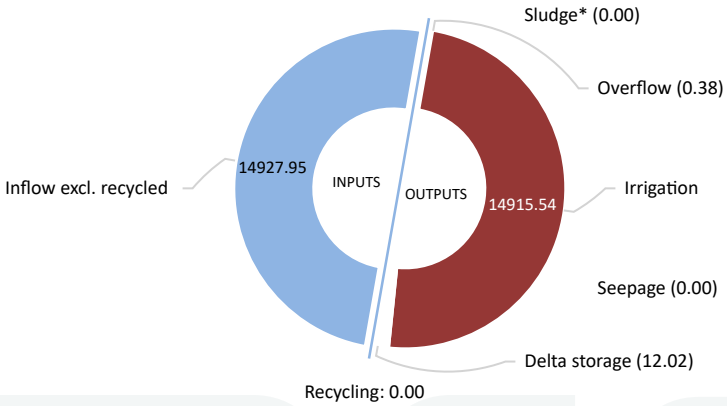
Name	Value
Inflow excl. recycled	437.34
Recycled	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.01
Irrigation	436.98
Seepage	0.00
Delta storage	0.35

Pond system phosphorus balance (kg/year)



Name	Value
Inflow excl. recycled	145.78
Recycled	0.00
Sludge	0.00
Overflow	0.00
Irrigation	145.66
Seepage	0.00
Delta storage	0.12

Pond system salt balance (kg/year)



Name	Value
Inflow excl. recycled	14927.95
Recycled	0.00
Sludge*	0.00
Overflow	0.38
Irrigation	14915.54
Seepage	0.00
Delta storage	12.02

* 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 information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond nutrient concentrations and salinity

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	21.14
Average phosphorus concentration of pond liquid (mg/L)	7.05
Average salinity of pond liquid (dS/m)	1.13

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	20.02
Final phosphorus concentration of pond liquid (mg/L)	6.67
Final salinity of pond liquid (dS/m)	1.07

Performance

Water use (assumes 100% irrigation efficiency)

Metric	Value
Pond water irrigated (m3/year)	15685.47
Average shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	15685.47
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

Metric	Value
Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	27.86
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	27.86
Average phosphorus concentration of irrigation water (mg/L)	9.29
Average salinity of irrigation water (dS/m)	1.49

Irrigation diagnostics

Metric	Value
No. periods/year without any irrigable effluent in the wet weather storage pond (periods/year)	0.00
Average length of such periods (days)	0.00

Irrigation triggering and application

No. Days without Irrigation Applied per Year: 54.70 (with rain exceeding specified rainfall threshold [53.70] and day outside of irrigation window [1.00])
No. Days without Irrigation Applied per Year: 54.70 (with not triggered)
No. Days with Irrigation Applied per Year: 310.56 (with supply limited - partial application [271.38] and full application [39.18])
No. Days with Irrigation Triggered per Year: 310.56

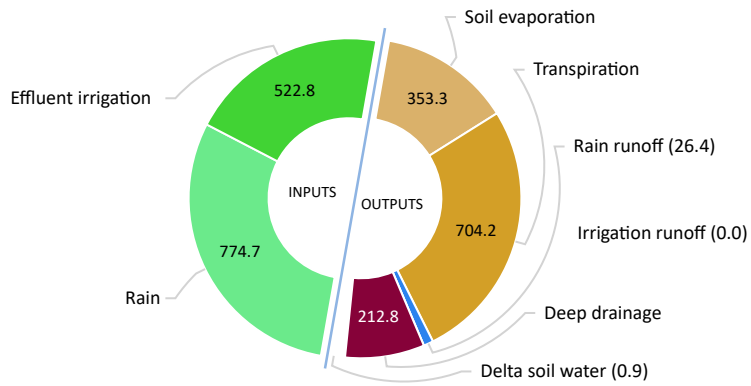
Performance

Paddock information

Paddock: New paddock, 3 ha

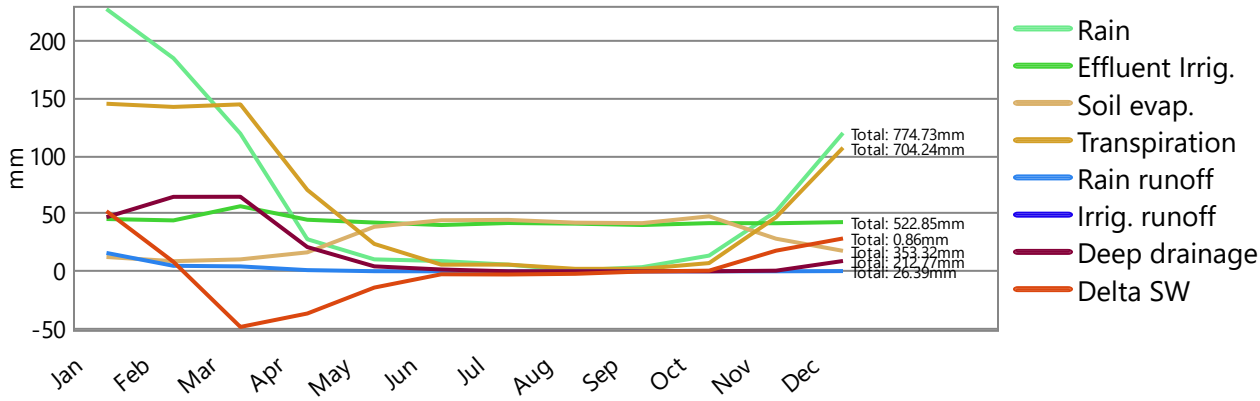
Soil Type: Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

Soil water balance (mm/year)

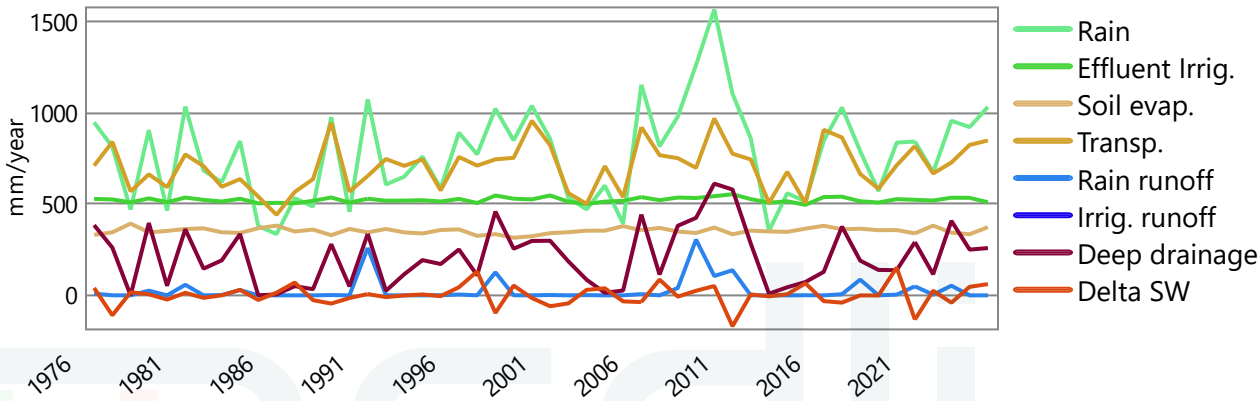


Name	Value
Rain	774.7
Effluent irrigation	522.8
Soil evaporation	353.3
Transpiration	704.2
Rain runoff	26.4
Irrigation runoff	0.0
Deep drainage	212.8
Delta soil water	0.9

Average monthly totals (mm)



Average annual totals (mm/year)



Performance

Paddock information

Paddock: New paddock, 3 ha
Soil Type: Brown Tenosol - Site Specific
Irrigation Ammonia-N Volatilisation Losses (kg/ha/year): 0.00
Proportion of Total Nitrogen in Irrigated Effluent as Ammonium-N (fraction): 0.40
Nitrogen Added by Irrigation: 145.66
Phosphorus Added by Irrigation: 48.55
Planting Regime: Monthly Green Covers - Deciduous forest cover

Plant salinity tolerance

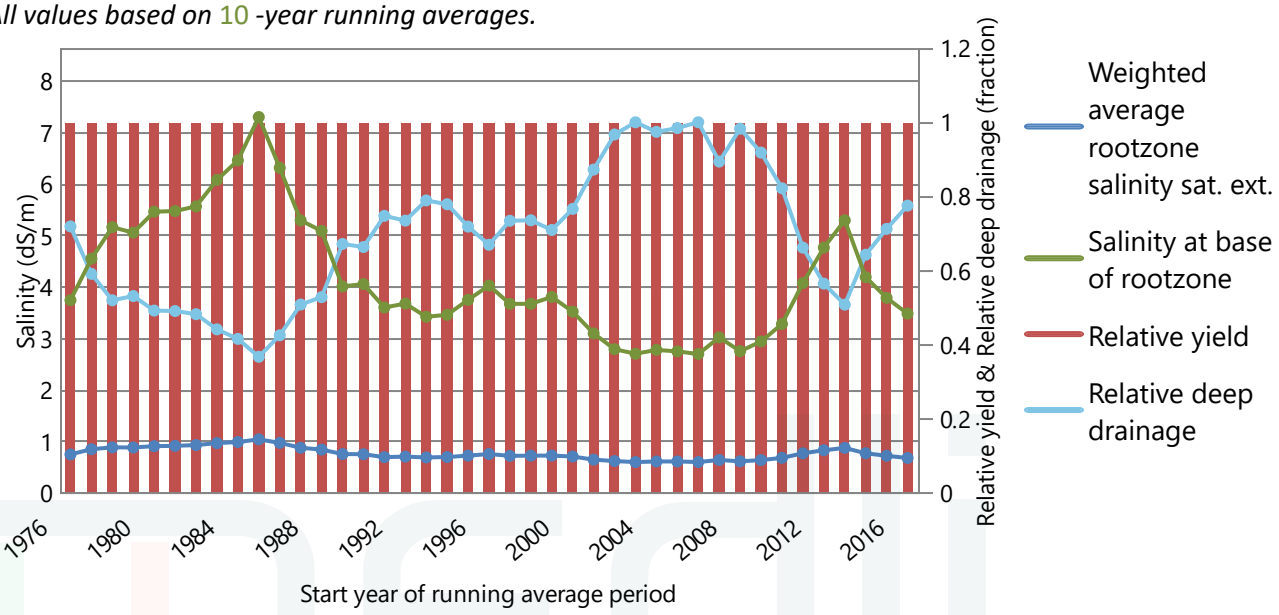
Metric	Value
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	20.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.20
No. years assumed for leaching to reach steady-state (years)	10.00

Soil salinity

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.64
Salt added by rainfall (kg/ha/year)	143.68
Average annual salt added & leached at steady state (kg/ha/year)	5115.53
Average leaching fraction based on 10 -year running averages (fraction)	0.38
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.77
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	4.17
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

All values based on 10 -year running averages.

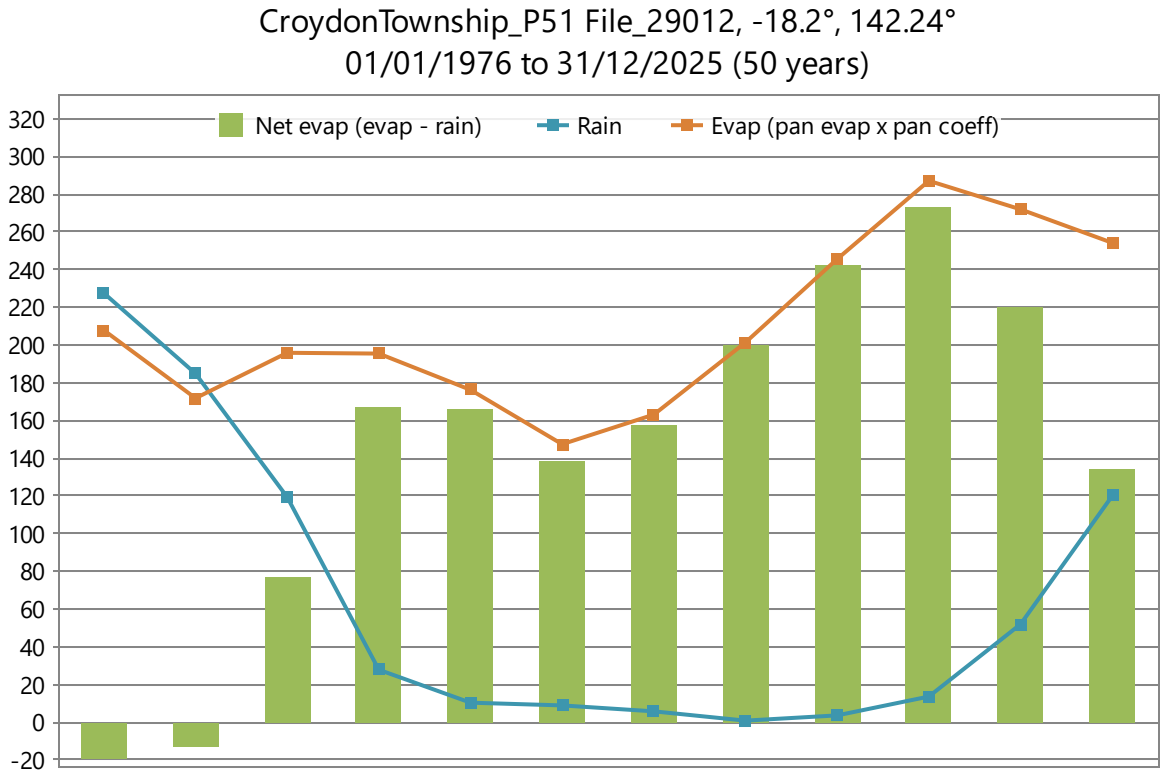


Diagnostics

Scenario information

Enterprise: Esmerelda Project

Climate long-term monthly averages (mm)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Evap	207.8	171.8	195.9	195.4	176.2	147.4	163.1	201.4	245.6	287.1	271.9	254.2	2517.8
Net evap	-19.7	-13.0	76.5	167.6	165.9	138.5	157.3	200.5	241.9	273.4	220.0	134.2	1743.1
Net evap/day	-0.6	-0.5	2.5	5.6	5.4	4.6	5.1	6.5	8.1	8.8	7.3	4.3	4.8

Diagnostics

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Effluent Type: - 15703.61 m3/year or 42.99 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.26 non-zero flow days/year.

Constituent	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

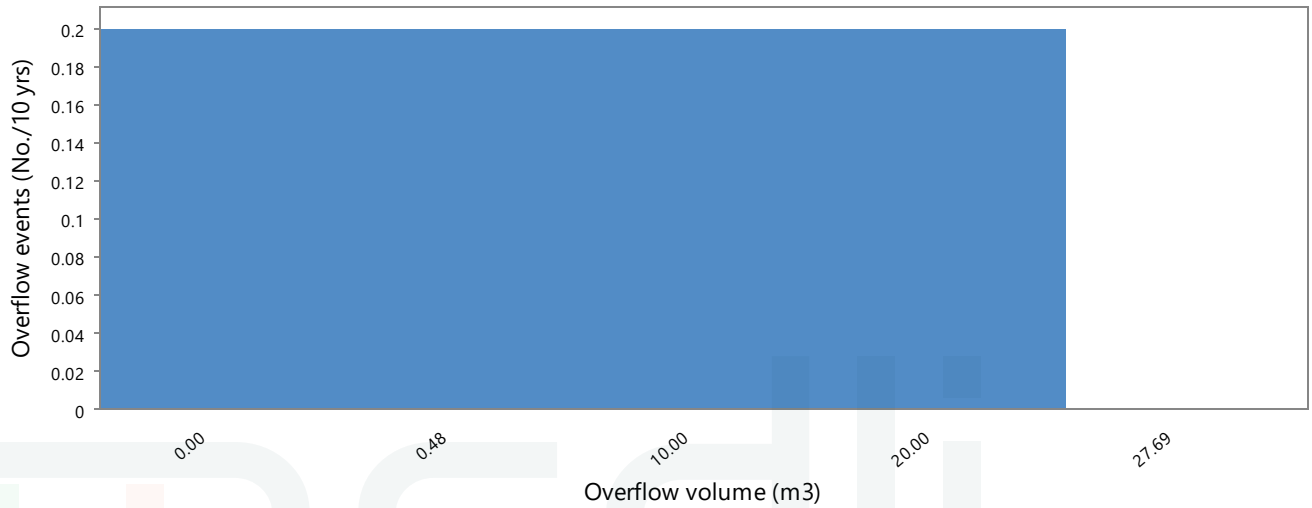
Ammonia-N loss from pond system water surface area: 0.00 kg/m2/year

Last pond (wet weather store): 2400.00 m3

Metric	Value
Theoretical hydraulic retention time (days)	55.82
Volume of overflow (m3/year) Average (minimum-maximum)	0.55 (0.00 - 27.69)
Volume of overflow per day (m3/day) Average (minimum-maximum)	0.00 (0.00 - 27.69)
No overflow days - Average per year (Total in run period)	0.02 (1)
No. overflow events per 10 years exceeding threshold of 0.480 m3* (events/10 years)	0.20
Average overflow event recurrence interval (years)	50.00
Average duration of overflow (days)	1.00
Probability of at least 90% effluent reuse (%)	100.00
Effluent reuse (propn. of inflow + net rain gain that is irrigated/removed with sludge) (fraction)	1.00
Average salinity (dS/m)	1.13
Salinity on final day of simulation (dS/m)	1.07

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

Volume distribution of the overflow events



Diagnostics

Scenario information

Area irrigated: 3 ha total area

Loading to whole irrigation area: (assuming 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	15685.47	5228.49
Total nitrogen applied (kg)	436.98	145.66
Total phosphorus applied (kg)	145.66	48.55
Total salts applied (kg)	14915.54	4971.85

Shandying

Metric	Value
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)
Minimum shandy water is used	No

Irrigation issues

Metric	Value
Number of days without irrigation (days/year)	54.70

Diagnostics

Paddock information

Paddock: New paddock, 3 ha

Irrigation: New irrigation method with 0% ammonium loss during irrigation

Irrigation triggered every 1 days and when rainfall is less than or equal to 0.00 mm
Irrigate a fixed amount of 3.50 mm
Irrigation window from 1/1 to 30/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil water balance (mm): Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Efflt. irrg.	45.4	44.2	56.5	44.7	42.3	40.2	41.9	41.3	40.2	41.8	41.7	42.7	522.8
Soil evap	12.4	8.8	10.4	16.5	38.6	44.3	44.6	42.2	41.8	47.7	28.3	17.8	353.3
Transpn.	145.3	142.6	144.8	70.6	23.8	5.8	5.8	2.2	2.2	7.1	46.9	107.2	704.2
Rain runoff	16.0	4.8	4.3	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	26.4
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	47.0	64.6	64.7	21.0	4.3	1.6	0.0	0.0	0.0	0.0	0.6	9.0	212.8
Delta SW	52.2	8.2	-48.2	-36.6	-14.1	-2.6	-2.8	-2.2	-0.2	0.6	17.9	28.5	0.9

Planting regime: Monthly Green Covers - Deciduous forest cover

Average monthly cover (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Average monthly crop factor (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	0.20
Average rooting depth in defined soil profile (mm)	820.00

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.

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.64
Salt added by rainfall (kg/ha/year)	143.68
Average annual salt added & leached at steady state (kg/ha/year)	5115.53
Average leaching fraction based on 10 -year running averages (fraction)	0.38
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.77
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	4.17
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 information

Messages generated when the scenario was run
Monthly Green Covers plant option does not model soil nitrogen and soil phosphorus.
NOTE: Groundwater nitrate module cannot be run when Monthly Green Covers plant option is chosen
UNCONDITIONAL FINISH

General Information

SCENARIO REPORT: Full run

General information

Enterprise: Esmerelda Project - Run 4 with 2400.00 m3 storage pond volume and 4.00 ha irrigation area
Client: Graphinex
MEDLI user: APEM\Jenna.Huckenswager

Description:

Onsite Workers Camp STP - Scenario 2

Scenario details: Scenario 2 - DIR, 4 ha

Map of location:

Note: If the map above appears as a dark box, check that the network is accessible and that the coordinates are not for a location in the ocean.



Description

Climate information

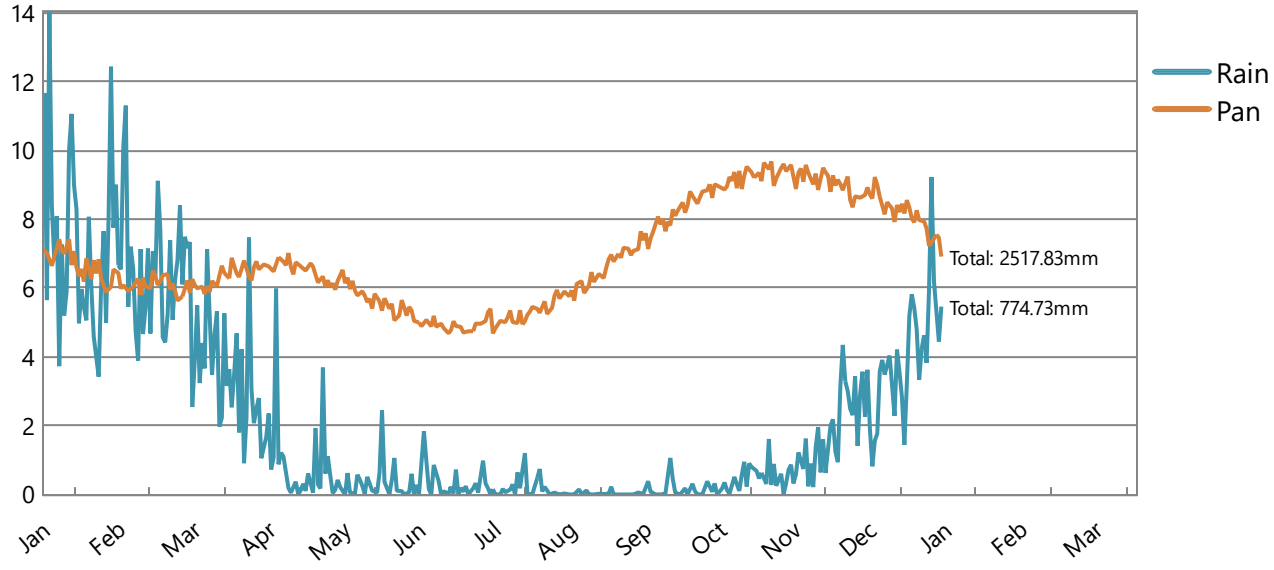
Climate Data Location: CroydonTownship_P51 File_29012, -18.2°, 142.24°
Run Period: 01/01/1976 to 31/12/2025 (50 years)

Climate statistics

	5th Percentile		50th Percentile		95th Percentile	
Rainfall (mm/year)	(Year 2013)	366.2	(Year 1977)	814.8	(Year 2006)	1129.4
Pan evaporation (mm/year)	(Year 1998)	2076.8	(Year 1992)	2545.6	(Year 1978)	2880.0

Climate data

Daily average across run period:



Description

Wastestream information

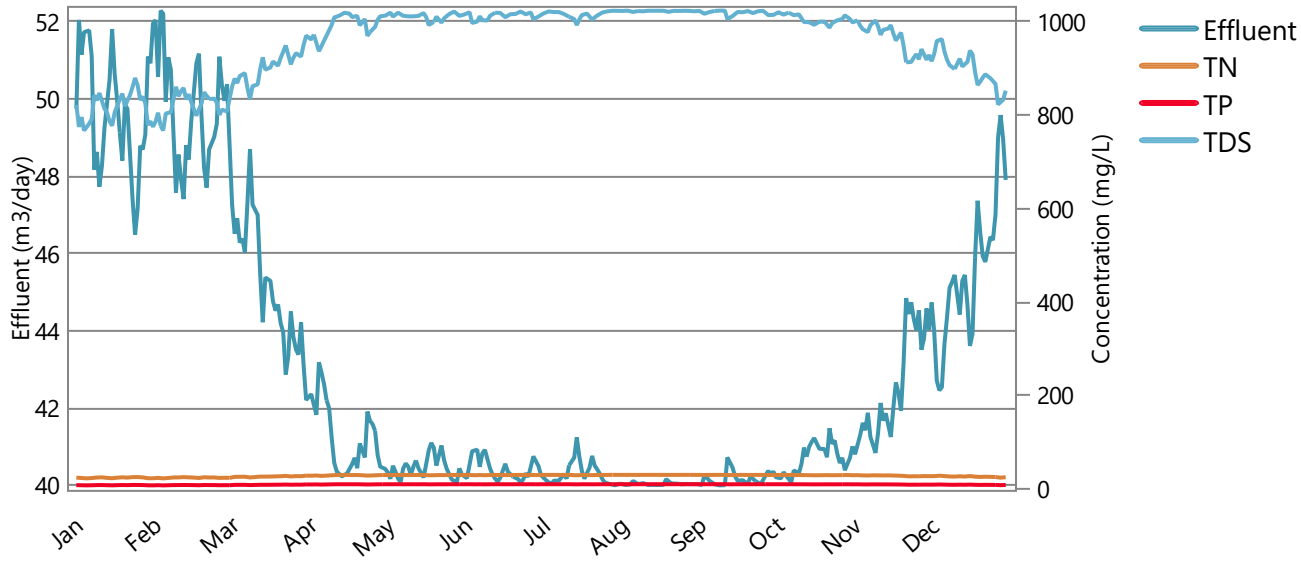
Wastestream Name: - New sewage treatment plant

Wastestream production description

New sewage treatment plant derived from a 200.0 EP (daily average) STP with a capacity of 2.00 times dry weather flow. The STP generates 14610.00 m3 effluent (average dry weather flow), and assumes Average infiltration into sewerage system during wet weather. Dry weather flow effluent quality is 30.00 mg/L total nitrogen, 10.00 mg/L total phosphorus and 1024.00 mg/L total dissoved salts. This wastestream is not separately pretreated.

Wastestream

Average Daily Quantity and Flow-Weighted Average Quality:



Wastestream

Effluent Quantity: 15703.61 m3/year or 42.99 m3/day (Min-Max 40.00 - 80.00)

Flow-Weighted Average (Min - Max) Daily Effluent Quality Entering the Pond System:

	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

STP bypass wastestream

Bypass Quantity: 93.33 m3_per_year (Min-Max: 0.00 - 126.08)

Flow-Weighted Average (Min - Max) Daily Bypass Flow Quality:

	Concentration (mg/L)	Load (tonnes/year)
Total nitrogen	24.25 (13.59 - 34.99)	2.26 (0.00 - 9.61)
Total phosphorus	17.32 (9.71 - 24.99)	1.62 (0.00 - 6.87)
Total dissolved salts	519.56 (291.15 - 749.84)	48.49 (0.00 - 205.98)

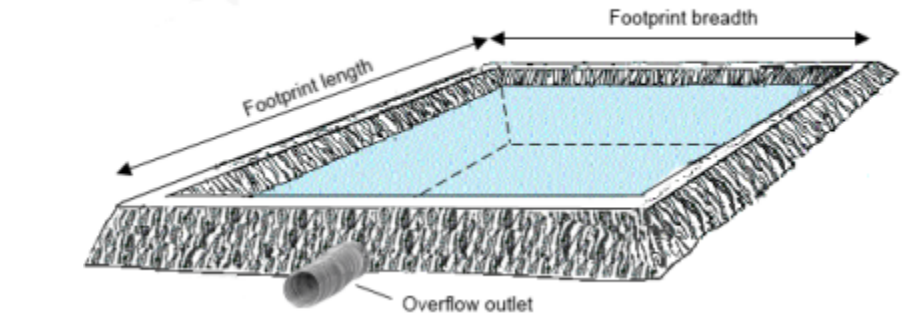
Description

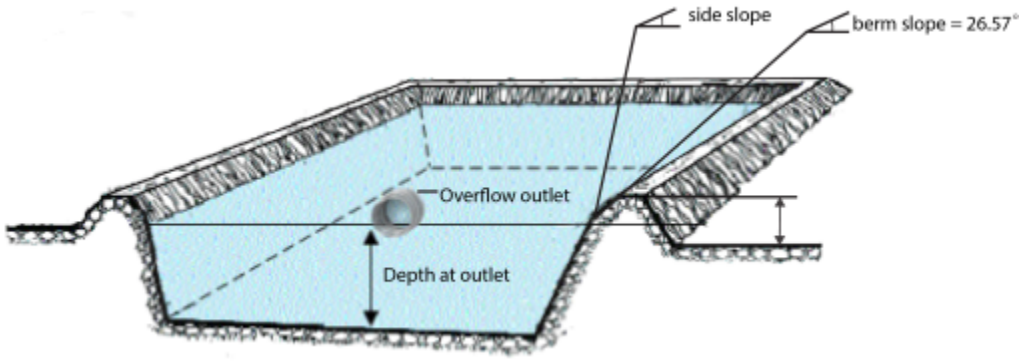
Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system details

	Pond 1
Maximum pond volume (m3)	2400.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	5.00
Maximum water surface area (m2)	480.00
Pond footprint length (m)	21.91
Pond footprint width (m)	21.91
Pond catchment area (m2)	480.00
Average active volume (m3)	53.68





Irrigation pump limits

Minimum pump rate limit (ML/day)	0.00
Maximum pump limit	As scheduled

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	No

Description

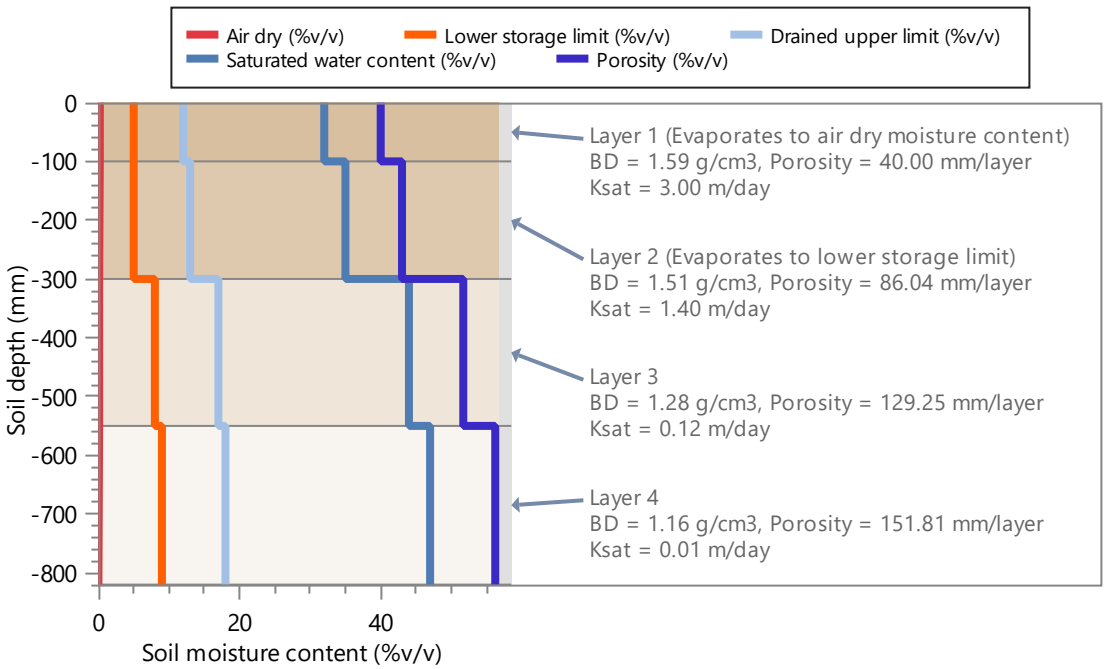
Paddock information

Paddock: New paddock, 4 ha

Soil type: Brown Tenosol - Site Specific, 820.00 mm defined profile depth

Profile porosity (mm)	407.09
Profile saturation water content (mm)	338.90
Profile drained upper limit (or field capacity) (mm)	129.10
Profile lower storage limit (or permanent wilting point) (mm)	59.30
Profile available water capacity (mm)	69.80
Profile limiting saturated hydraulic conductivity (m/day)	0.01
Surface saturated hydraulic conductivity (m/day)	3.00
Runoff curve number II (coefficient)	70.00
Soil evaporation U (mm)	9.50
Soil evaporation Cona (mm/sqrt day)	4.00

Profile



Planting regime: Monthly Green Covers - Deciduous forest cover

Average monthly cover (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 1 x Pan coefficient 1)	1.00
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	0.20
Potential rooting depth in defined soil profile (mm)	820.00
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	20.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.20

Irrigation rules: New irrigation method

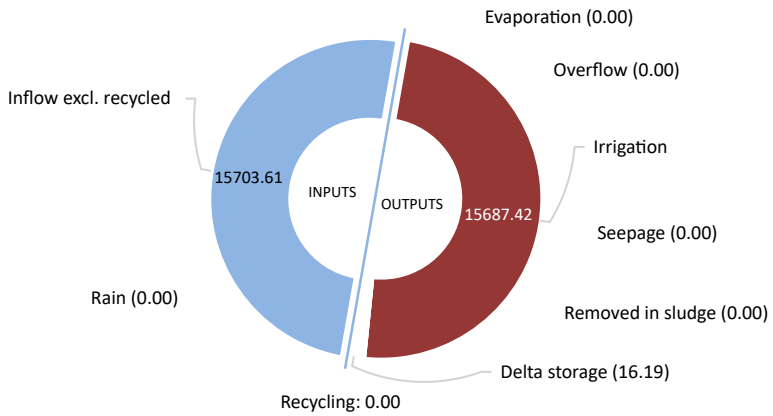
Rule 1. Irrigation triggered every 1 days and rainfall is less than or equal to 0.00 mm
Rule 2. Irrigate a fixed amount of 3.50 mm each day
Rule 3. Irrigation window from 1/1 to 30/12 including the days specified
Rule 4. A minimum of 0 days must be skipped between irrigation events

Performance

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank (wet weather storage pond: 2400 m3)

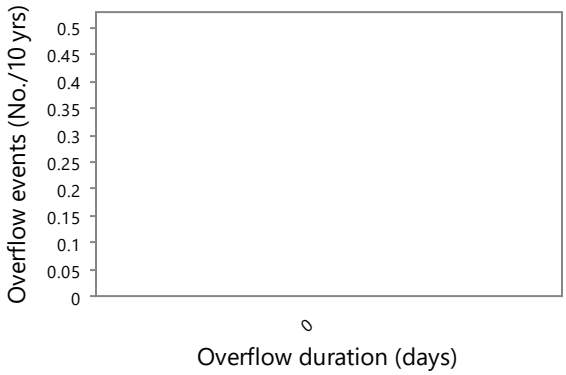
Pond system water balance (m3/year)

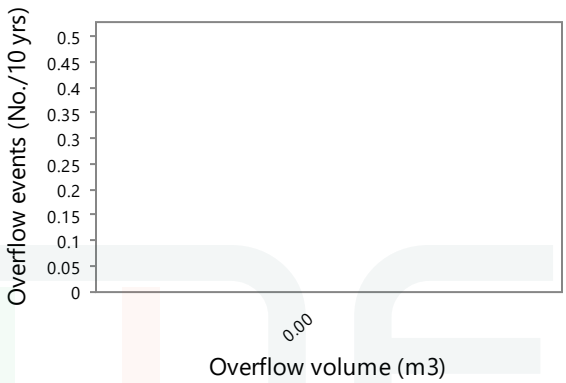


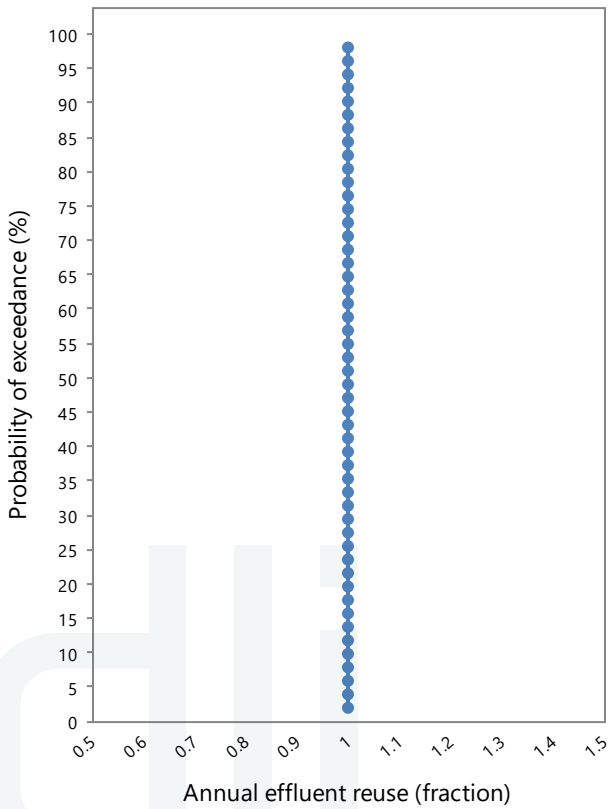
Name	Value
Rain	0.00
Inflow excl. recycled	15703.61
Recycled	0.00
Evaporation	0.00
Overflow	0.00
Irrigation	15687.42
Seepage	0.00
Removed in sludge	0.00
Delta storage	16.19

Overflow and reuse diagnostics

Metric	Value
Total volume of overflow (m3/10 years)	0.00
Total number of overflow events (events/10 years)	0.00
Total number of pond overflow days (days/10 years)	0.00
Probability of at least 90% effluent reuse (%)	100.00
Effluent reuse (fraction)	1.00





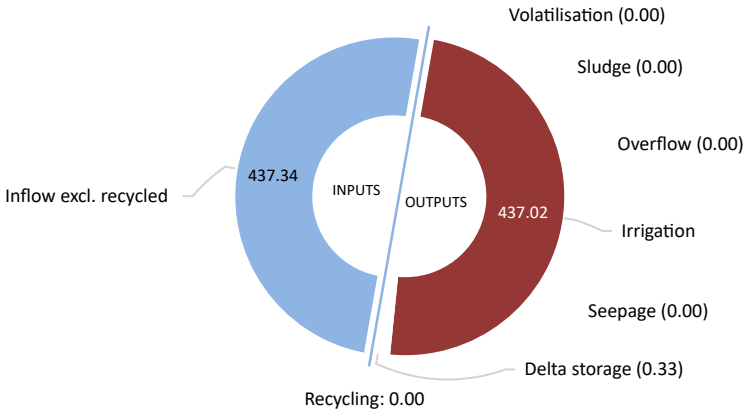


Performance

Pond system information

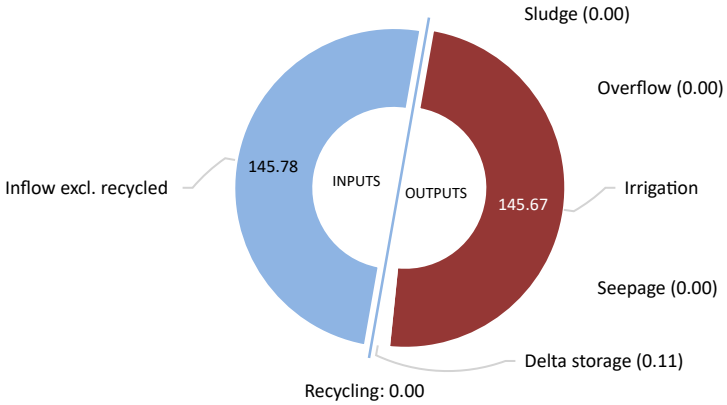
Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system nitrogen balance (kg/year)



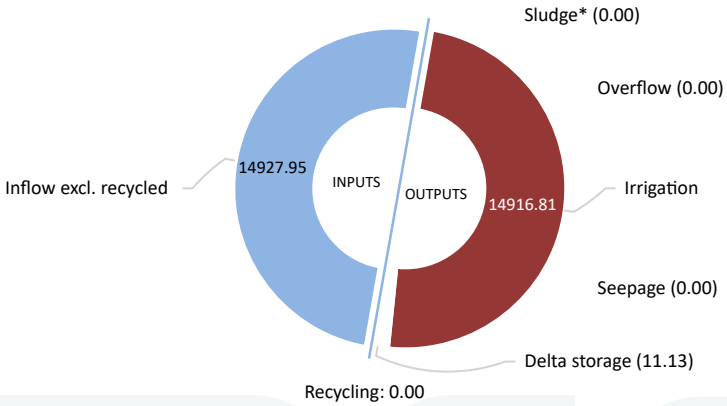
Name	Value
Inflow excl. recycled	437.34
Recycled	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.00
Irrigation	437.02
Seepage	0.00
Delta storage	0.33

Pond system phosphorus balance (kg/year)



Name	Value
Inflow excl. recycled	145.78
Recycled	0.00
Sludge	0.00
Overflow	0.00
Irrigation	145.67
Seepage	0.00
Delta storage	0.11

Pond system salt balance (kg/year)



Name	Value
Inflow excl. recycled	14927.95
Recycled	0.00
Sludge*	0.00
Overflow	0.00
Irrigation	14916.81
Seepage	0.00
Delta storage	11.13

* 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 information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond nutrient concentrations and salinity

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	20.40
Average phosphorus concentration of pond liquid (mg/L)	6.80
Average salinity of pond liquid (dS/m)	1.09

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	20.14
Final phosphorus concentration of pond liquid (mg/L)	6.71
Final salinity of pond liquid (dS/m)	1.07

Performance

Water use (assumes 100% irrigation efficiency)

Metric	Value
Pond water irrigated (m3/year)	15687.42
Average shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	15687.42
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

Metric	Value
Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	27.86
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	27.86
Average phosphorus concentration of irrigation water (mg/L)	9.29
Average salinity of irrigation water (dS/m)	1.49

Irrigation diagnostics

Metric	Value
No. periods/year without any irrigable effluent in the wet weather storage pond (periods/year)	0.00
Average length of such periods (days)	0.00

Irrigation triggering and application

No. Days without Irrigation Applied per Year: 54.70 (with rain exceeding specified rainfall threshold [53.70] and day outside of irrigation window [1.00])
No. Days without Irrigation Applied per Year: 54.70 (with not triggered)
No. Days with Irrigation Applied per Year: 310.56 (with supply limited - partial application [289.26] and full application [21.30])
No. Days with Irrigation Triggered per Year: 310.56

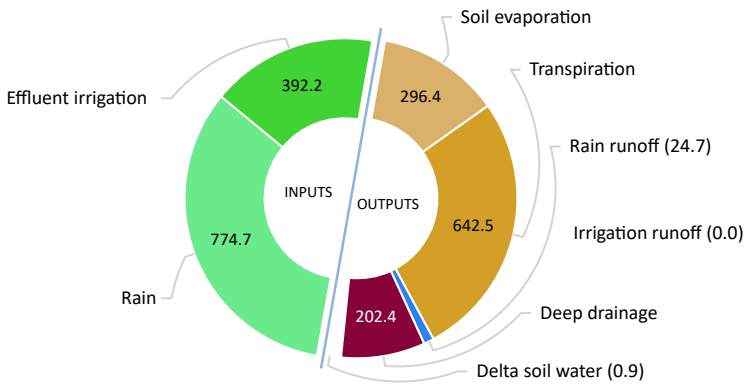
Performance

Paddock information

Paddock: New paddock, 4 ha

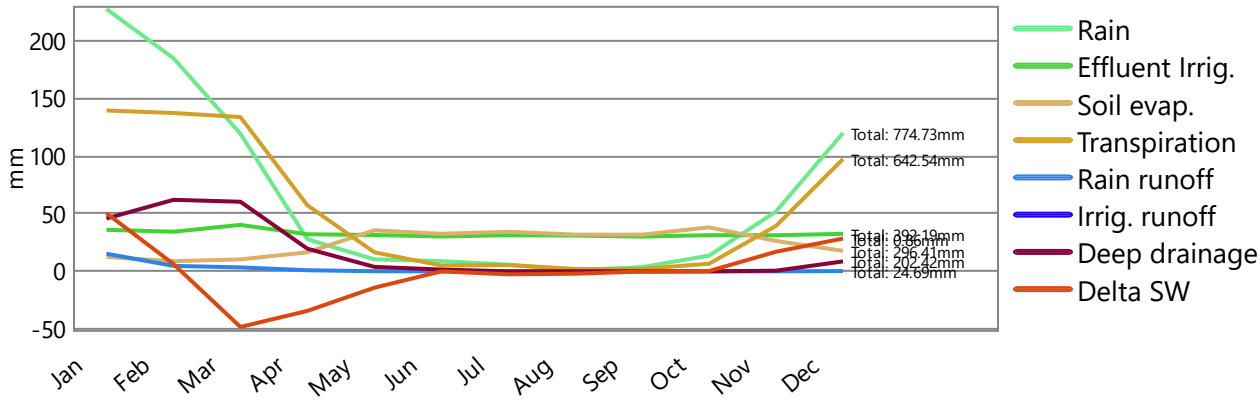
Soil Type: Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

Soil water balance (mm/year)

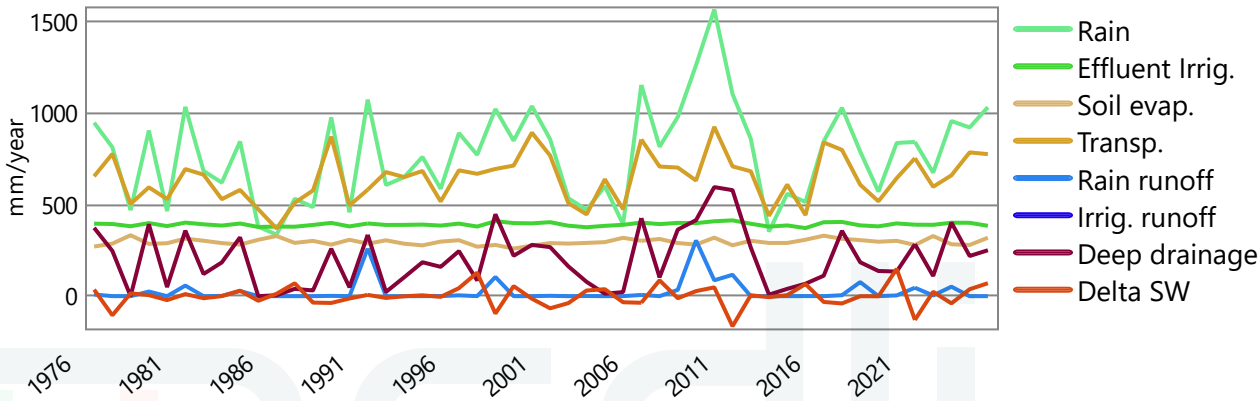


Name	Value
Rain	774.7
Effluent irrigation	392.2
Soil evaporation	296.4
Transpiration	642.5
Rain runoff	24.7
Irrigation runoff	0.0
Deep drainage	202.4
Delta soil water	0.9

Average monthly totals (mm)



Average annual totals (mm/year)



Performance

Paddock information

Paddock: New paddock, 4 ha
Soil Type: Brown Tenosol - Site Specific
Irrigation Ammonia-N Volatilisation Losses (kg/ha/year): 0.00
Proportion of Total Nitrogen in Irrigated Effluent as Ammonium-N (fraction): 0.40
Nitrogen Added by Irrigation: 109.25
Phosphorus Added by Irrigation: 36.42
Planting Regime: Monthly Green Covers - Deciduous forest cover

Plant salinity tolerance

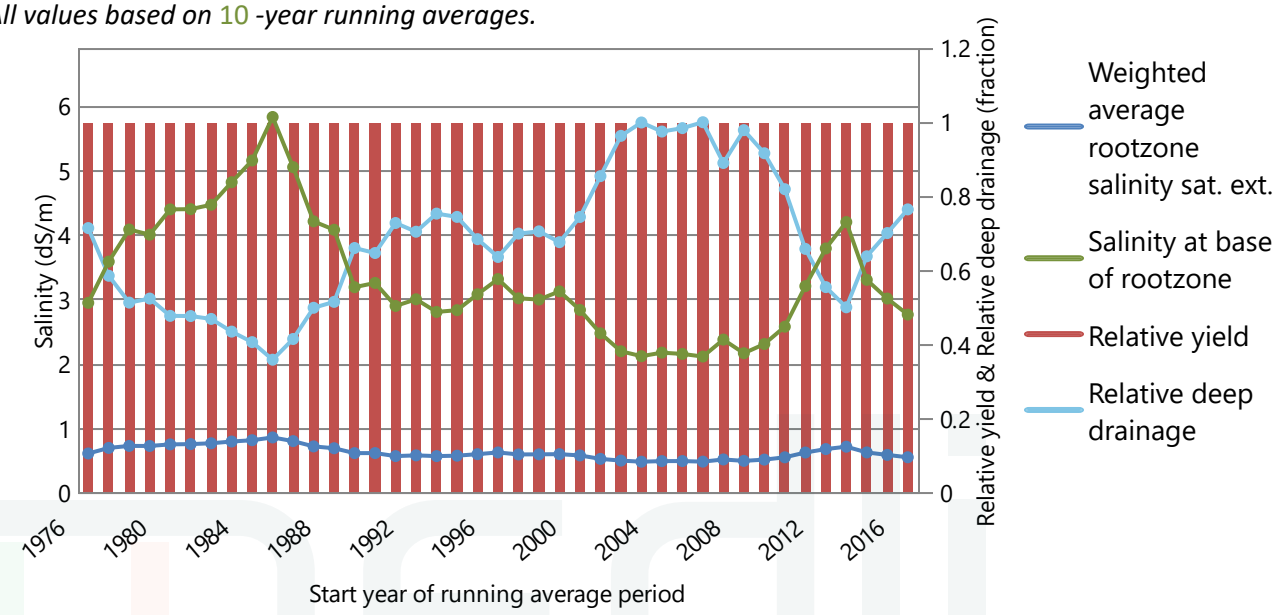
Metric	Value
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	20.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.20
No. years assumed for leaching to reach steady-state (years)	10.00

Soil salinity

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.54
Salt added by rainfall (kg/ha/year)	144.01
Average annual salt added & leached at steady state (kg/ha/year)	3873.21
Average leaching fraction based on 10 -year running averages (fraction)	0.39
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.63
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	3.33
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

All values based on 10 -year running averages.

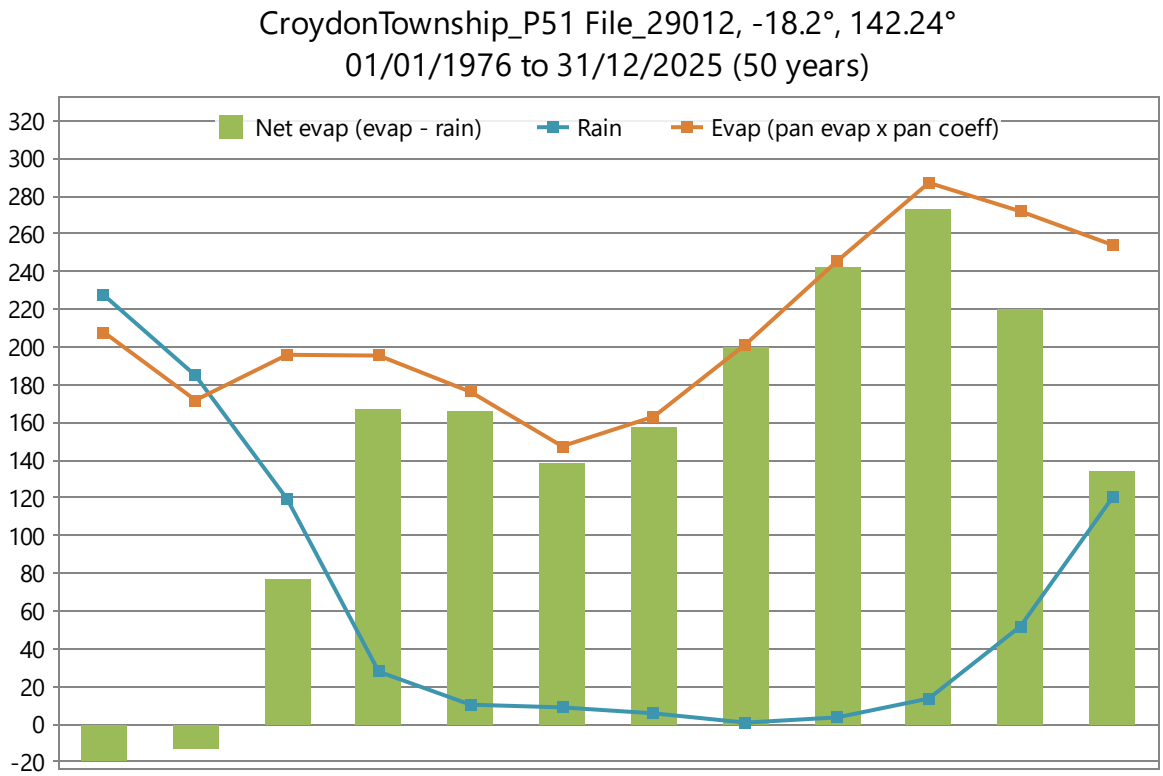


Diagnostics

Scenario information

Enterprise: Esmerelda Project

Climate long-term monthly averages (mm)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Evap	207.8	171.8	195.9	195.4	176.2	147.4	163.1	201.4	245.6	287.1	271.9	254.2	2517.8
Net evap	-19.7	-13.0	76.5	167.6	165.9	138.5	157.3	200.5	241.9	273.4	220.0	134.2	1743.1
Net evap/day	-0.6	-0.5	2.5	5.6	5.4	4.6	5.1	6.5	8.1	8.8	7.3	4.3	4.8

Diagnostics

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Effluent Type: - 15703.61 m3/year or 42.99 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.26 non-zero flow days/year.

Constituent	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

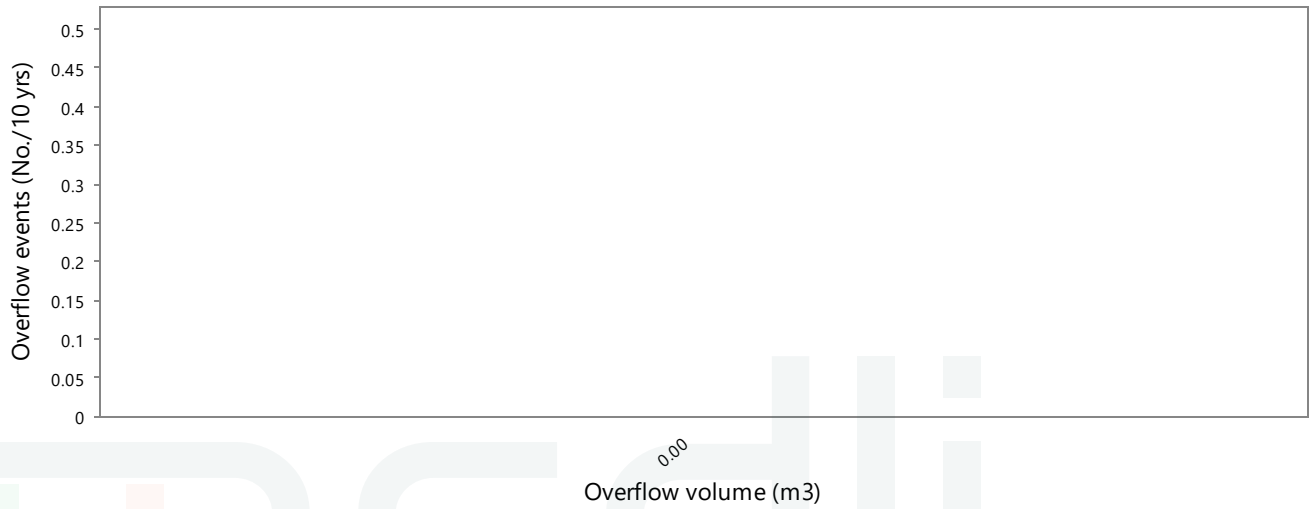
Ammonia-N loss from pond system water surface area: 0.00 kg/m2/year

Last pond (wet weather store): 2400.00 m3

Metric	Value
Theoretical hydraulic retention time (days)	55.82
Volume of overflow (m3/year) Average (minimum-maximum)	0.00 (0.00 - 0.00)
Volume of overflow per day (m3/day) Average (minimum-maximum)	0.00 (0.00 - 0.00)
No overflow days - Average per year (Total in run period)	0.00 (0)
No. overflow events per 10 years exceeding threshold of 0.480 m3* (events/10 years)	0.00
Average overflow event recurrence interval (years)	0.00
Average duration of overflow (days)	0.00
Probability of at least 90% effluent reuse (%)	100.00
Effluent reuse (propn. of inflow + net rain gain that is irrigated/removed with sludge) (fraction)	1.00
Average salinity (dS/m)	1.09
Salinity on final day of simulation (dS/m)	1.07

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

Volume distribution of the overflow events



Diagnostics

Scenario information

Area irrigated: 4 ha total area

Loading to whole irrigation area: (assuming 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	15687.42	3921.85
Total nitrogen applied (kg)	437.02	109.25
Total phosphorus applied (kg)	145.67	36.42
Total salts applied (kg)	14916.81	3729.20

Shandying

Metric	Value
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)
Minimum shandy water is used	No

Irrigation issues

Metric	Value
Number of days without irrigation (days/year)	54.70

Diagnostics

Paddock information

Paddock: New paddock, 4 ha

Irrigation: New irrigation method with 0% ammonium loss during irrigation

Irrigation triggered every 1 days and when rainfall is less than or equal to 0.00 mm
Irrigate a fixed amount of 3.50 mm
Irrigation window from 1/1 to 30/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil water balance (mm): Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Efflt. irrg.	36.0	34.4	40.3	32.2	31.5	30.2	31.3	31.0	30.1	31.4	31.3	32.5	392.2
Soil evap	12.4	8.8	10.4	16.5	35.6	32.6	34.3	31.8	31.8	38.1	26.3	17.8	296.4
Transpn.	139.5	137.3	133.8	57.3	16.5	5.1	5.4	2.1	2.1	6.6	39.4	97.4	642.5
Rain runoff	15.3	4.7	3.4	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	24.7
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	45.9	62.0	60.3	19.6	3.9	1.5	0.0	0.0	0.0	0.0	0.6	8.6	202.4
Delta SW	50.4	6.4	-48.2	-34.3	-14.2	0.0	-2.6	-2.0	-0.2	0.3	17.0	28.5	0.9

Planting regime: Monthly Green Covers - Deciduous forest cover

Average monthly cover (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Average monthly crop factor (fraction) (minimum - maximum)	0.75 (0.47 - 0.95)
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	0.20
Average rooting depth in defined soil profile (mm)	820.00

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.

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.54
Salt added by rainfall (kg/ha/year)	144.01
Average annual salt added & leached at steady state (kg/ha/year)	3873.21
Average leaching fraction based on 10 -year running averages (fraction)	0.39
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.63
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	3.33
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 information

Messages generated when the scenario was run
Monthly Green Covers plant option does not model soil nitrogen and soil phosphorus.
NOTE: Groundwater nitrate module cannot be run when Monthly Green Covers plant option is chosen
UNCONDITIONAL FINISH

General Information

SCENARIO REPORT: Full run

General information

Enterprise: Esmerelda Project - Run 3 with 2400.00 m3 storage pond volume and 3.00 ha irrigation area
Client: Graphinex
MEDLI user: APEM\Jenna.Huckenswager

Description:

Onsite Workers Camp STP - Scenario 3

Scenario details: Sensitivity Analysis - Rhodes Pasture - 3 ha

Map of location:

Note: If the map above appears as a dark box, check that the network is accessible and that the coordinates are not for a location in the ocean.



Description

Climate information

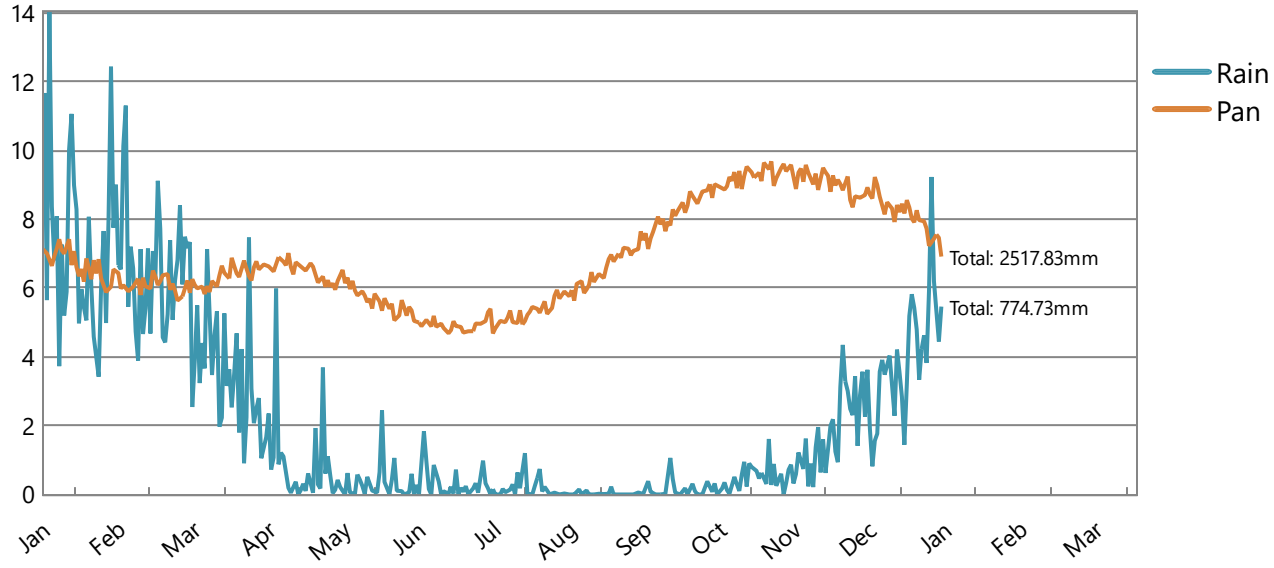
Climate Data Location: CroydonTownship_P51 File_29012, -18.2°, 142.24°
Run Period: 01/01/1976 to 31/12/2025 (50 years)

Climate statistics

	5th Percentile		50th Percentile		95th Percentile	
Rainfall (mm/year)	(Year 2013)	366.2	(Year 1977)	814.8	(Year 2006)	1129.4
Pan evaporation (mm/year)	(Year 1998)	2076.8	(Year 1992)	2545.6	(Year 1978)	2880.0

Climate data

Daily average across run period:



Description

Wastestream information

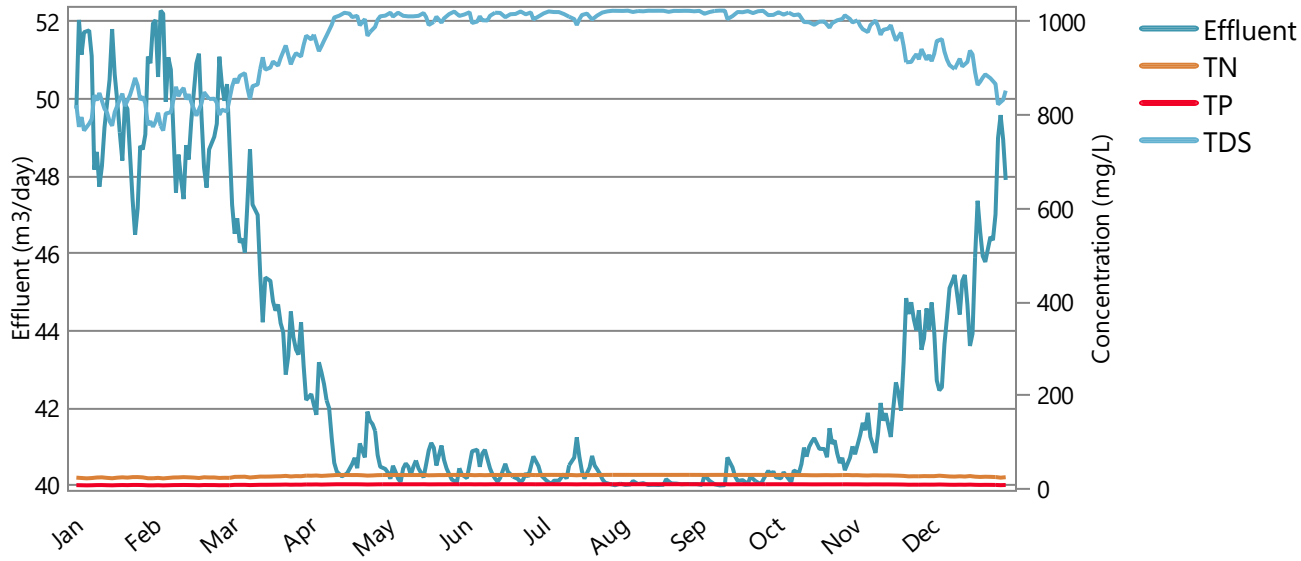
Wastestream Name: - New sewage treatment plant

Wastestream production description

New sewage treatment plant derived from a 200.0 EP (daily average) STP with a capacity of 2.00 times dry weather flow. The STP generates 14610.00 m3 effluent (average dry weather flow), and assumes Average infiltration into sewerage system during wet weather. Dry weather flow effluent quality is 30.00 mg/L total nitrogen, 10.00 mg/L total phosphorus and 1024.00 mg/L total dissoved salts. This wastestream is not separately pretreated.

Wastestream

Average Daily Quantity and Flow-Weighted Average Quality:



Wastestream

Effluent Quantity: 15703.61 m3/year or 42.99 m3/day (Min-Max 40.00 - 80.00)

Flow-Weighted Average (Min - Max) Daily Effluent Quality Entering the Pond System:

	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

STP bypass wastestream

Bypass Quantity: 93.33 m3_per_year (Min-Max: 0.00 - 126.08)

Flow-Weighted Average (Min - Max) Daily Bypass Flow Quality:

	Concentration (mg/L)	Load (tonnes/year)
Total nitrogen	24.25 (13.59 - 34.99)	2.26 (0.00 - 9.61)
Total phosphorus	17.32 (9.71 - 24.99)	1.62 (0.00 - 6.87)
Total dissolved salts	519.56 (291.15 - 749.84)	48.49 (0.00 - 205.98)

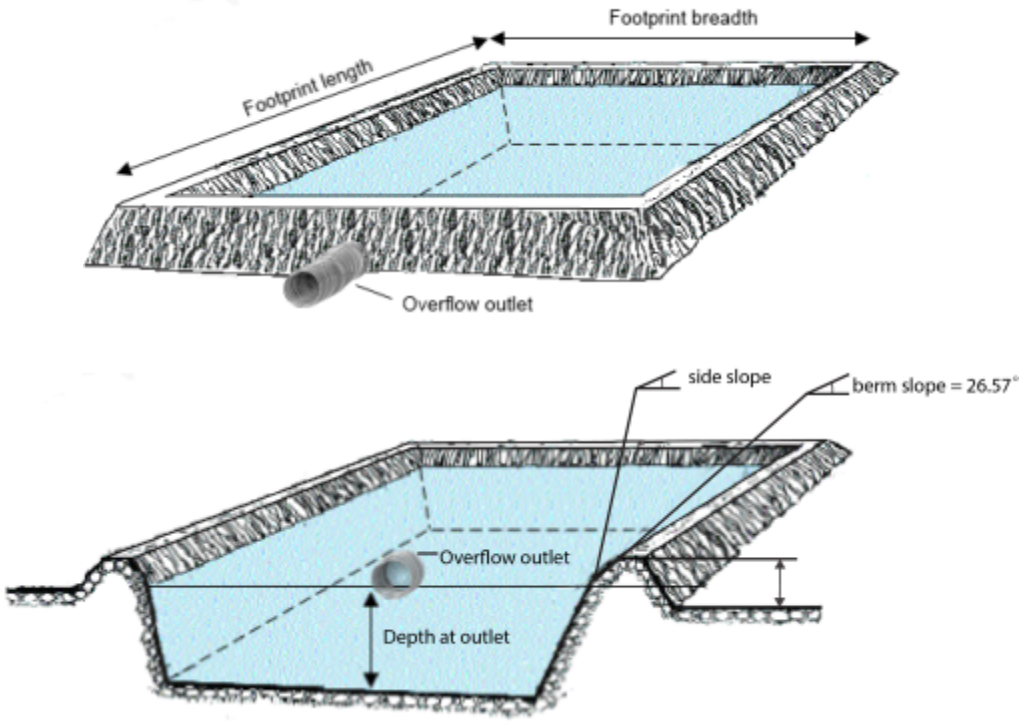
Description

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system details

	Pond 1
Maximum pond volume (m3)	2400.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	5.00
Maximum water surface area (m2)	480.00
Pond footprint length (m)	21.91
Pond footprint width (m)	21.91
Pond catchment area (m2)	480.00
Average active volume (m3)	85.53



Irrigation pump limits

Minimum pump rate limit (ML/day)	0.00
Maximum pump limit	As scheduled

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	No

Description

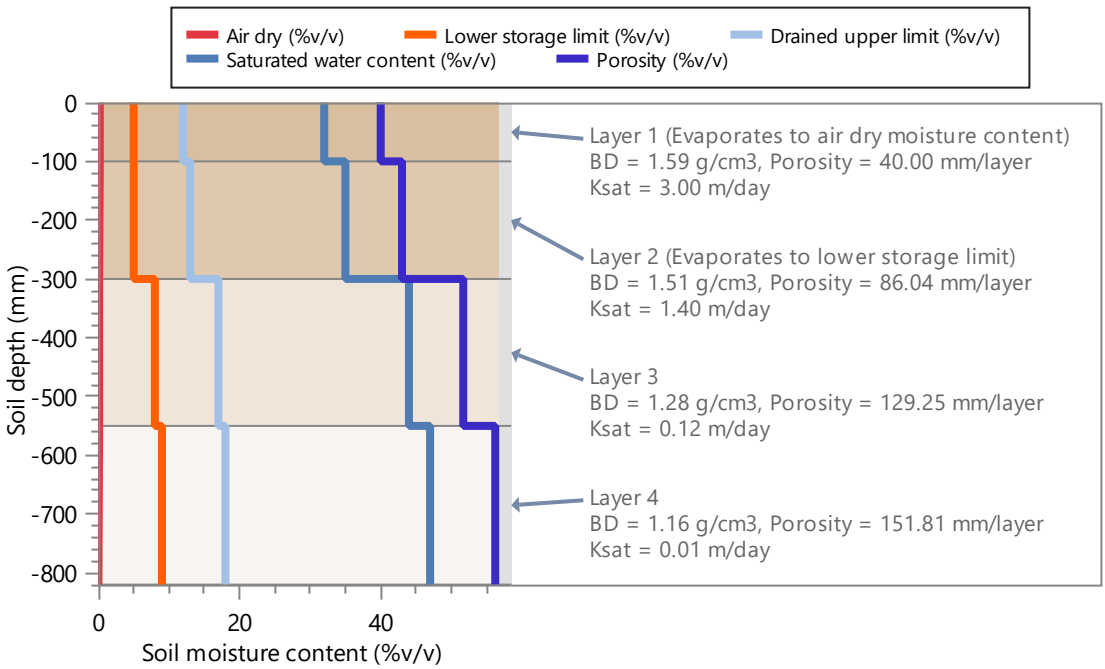
Paddock information

Paddock: New paddock, 3 ha

Soil type: Brown Tenosol - Site Specific, 820.00 mm defined profile depth

Profile porosity (mm)	407.09
Profile saturation water content (mm)	338.90
Profile drained upper limit (or field capacity) (mm)	129.10
Profile lower storage limit (or permanent wilting point) (mm)	59.30
Profile available water capacity (mm)	69.80
Profile limiting saturated hydraulic conductivity (m/day)	0.01
Surface saturated hydraulic conductivity (m/day)	3.00
Runoff curve number II (coefficient)	70.00
Soil evaporation U (mm)	9.50
Soil evaporation Cona (mm/sqrt day)	4.00

Profile



Planting regime: Continuous Rhodes grass pasture

Average monthly cover (fraction) (minimum - maximum)	0.72 (0.69 - 0.73)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.9 x Pan coefficient 1)	0.90
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	1.00
Potential rooting depth in defined soil profile (mm)	820.00
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	7.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03

Irrigation rules: New irrigation method

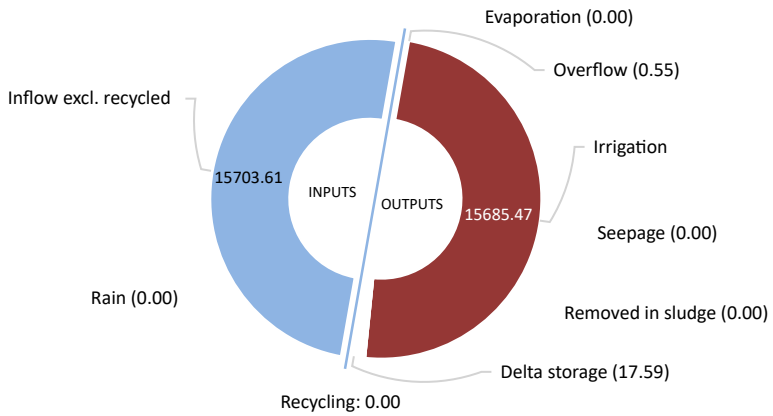
Rule 1. Irrigation triggered every 1 days and rainfall is less than or equal to 0.00 mm
Rule 2. Irrigate a fixed amount of 3.50 mm each day
Rule 3. Irrigation window from 1/1 to 30/12 including the days specified
Rule 4. A minimum of 0 days must be skipped between irrigation events

Performance

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank (wet weather storage pond: 2400 m3)

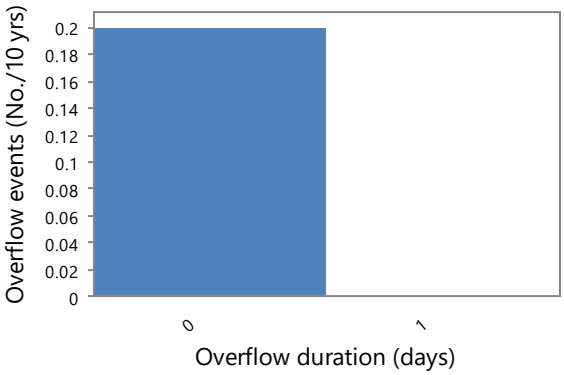
Pond system water balance (m3/year)

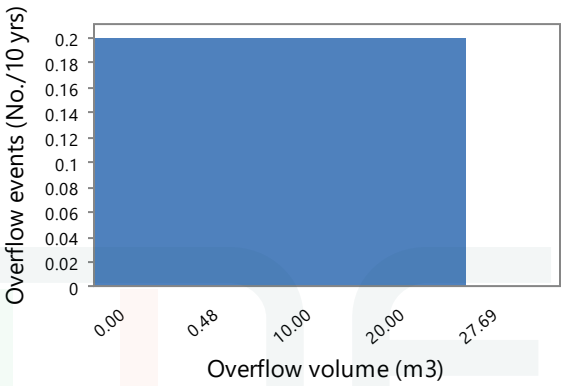


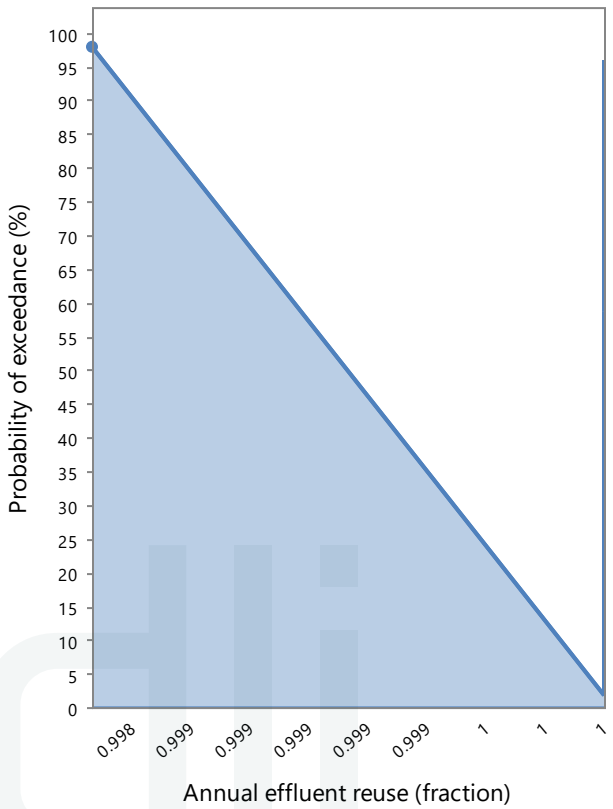
Name	Value
Rain	0.00
Inflow excl. recycled	15703.61
Recycled	0.00
Evaporation	0.00
Overflow	0.55
Irrigation	15685.47
Seepage	0.00
Removed in sludge	0.00
Delta storage	17.59

Overflow and reuse diagnostics

Metric	Value
Total volume of overflow (m3/10 years)	5.54
Total number of overflow events (events/10 years)	0.20
Total number of pond overflow days (days/10 years)	0.20
Probability of at least 90% effluent reuse (%)	100.00
Effluent reuse (fraction)	1.00





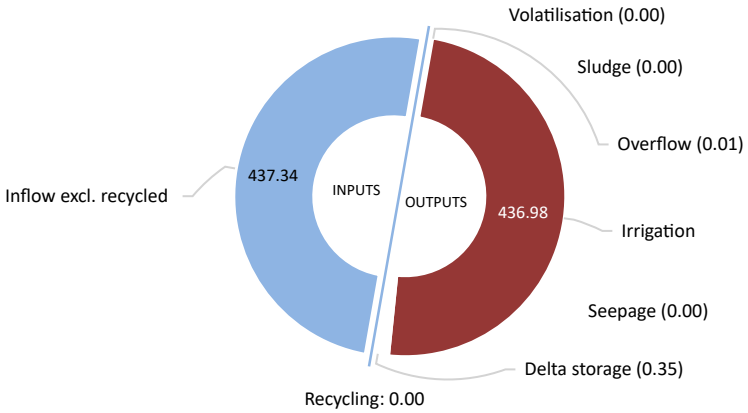


Performance

Pond system information

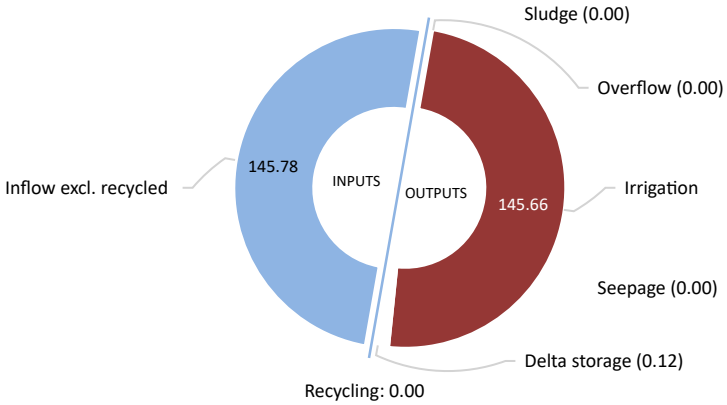
Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system nitrogen balance (kg/year)



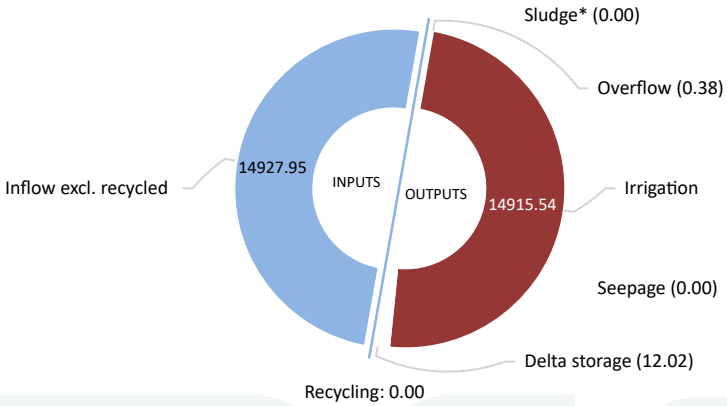
Name	Value
Inflow excl. recycled	437.34
Recycled	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.01
Irrigation	436.98
Seepage	0.00
Delta storage	0.35

Pond system phosphorus balance (kg/year)



Name	Value
Inflow excl. recycled	145.78
Recycled	0.00
Sludge	0.00
Overflow	0.00
Irrigation	145.66
Seepage	0.00
Delta storage	0.12

Pond system salt balance (kg/year)



Name	Value
Inflow excl. recycled	14927.95
Recycled	0.00
Sludge*	0.00
Overflow	0.38
Irrigation	14915.54
Seepage	0.00
Delta storage	12.02

* 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 information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond nutrient concentrations and salinity

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	21.14
Average phosphorus concentration of pond liquid (mg/L)	7.05
Average salinity of pond liquid (dS/m)	1.13

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	20.02
Final phosphorus concentration of pond liquid (mg/L)	6.67
Final salinity of pond liquid (dS/m)	1.07

Performance

Water use (assumes 100% irrigation efficiency)

Metric	Value
Pond water irrigated (m3/year)	15685.47
Average shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	15685.47
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

Metric	Value
Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	27.86
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	27.86
Average phosphorus concentration of irrigation water (mg/L)	9.29
Average salinity of irrigation water (dS/m)	1.49

Irrigation diagnostics

Metric	Value
No. periods/year without any irrigable effluent in the wet weather storage pond (periods/year)	0.00
Average length of such periods (days)	0.00

Irrigation triggering and application

No. Days without Irrigation Applied per Year: 54.70 (with rain exceeding specified rainfall threshold [53.70] and day outside of irrigation window [1.00])
No. Days without Irrigation Applied per Year: 54.70 (with not triggered)
No. Days with Irrigation Applied per Year: 310.56 (with supply limited - partial application [271.38] and full application [39.18])
No. Days with Irrigation Triggered per Year: 310.56

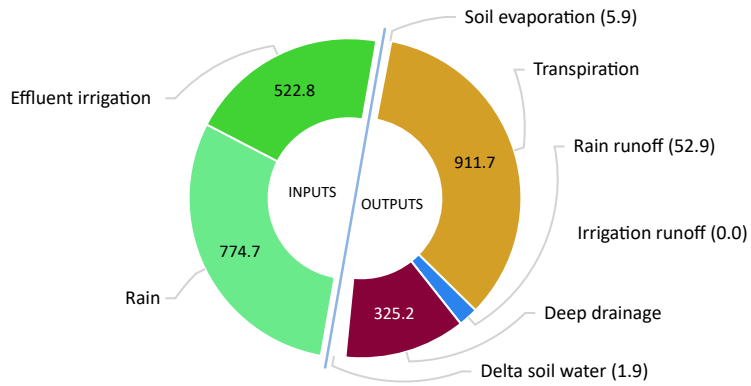
Performance

Paddock information

Paddock: New paddock, 3 ha

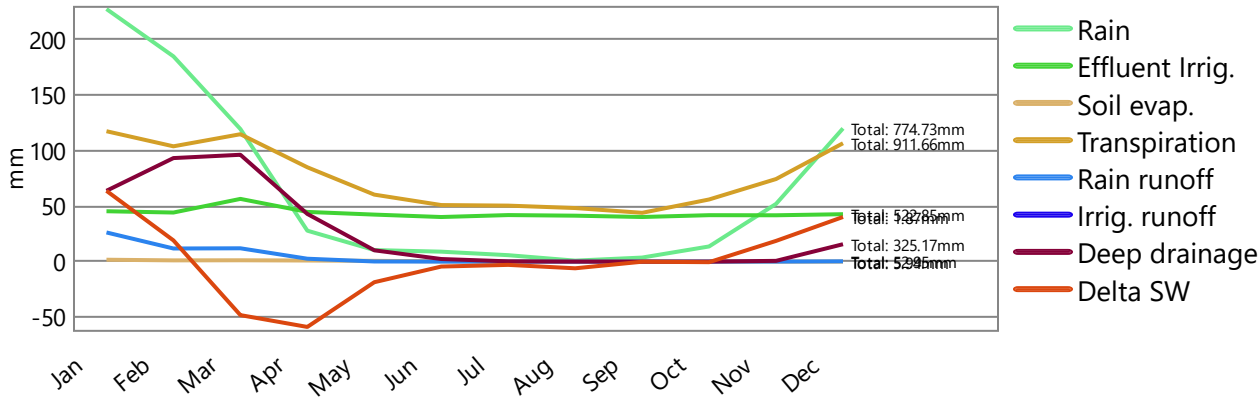
Soil Type: Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

Soil water balance (mm/year)



Name	Value
Rain	774.7
Effluent irrigation	522.8
Soil evaporation	5.9
Transpiration	911.7
Rain runoff	52.9
Irrigation runoff	0.0
Deep drainage	325.2
Delta soil water	1.9

Average monthly totals (mm)



Average annual totals (mm/year)

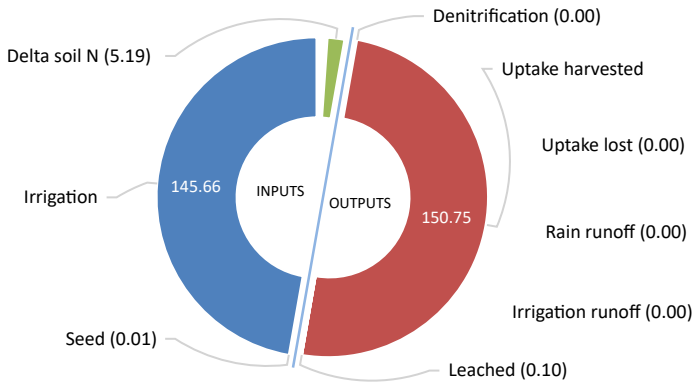


Performance

Paddock information

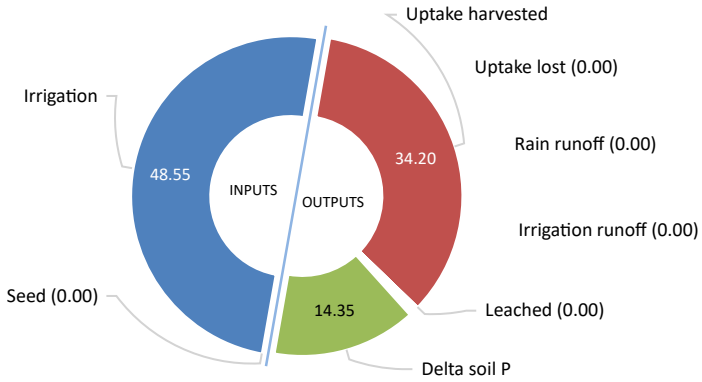
Paddock: New paddock, 3 ha
Soil Type: Brown Tenosol - Site Specific
Irrigation Ammonia-N Volatilisation Losses (kg/ha/year): 0.00
Proportion of Total Nitrogen in Irrigated Effluent as Ammonium (fraction): 0.40

Soil nitrogen balance (kg/ha/year)



Name	Value
Seed	0.01
Irrigation	145.66
Denitrification	2.51E-03
Uptake harvested	150.75
Uptake lost	0.00
Rain runoff	0.00
Irrigation runoff	0.00
Leached	0.10
Delta soil N	-5.19

Soil phosphorus balance (kg/ha/year)



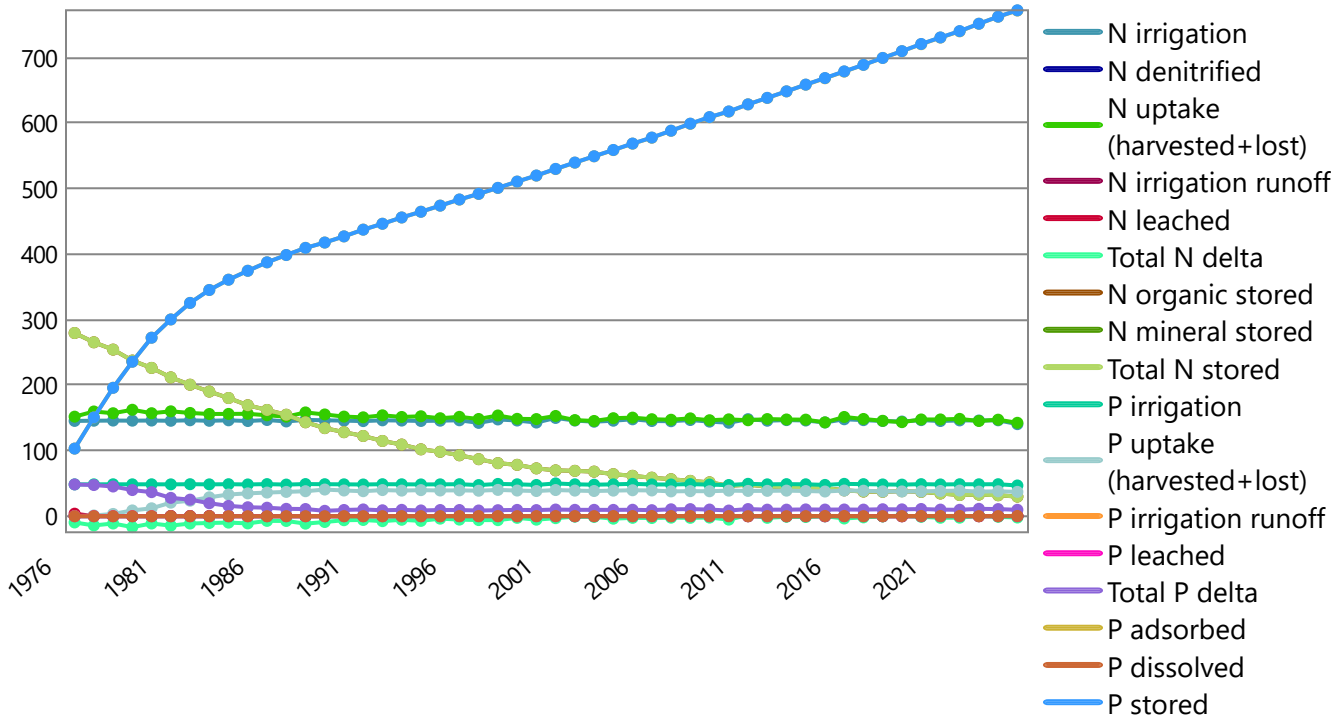
Name	Value
Seed	1.80E-03
Irrigation	48.55
Uptake harvested	34.20
Uptake lost	0.00
Rain runoff	0.00
Irrigation runoff	0.00
Leached	3.59E-03
Delta soil P	14.35

Performance

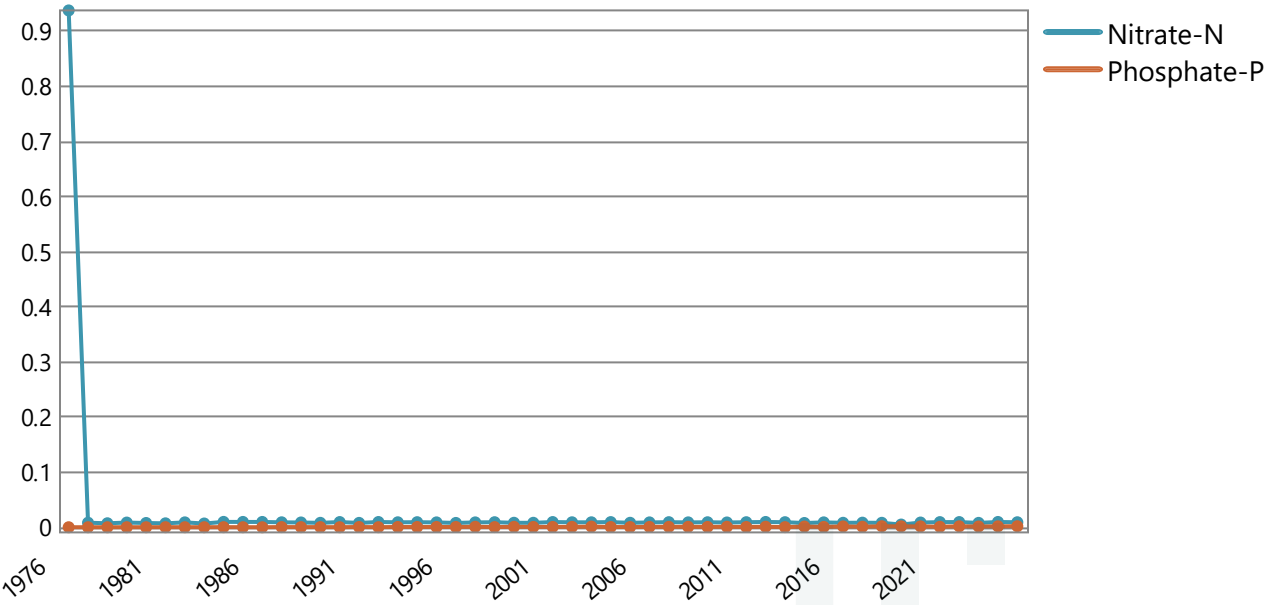
Paddock information

Paddock: New paddock, 3 ha
Soil Type: Brown Tenosol - Site Specific

Annual nutrient totals (kg/ha)



Annual nutrient leaching concentration (mg/L)



Performance

Paddock information

Paddock: New paddock, 3 ha
Soil Type: Brown Tenosol - Site Specific
Planting Regime: Continuous Rhodes grass pasture

Plant growth (minimum - maximum)

Metric	Value
Average annual shoot dry matter harvestable yield* (kg/ha/year)	13052.35 (12011.85 - 13806.09)
Average annual shoot dry matter lost (kg/ha/year)	0.00 (0.00 - 0.00)
Average monthly plant (green) cover (fraction)	0.72 (0.69 - 0.73)
Average monthly root depth (mm)	819.17 (812.13 - 820.00)

Plant nutrient uptake (minimum - maximum)

Metric	Value
Average annual shoot nitrogen in harvestable yield* (kg/ha/year)	150.75 (142.51 - 162.41)
Average annual shoot nitrogen lost (kg/ha/year)	0.00 (0.00 - 0.00)
Average annual shoot phosphorus in harvestable yield* (kg/ha/year)	34.20 (0.12 - 40.62)
Average annual shoot phosphorus lost (kg/ha/year)	0.00 (0.00 - 0.00)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.003 (0.000 - 0.003)

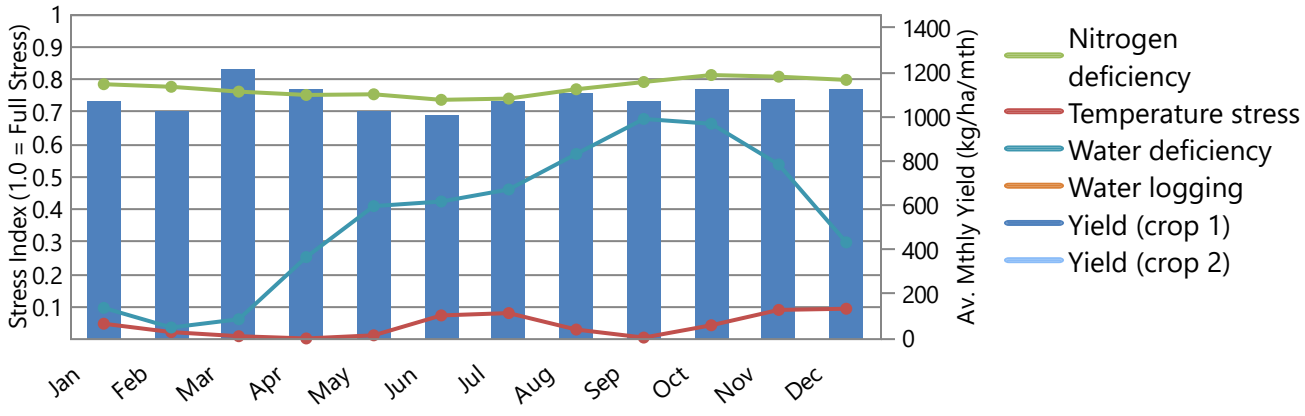
*Harvestable yield is a measure of *net* gain over a nominated period - say monthly. It is the total shoot-dry-matter gain minus any shot-dry-matter loss within a given period. Hence, just like financial investments, negative harvestable yields may occur when the (episodic) losses exceed the gains made within a particular accounting period.

Performance

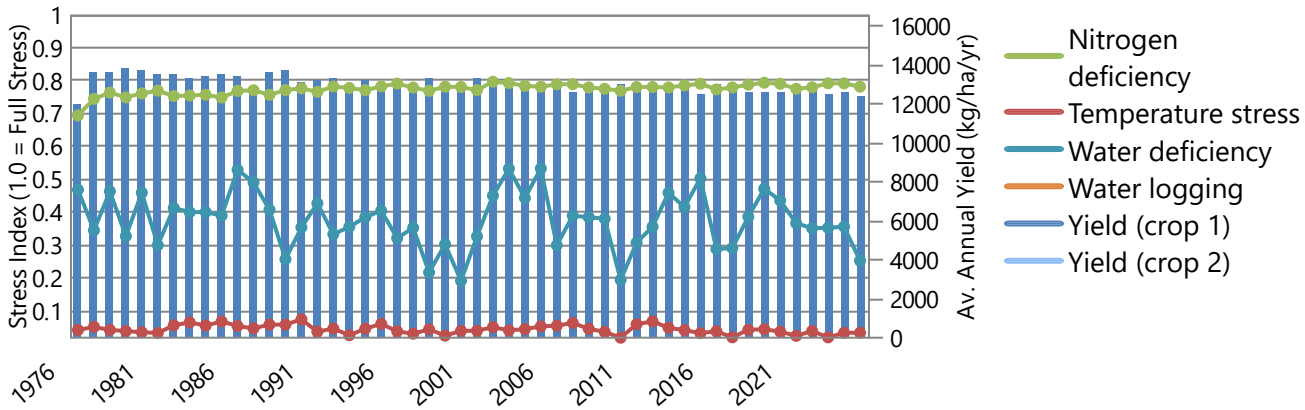
Paddock information

Paddock: New paddock, 3 ha
Soil Type: Brown Tenosol - Site Specific
Planting Regime: Continuous Rhodes grass pasture

Av. monthly stresses & harvestable yield* (kg/ha/month)



Av. annual stresses & harvestable yield* (kg/ha/year)



*Harvestable yield is a measure of *net* gain over a nominated period - say monthly. It is the total shoot-dry-matter gain minus any shot-dry-matter loss within a given period. Hence, just like financial investments, negative harvestable yields may occur when the (episodic) losses exceed the gains made within a particular accounting period.

Normal and forced harvest information

No. of Harvests per Year: 2.28 (normal).
No. Days without Crop per Year (no./year): 0.00

Performance

Paddock information

Paddock: New paddock, 3 ha
Soil Type: Brown Tenosol - Site Specific
Planting Regime: Continuous Rhodes grass pasture

Plant salinity tolerance

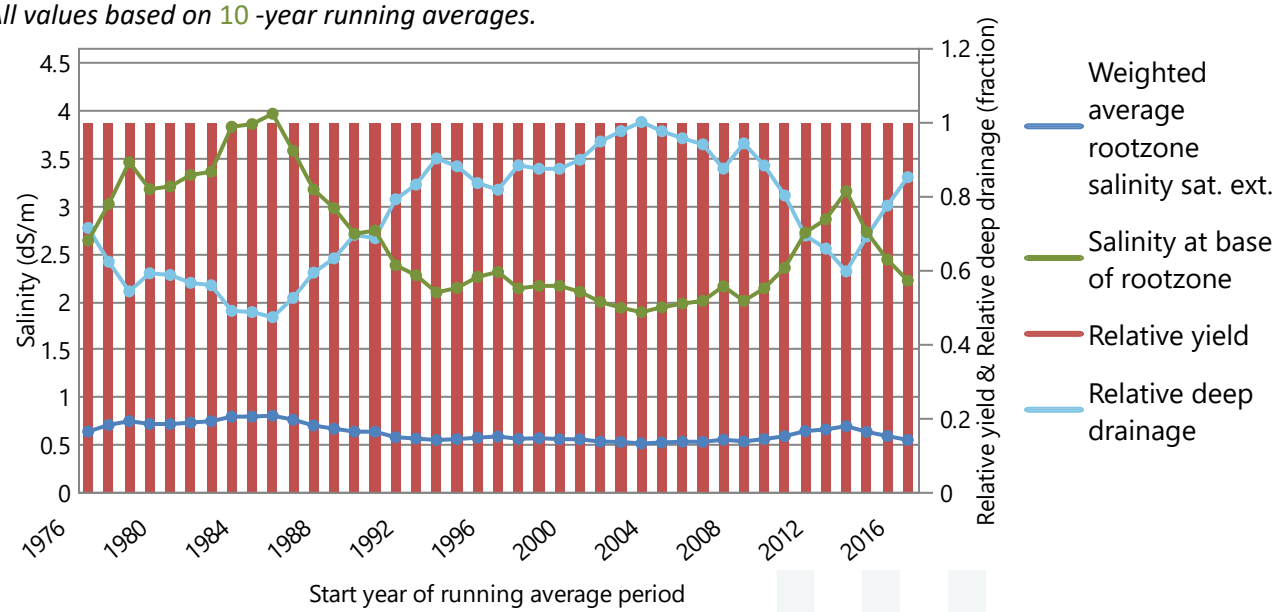
Metric	Value
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	7.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03
No. years assumed for leaching to reach steady-state (years)	10.00

Soil salinity

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.65
Salt added by rainfall (kg/ha/year)	138.58
Average annual salt added & leached at steady state (kg/ha/year)	5110.43
Average leaching fraction based on 10 -year running averages (fraction)	0.48
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.63
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	2.63
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

All values based on 10 -year running averages.

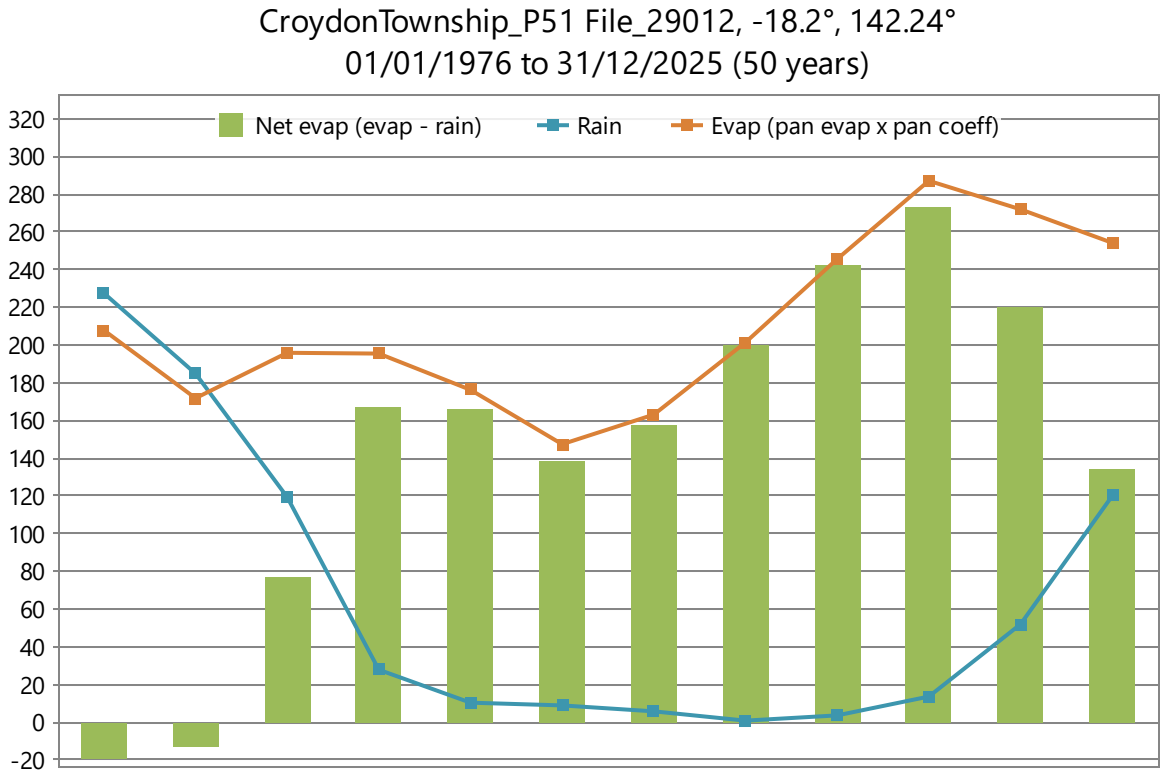


Diagnostics

Scenario information

Enterprise: Esmerelda Project

Climate long-term monthly averages (mm)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Evap	207.8	171.8	195.9	195.4	176.2	147.4	163.1	201.4	245.6	287.1	271.9	254.2	2517.8
Net evap	-19.7	-13.0	76.5	167.6	165.9	138.5	157.3	200.5	241.9	273.4	220.0	134.2	1743.1
Net evap/day	-0.6	-0.5	2.5	5.6	5.4	4.6	5.1	6.5	8.1	8.8	7.3	4.3	4.8

Diagnostics

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Effluent Type: - 15703.61 m3/year or 42.99 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.26 non-zero flow days/year.

Constituent	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

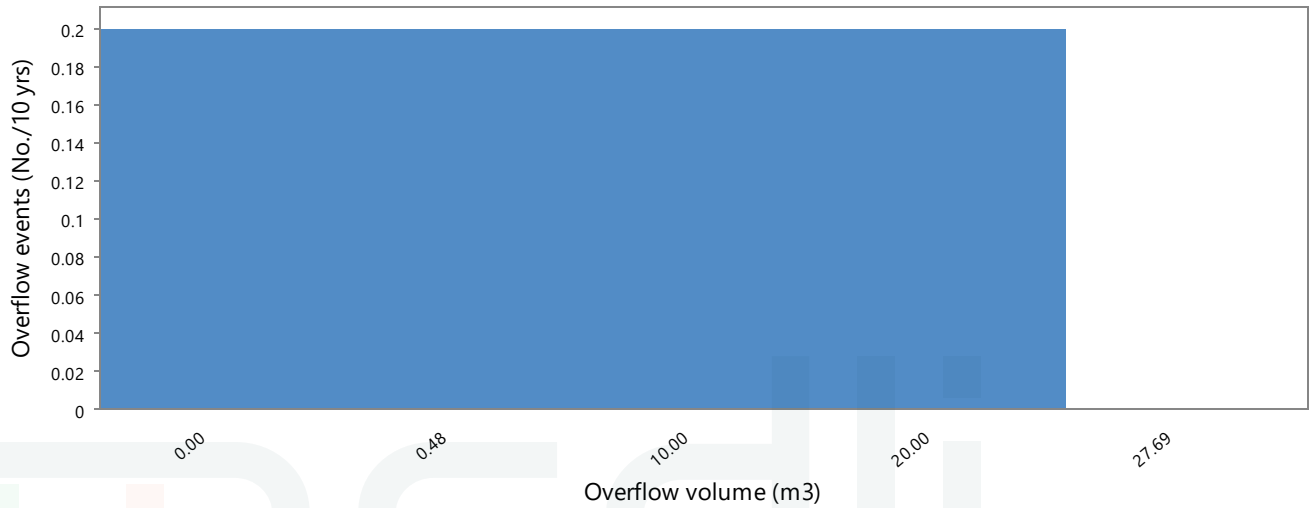
Ammonia-N loss from pond system water surface area: 0.00 kg/m2/year

Last pond (wet weather store): 2400.00 m3

Metric	Value
Theoretical hydraulic retention time (days)	55.82
Volume of overflow (m3/year) Average (minimum-maximum)	0.55 (0.00 - 27.69)
Volume of overflow per day (m3/day) Average (minimum-maximum)	0.00 (0.00 - 27.69)
No overflow days - Average per year (Total in run period)	0.02 (1)
No. overflow events per 10 years exceeding threshold of 0.480 m3* (events/10 years)	0.20
Average overflow event recurrence interval (years)	50.00
Average duration of overflow (days)	1.00
Probability of at least 90% effluent reuse (%)	100.00
Effluent reuse (propn. of inflow + net rain gain that is irrigated/removed with sludge) (fraction)	1.00
Average salinity (dS/m)	1.13
Salinity on final day of simulation (dS/m)	1.07

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

Volume distribution of the overflow events



Diagnostics

Scenario information

Area irrigated: 3 ha total area

Loading to whole irrigation area: (assuming 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	15685.47	5228.49
Total nitrogen applied (kg)	436.98	145.66
Total phosphorus applied (kg)	145.66	48.55
Total salts applied (kg)	14915.54	4971.85

Shandying

Metric	Value
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)
Minimum shandy water is used	No

Irrigation issues

Metric	Value
Number of days without irrigation (days/year)	54.70

Diagnostics

Paddock information

Paddock: - New paddock, 3 ha

Irrigation: New irrigation method with 0% ammonium loss during irrigation

Irrigation Rules
Irrigation triggered every 1 days and when rainfall is less than or equal to 0.00 mm
Irrigate a fixed amount of 3.50 mm
Irrigation window from 1/1 to 30/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil water balance (mm): Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Efflt. irrg.	45.4	44.2	56.5	44.7	42.3	40.2	41.9	41.3	40.2	41.8	41.7	42.7	522.8
Soil evap	1.7	1.1	1.2	1.0	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	5.9
Transpn.	117.4	103.8	114.7	84.9	60.3	50.9	50.4	48.2	43.9	56.0	74.4	106.6	911.7
Rain runoff	26.2	11.8	12.0	2.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	52.9
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	63.8	93.2	96.2	42.9	10.2	2.3	0.2	0.0	0.0	0.0	0.7	15.7	325.2
Delta SW	63.7	19.1	-48.2	-58.9	-18.6	-4.5	-3.0	-6.0	-0.1	-0.5	18.6	40.2	1.9

Soil nitrogen balance: (Concentrations are flow-weighted)

Metric	Value
Average annual nitrogen added in seed (kg/ha/year)	0.01
Average annual nitrogen added from irrigation (kg/ha/year)	145.66
Av. annual soil N removed by uptake (harvest + lost) (kg/ha/year)	150.75 (150.75, 0.00)
Av. annual soil nitrogen removed by denitrification (kg/ha/year)	2.51E-03
Average annual soil nitrogen leached (kg/ha/year)	0.10
Soil organic-N kg/ha (Initial - Final)	278.25 - 29.85
Soil inorganic-N kg/ha (Initial - Final)	10.94 - 0.01
Average nitrate-N concentration of deep drainage (Max annual concentration)	
Across all years (mg/L)	0.03 (0.94)
Excluding first year of data (mg/L)	0.01 (0.01)

Soil phosphorus balance: (Concentrations are flow-weighted)

Metric	Value
Average annual phosphorus added in seed (kg/ha/year)	1.80E-03
Average annual phosphorus added from irrigation (kg/ha/year)	48.55
Av. annual soil P removed by uptake (harvest + lost) (kg/ha/yr)	34.20 (34.20, 0.00)
Average annual soil phosphorus leached (kg/ha/year)	3.59E-03
Dissolved phosphorus (kg/ha) (Initial - Final)	3.87E-04 - 0.36
Adsorbed phosphorus (kg/ha) (Initial - Final)	54.71 - 771.78
Average phosphate-P concentration in rootzone (mg/L)	0.09
Average phosphate-P concentration of deep drainage (Max annual concentration)	
Across all years (mg/L)	1.10E-03 (2.27E-03)
Last year only (mg/L)	2.27E-03 (N.D.*)
Design soil profile storage life based on average infiltrated water phosphorus concn. of 3.90 mg/L (years)	407.28

* Not determined

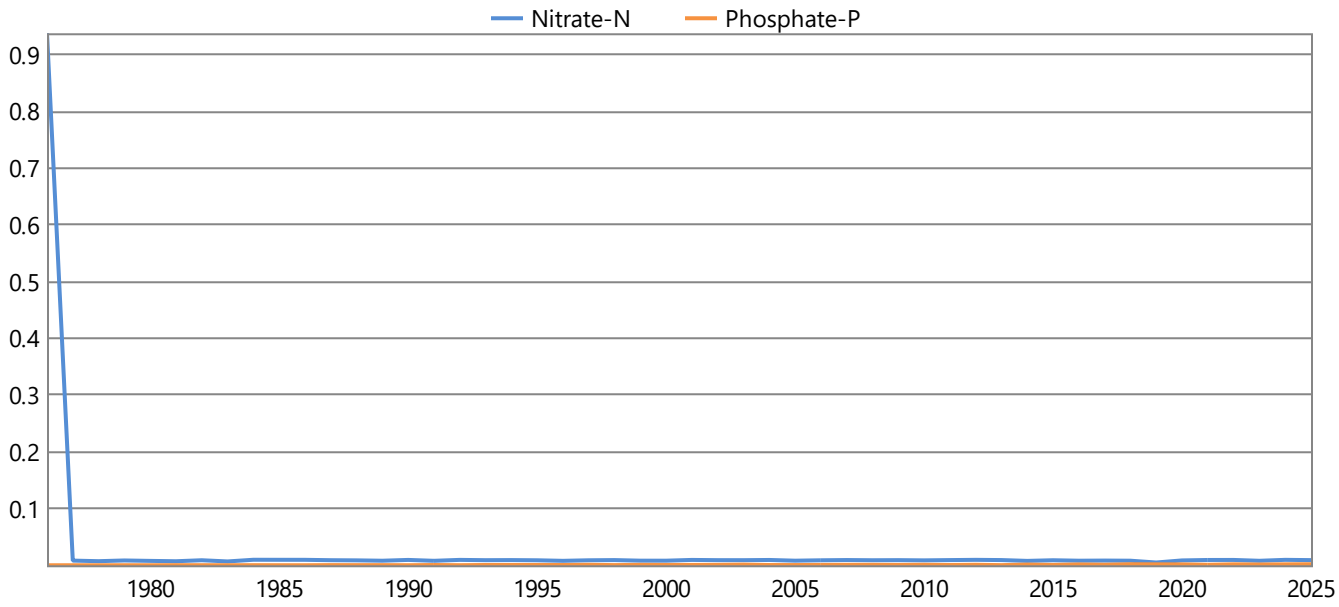
Diagnostics

Paddock information

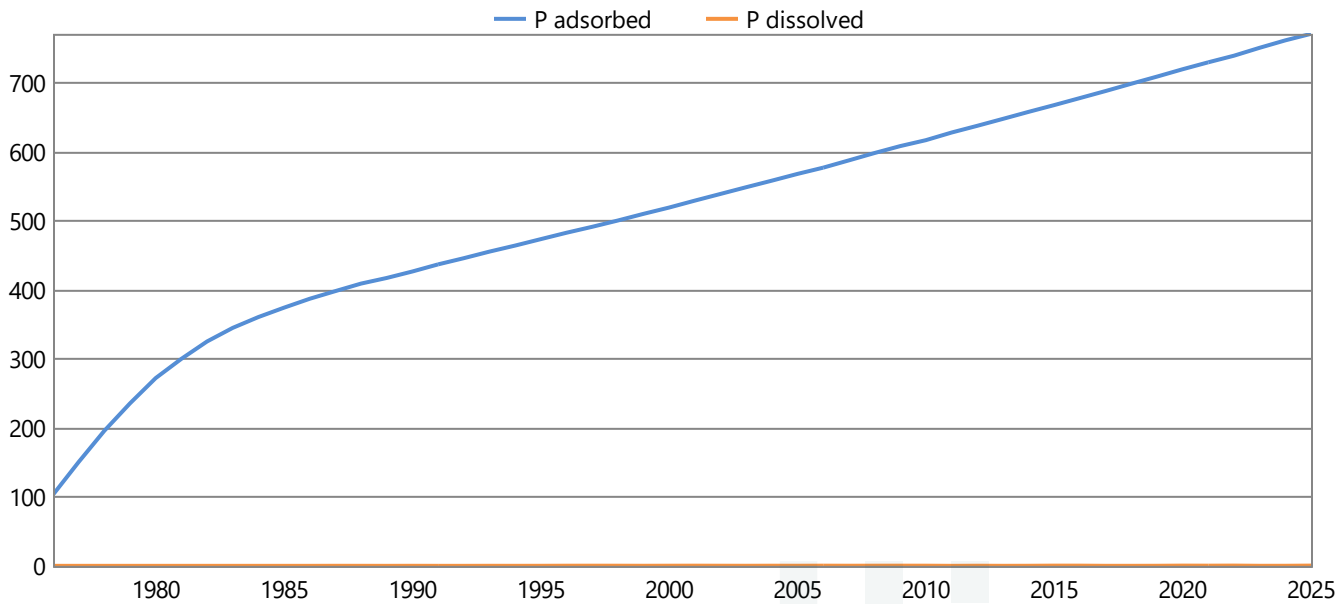
Paddock: New paddock, 3 ha

Irrigation: New irrigation method with 0% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual phosphate-P in soil (kg/ha)



Diagnostics

Paddock information

Paddock: New paddock, 3 ha

Planting Regime: Continuous Rhodes grass pasture

Average plant performance (minimum - maximum)

Metric	Value
Average annual shoot dry matter harvestable yield (kg/ha/year)	13052.35 (12011.85 - 13806.09)
Average annual shoot dry matter lost (kg/ha/year)	0.00 (0.00 - 0.00)
Average monthly plant (green) cover (fraction)	0.72 (0.69 - 0.73)
Average monthly crop factor (fraction)	0.64 (0.62 - 0.65)
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	1.00
Average monthly root depth (mm)	819.17 (812.13 - 820.00)
Average number of normal harvests per year (no./year)	2.28 (2.00 - 3.00)
Average number of normal harvests for last five years only (no./year)	2.20
Average number of forced harvests per year (no./year)	0.00 (0.00 - 0.00)
Average number of forced harvests for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.77 (0.69 - 0.80)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.05 (0.00 - 0.15)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.08 (0.00 - 0.21)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.37 (0.04 - 0.68)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop per year. Excludes bare fallow days (days)	0.00

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.

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.65
Salt added by rainfall (kg/ha/year)	138.58
Average annual salt added & leached at steady state (kg/ha/year)	5110.43
Average leaching fraction based on 10 -year running averages (fraction)	0.48
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.63
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	2.63
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 information

Messages generated when the scenario was run
WARNING: Plant phosphorus deficiency. No soil phosphorus has been available for plant uptake for 1.54% of days of simulation.
UNCONDITIONAL FINISH

General Information

SCENARIO REPORT: Full run

General information

Enterprise: Esmerelda Project - Run 4 with 2400.00 m3 storage pond volume and 4.00 ha irrigation area
Client: Graphinex
MEDLI user: APEM\Jenna.Huckenswager

Description:

Onsite Workers Camp STP - Scenario 3

Scenario details: Sensitivity Analysis - Rhodes Pasture, 4 ha

Map of location:

Note: If the map above appears as a dark box, check that the network is accessible and that the coordinates are not for a location in the ocean.



Description

Climate information

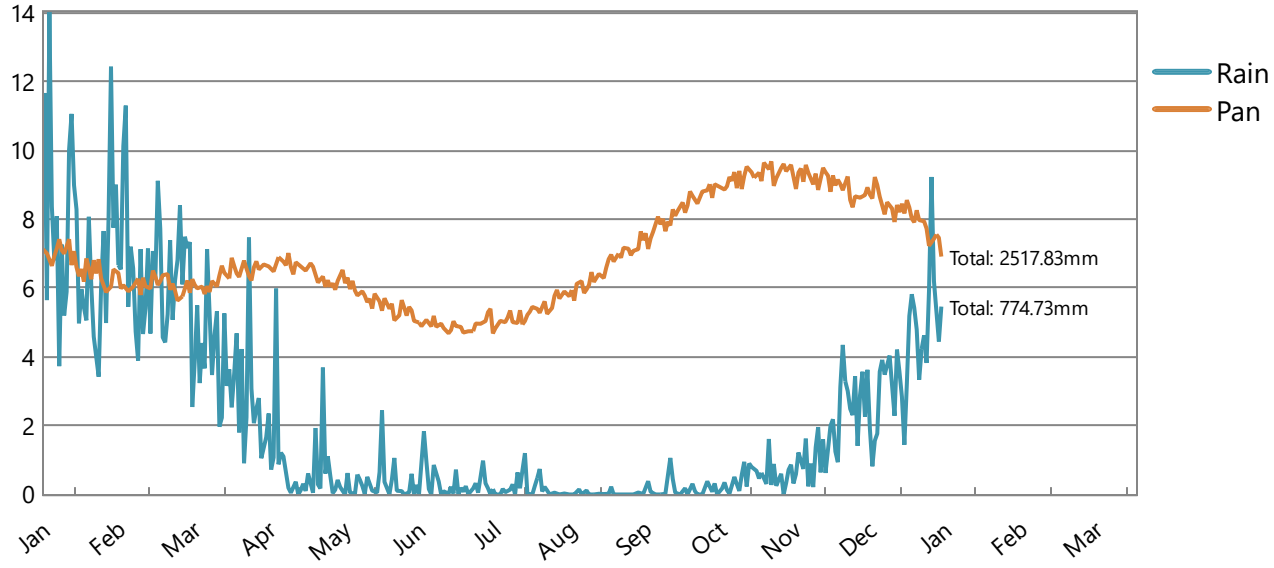
Climate Data Location: CroydonTownship_P51 File_29012, -18.2°, 142.24°
Run Period: 01/01/1976 to 31/12/2025 (50 years)

Climate statistics

	5th Percentile		50th Percentile		95th Percentile	
Rainfall (mm/year)	(Year 2013)	366.2	(Year 1977)	814.8	(Year 2006)	1129.4
Pan evaporation (mm/year)	(Year 1998)	2076.8	(Year 1992)	2545.6	(Year 1978)	2880.0

Climate data

Daily average across run period:



Description

Wastestream information

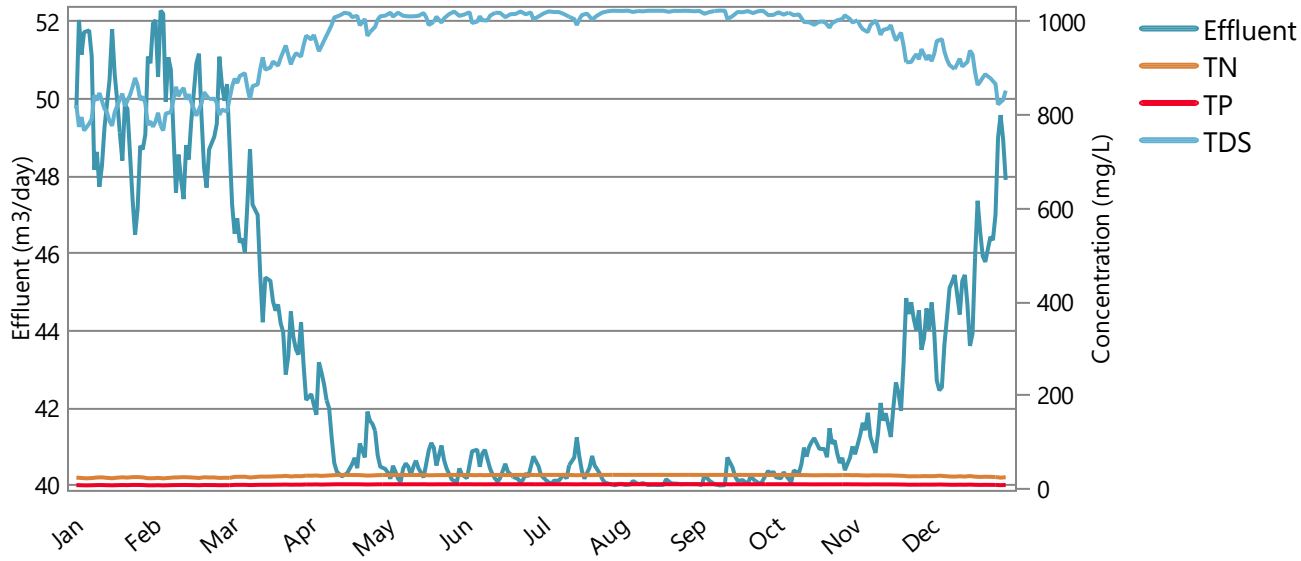
Wastestream Name: - New sewage treatment plant

Wastestream production description

New sewage treatment plant derived from a 200.0 EP (daily average) STP with a capacity of 2.00 times dry weather flow. The STP generates 14610.00 m3 effluent (average dry weather flow), and assumes Average infiltration into sewerage system during wet weather. Dry weather flow effluent quality is 30.00 mg/L total nitrogen, 10.00 mg/L total phosphorus and 1024.00 mg/L total dissoved salts. This wastestream is not separately pretreated.

Wastestream

Average Daily Quantity and Flow-Weighted Average Quality:



Wastestream

Effluent Quantity: 15703.61 m3/year or 42.99 m3/day (Min-Max 40.00 - 80.00)

Flow-Weighted Average (Min - Max) Daily Effluent Quality Entering the Pond System:

	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

STP bypass wastestream

Bypass Quantity: 93.33 m3_per_year (Min-Max: 0.00 - 126.08)

Flow-Weighted Average (Min - Max) Daily Bypass Flow Quality:

	Concentration (mg/L)	Load (tonnes/year)
Total nitrogen	24.25 (13.59 - 34.99)	2.26 (0.00 - 9.61)
Total phosphorus	17.32 (9.71 - 24.99)	1.62 (0.00 - 6.87)
Total dissolved salts	519.56 (291.15 - 749.84)	48.49 (0.00 - 205.98)

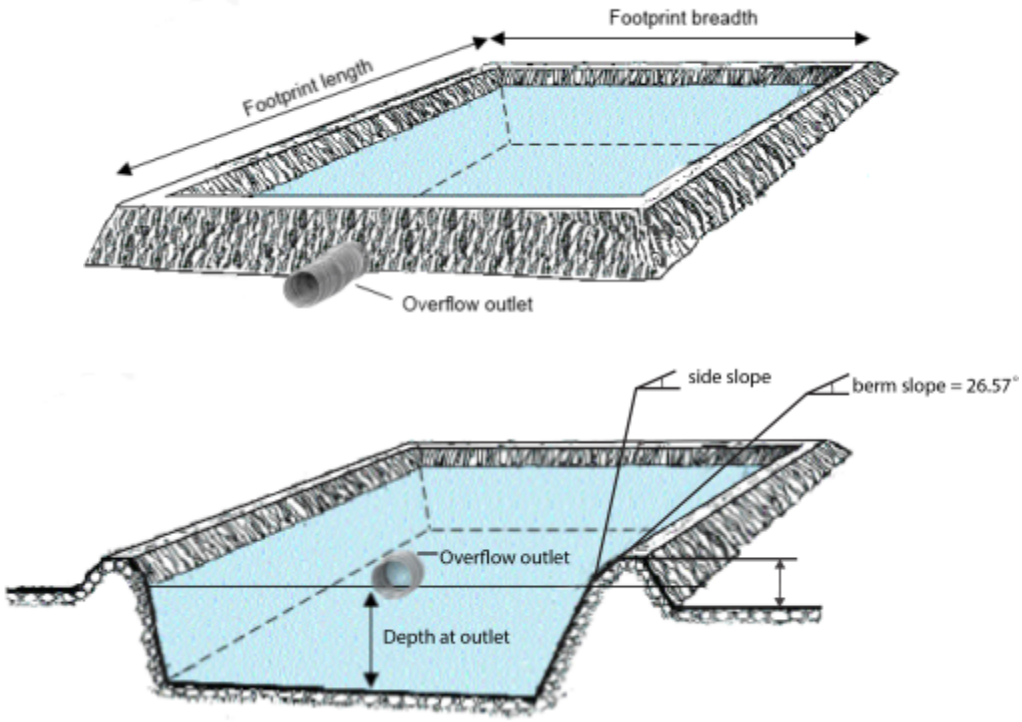
Description

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system details

	Pond 1
Maximum pond volume (m3)	2400.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	5.00
Maximum water surface area (m2)	480.00
Pond footprint length (m)	21.91
Pond footprint width (m)	21.91
Pond catchment area (m2)	480.00
Average active volume (m3)	53.68



Irrigation pump limits

Minimum pump rate limit (ML/day)	0.00
Maximum pump limit	As scheduled

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	No

Description

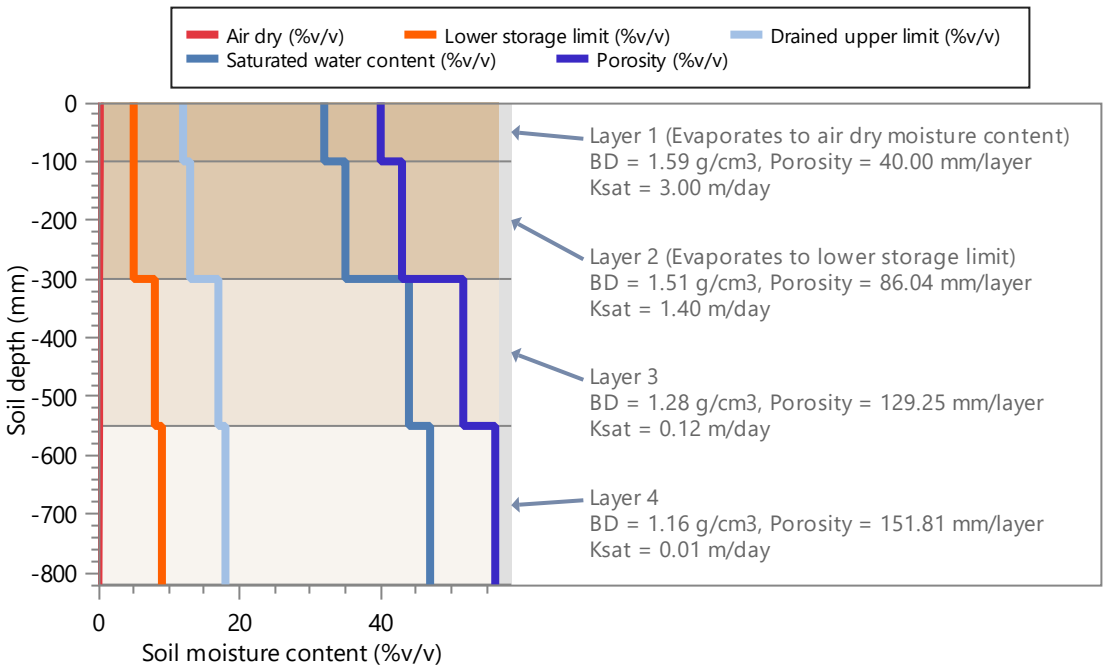
Paddock information

Paddock: New paddock, 4 ha

Soil type: Brown Tenosol - Site Specific, 820.00 mm defined profile depth

Profile porosity (mm)	407.09
Profile saturation water content (mm)	338.90
Profile drained upper limit (or field capacity) (mm)	129.10
Profile lower storage limit (or permanent wilting point) (mm)	59.30
Profile available water capacity (mm)	69.80
Profile limiting saturated hydraulic conductivity (m/day)	0.01
Surface saturated hydraulic conductivity (m/day)	3.00
Runoff curve number II (coefficient)	70.00
Soil evaporation U (mm)	9.50
Soil evaporation Cona (mm/sqrt day)	4.00

Profile



Planting regime: Continuous Rhodes grass pasture

Average monthly cover (fraction) (minimum - maximum)	0.71 (0.69 - 0.72)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.9 x Pan coefficient 1)	0.90
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	1.00
Potential rooting depth in defined soil profile (mm)	820.00
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	7.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03

Irrigation rules: New irrigation method

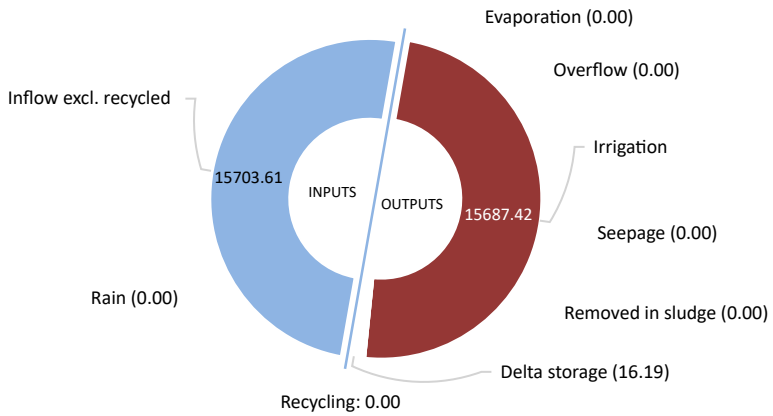
Rule 1. Irrigation triggered every 1 days and rainfall is less than or equal to 0.00 mm
Rule 2. Irrigate a fixed amount of 3.50 mm each day
Rule 3. Irrigation window from 1/1 to 30/12 including the days specified
Rule 4. A minimum of 0 days must be skipped between irrigation events

Performance

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank (wet weather storage pond: 2400 m3)

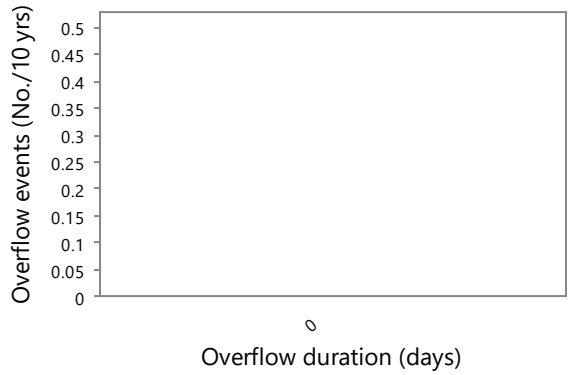
Pond system water balance (m3/year)

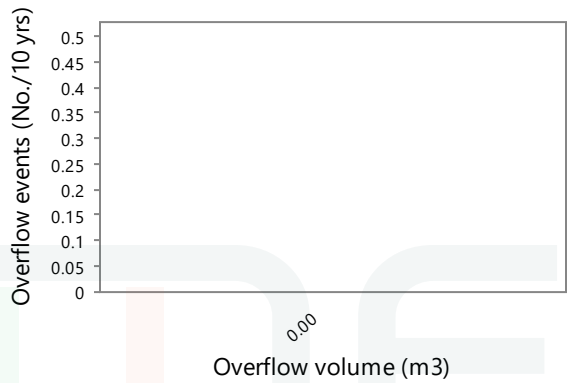


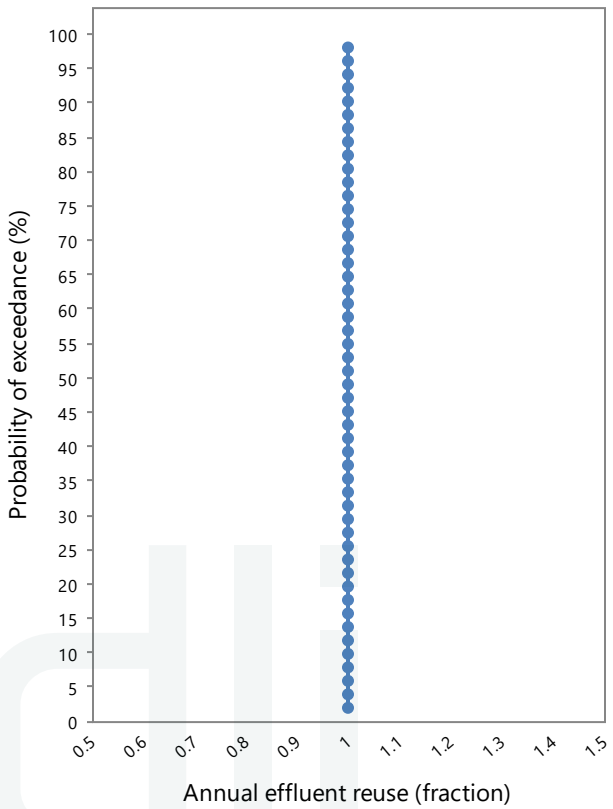
Name	Value
Rain	0.00
Inflow excl. recycled	15703.61
Recycled	0.00
Evaporation	0.00
Overflow	0.00
Irrigation	15687.42
Seepage	0.00
Removed in sludge	0.00
Delta storage	16.19

Overflow and reuse diagnostics

Metric	Value
Total volume of overflow (m3/10 years)	0.00
Total number of overflow events (events/10 years)	0.00
Total number of pond overflow days (days/10 years)	0.00
Probability of at least 90% effluent reuse (%)	100.00
Effluent reuse (fraction)	1.00





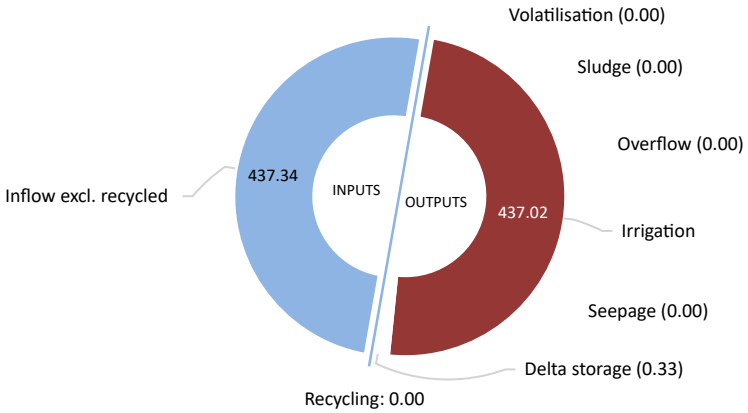


Performance

Pond system information

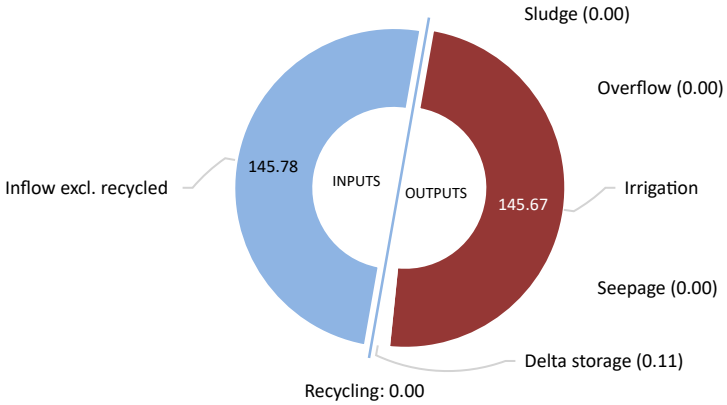
Pond System Configuration: 1 closed (sludge-free) storage tank

Pond system nitrogen balance (kg/year)



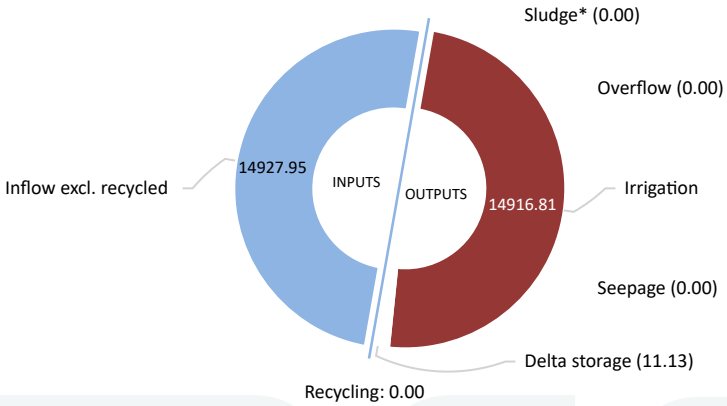
Name	Value
Inflow excl. recycled	437.34
Recycled	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.00
Irrigation	437.02
Seepage	0.00
Delta storage	0.33

Pond system phosphorus balance (kg/year)



Name	Value
Inflow excl. recycled	145.78
Recycled	0.00
Sludge	0.00
Overflow	0.00
Irrigation	145.67
Seepage	0.00
Delta storage	0.11

Pond system salt balance (kg/year)



Name	Value
Inflow excl. recycled	14927.95
Recycled	0.00
Sludge*	0.00
Overflow	0.00
Irrigation	14916.81
Seepage	0.00
Delta storage	11.13

* 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 information

Pond System Configuration: 1 closed (sludge-free) storage tank

Pond nutrient concentrations and salinity

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	20.40
Average phosphorus concentration of pond liquid (mg/L)	6.80
Average salinity of pond liquid (dS/m)	1.09

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	20.14
Final phosphorus concentration of pond liquid (mg/L)	6.71
Final salinity of pond liquid (dS/m)	1.07

Performance

Water use (assumes 100% irrigation efficiency)

Metric	Value
Pond water irrigated (m3/year)	15687.42
Average shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	15687.42
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

Metric	Value
Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	27.86
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	27.86
Average phosphorus concentration of irrigation water (mg/L)	9.29
Average salinity of irrigation water (dS/m)	1.49

Irrigation diagnostics

Metric	Value
No. periods/year without any irrigable effluent in the wet weather storage pond (periods/year)	0.00
Average length of such periods (days)	0.00

Irrigation triggering and application

No. Days without Irrigation Applied per Year: 54.70 (with rain exceeding specified rainfall threshold [53.70] and day outside of irrigation window [1.00])
No. Days without Irrigation Applied per Year: 54.70 (with not triggered)
No. Days with Irrigation Applied per Year: 310.56 (with supply limited - partial application [289.26] and full application [21.30])
No. Days with Irrigation Triggered per Year: 310.56

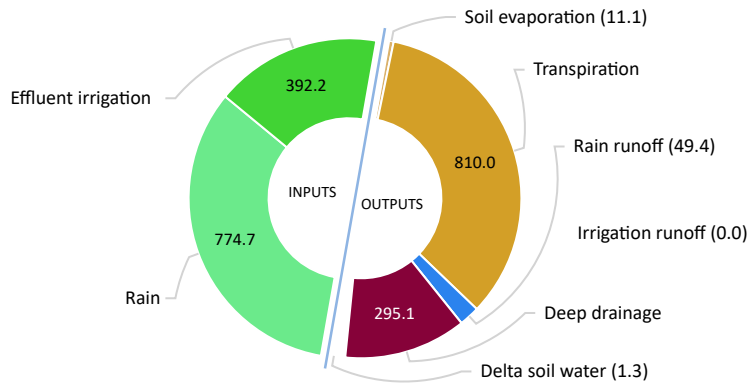
Performance

Paddock information

Paddock: New paddock, 4 ha

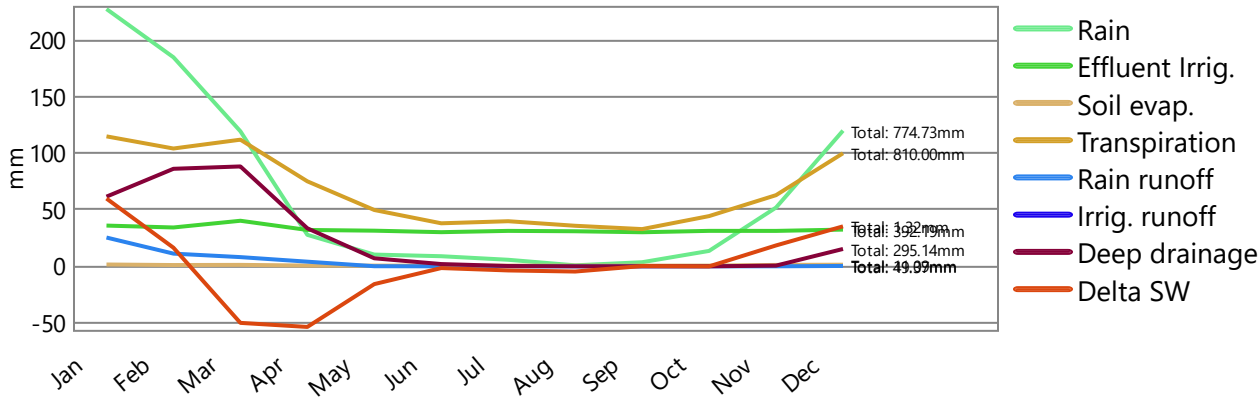
Soil Type: Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

Soil water balance (mm/year)

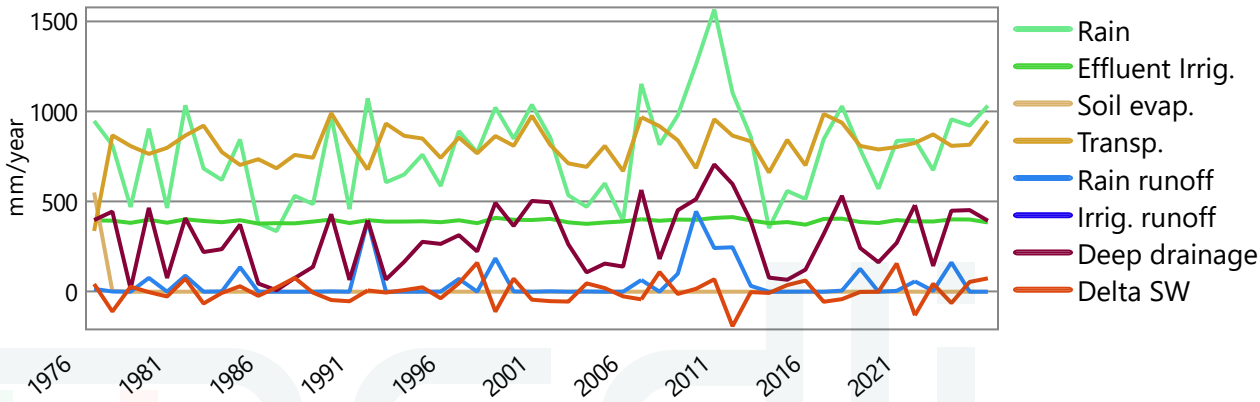


Name	Value
Rain	774.7
Effluent irrigation	392.2
Soil evaporation	11.1
Transpiration	810.0
Rain runoff	49.4
Irrigation runoff	0.0
Deep drainage	295.1
Delta soil water	1.3

Average monthly totals (mm)



Average annual totals (mm/year)

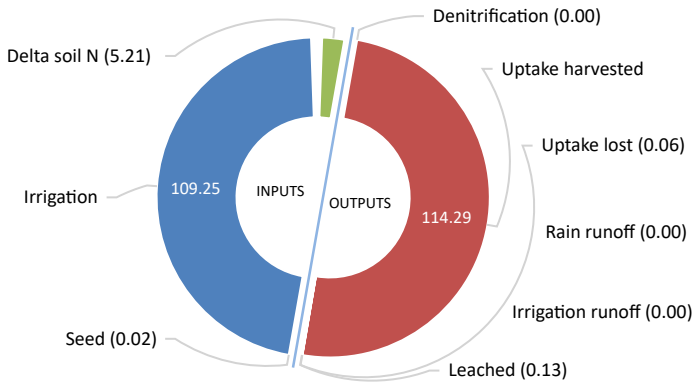


Performance

Paddock information

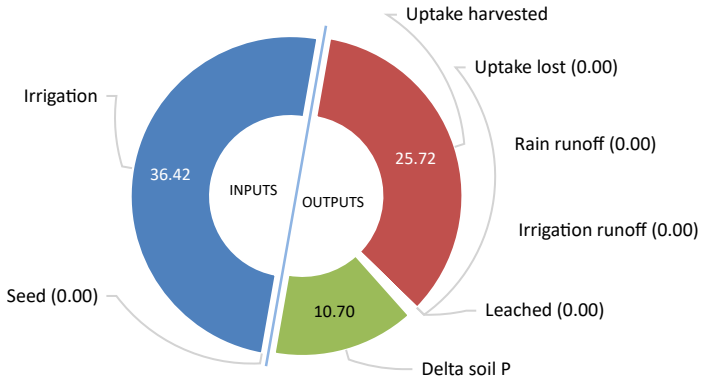
Paddock: New paddock, 4 ha
Soil Type: Brown Tenosol - Site Specific
Irrigation Ammonia-N Volatilisation Losses (kg/ha/year): 0.00
Proportion of Total Nitrogen in Irrigated Effluent as Ammonium (fraction): 0.40

Soil nitrogen balance (kg/ha/year)



Name	Value
Seed	0.02
Irrigation	109.25
Denitrification	2.20E-03
Uptake harvested	114.29
Uptake lost	0.06
Rain runoff	0.00
Irrigation runoff	0.00
Leached	0.13
Delta soil N	-5.21

Soil phosphorus balance (kg/ha/year)



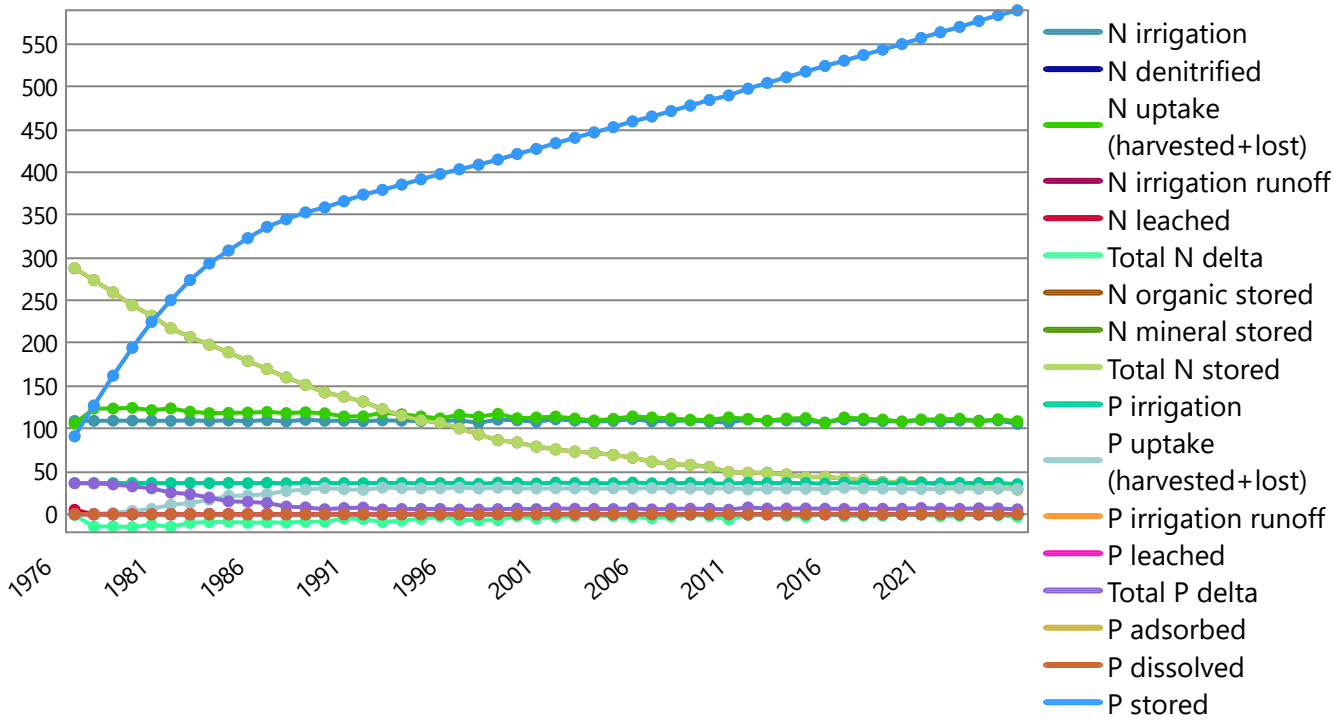
Name	Value
Seed	3.60E-03
Irrigation	36.42
Uptake harvested	25.72
Uptake lost	1.57E-04
Rain runoff	0.00
Irrigation runoff	0.00
Leached	2.55E-03
Delta soil P	10.70

Performance

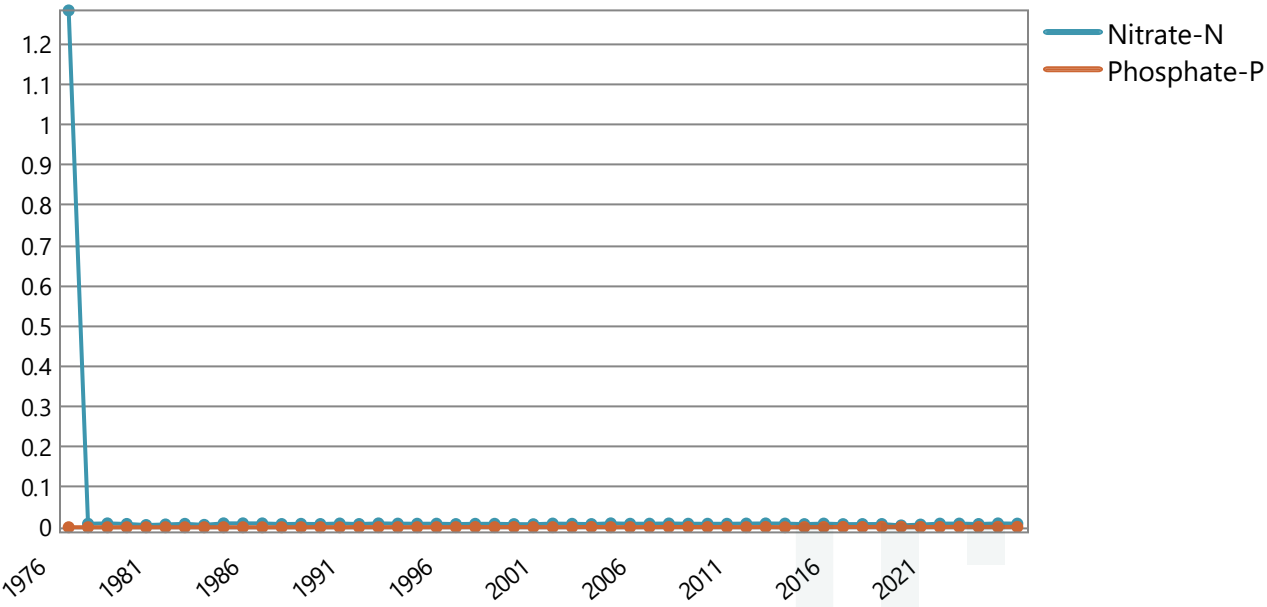
Paddock information

Paddock: New paddock, 4 ha
Soil Type: Brown Tenosol - Site Specific

Annual nutrient totals (kg/ha)



Annual nutrient leaching concentration (mg/L)



Performance

Paddock information

Paddock: New paddock, 4 ha
Soil Type: Brown Tenosol - Site Specific
Planting Regime: Continuous Rhodes grass pasture

Plant growth (minimum - maximum)

Metric	Value
Average annual shoot dry matter harvestable yield* (kg/ha/year)	10188.79 (7659.10 - 11943.79)
Average annual shoot dry matter lost (kg/ha/year)	6.00 (0.00 - 300.00)
Average monthly plant (green) cover (fraction)	0.71 (0.69 - 0.72)
Average monthly root depth (mm)	811.96 (803.60 - 820.00)

Plant nutrient uptake (minimum - maximum)

Metric	Value
Average annual shoot nitrogen in harvestable yield* (kg/ha/year)	114.29 (103.12 - 124.48)
Average annual shoot nitrogen lost (kg/ha/year)	0.06 (0.00 - 3.02)
Average annual shoot phosphorus in harvestable yield* (kg/ha/year)	25.72 (0.17 - 31.07)
Average annual shoot phosphorus lost (kg/ha/year)	0.00 (0.00 - 0.01)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.003 (0.000 - 0.003)

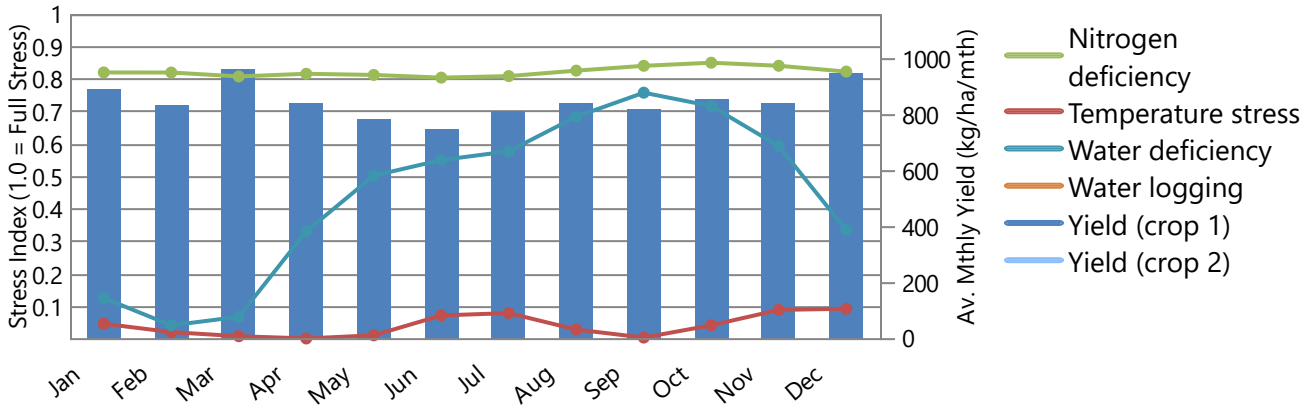
*Harvestable yield is a measure of *net* gain over a nominated period - say monthly. It is the total shoot-dry-matter gain minus any shot-dry-matter loss within a given period. Hence, just like financial investments, negative harvestable yields may occur when the (episodic) losses exceed the gains made within a particular accounting period.

Performance

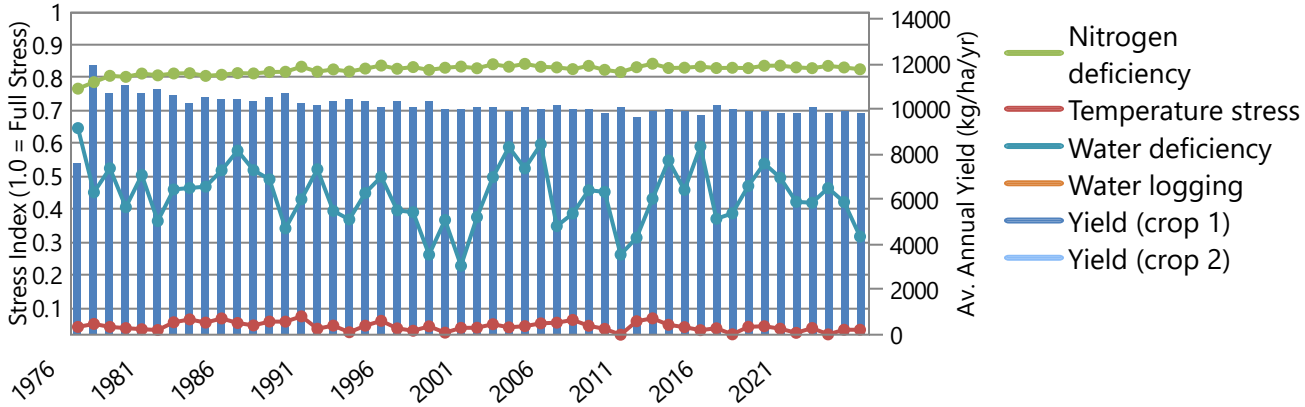
Paddock information

Paddock: New paddock, 4 ha
Soil Type: Brown Tenosol - Site Specific
Planting Regime: Continuous Rhodes grass pasture

Av. monthly stresses & harvestable yield* (kg/ha/month)



Av. annual stresses & harvestable yield* (kg/ha/year)



*Harvestable yield is a measure of *net* gain over a nominated period - say monthly. It is the total shoot-dry-matter gain minus any shot-dry-matter loss within a given period. Hence, just like financial investments, negative harvestable yields may occur when the (episodic) losses exceed the gains made within a particular accounting period.

Normal and forced harvest information

No. of Harvests per Year: 1.76 (normal), 0.02 (forced by crop death due to nitrogen stress).
No. Days without Crop per Year (no./year): 2.96 (due to water stress)

Performance

Paddock information

Paddock: New paddock, 4 ha
Soil Type: Brown Tenosol - Site Specific
Planting Regime: Continuous Rhodes grass pasture

Plant salinity tolerance

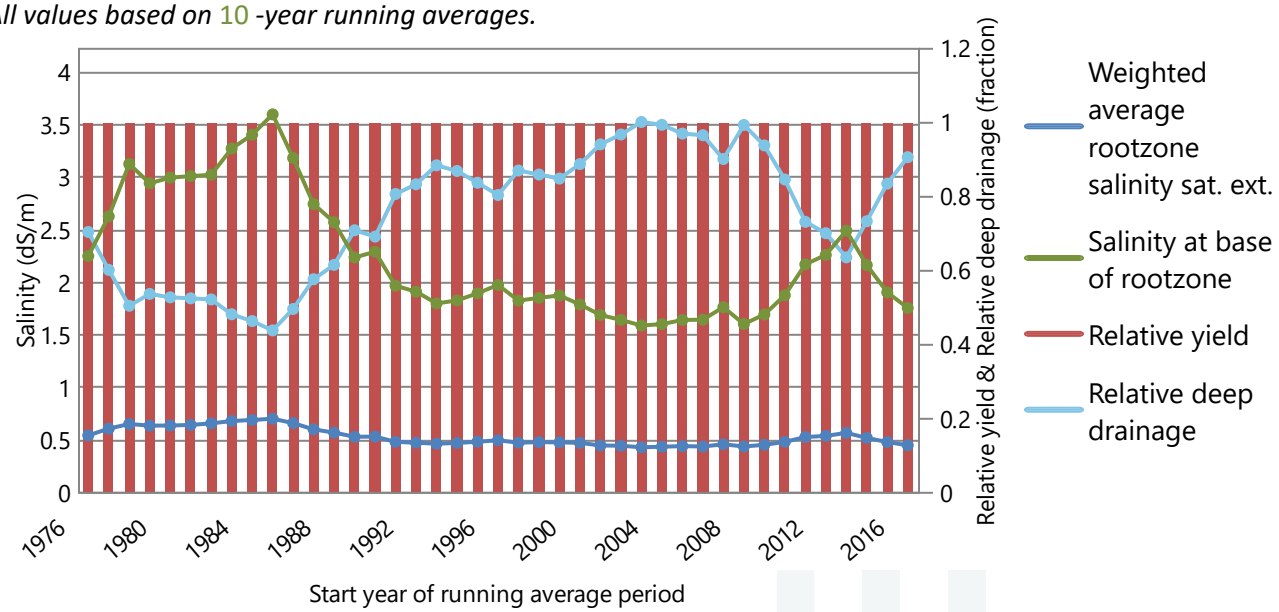
Metric	Value
Salt tolerance	Tolerant
Salinity threshold (dS/m soil saturation extract)	7.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03
No. years assumed for leaching to reach steady-state (years)	10.00

Soil salinity

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.55
Salt added by rainfall (kg/ha/year)	139.27
Average annual salt added & leached at steady state (kg/ha/year)	3868.47
Average leaching fraction based on 10 -year running averages (fraction)	0.48
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.53
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	2.23
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

All values based on 10 -year running averages.

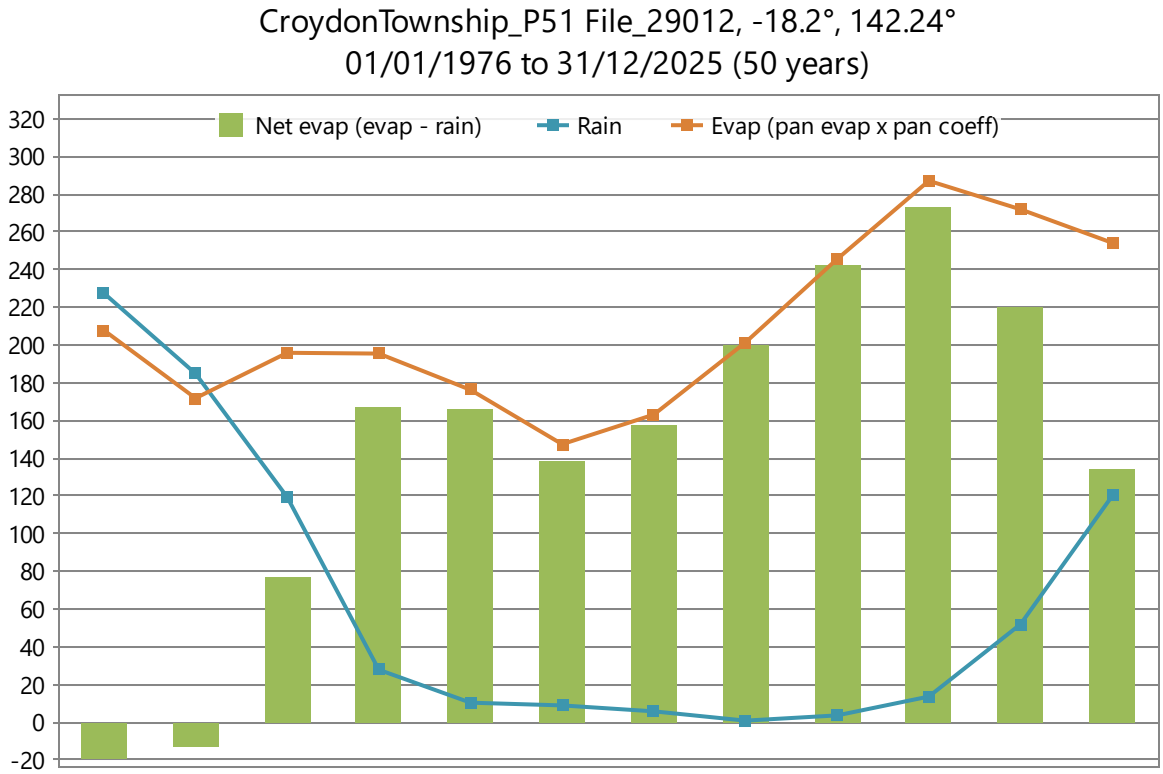


Diagnostics

Scenario information

Enterprise: Esmerelda Project

Climate long-term monthly averages (mm)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Evap	207.8	171.8	195.9	195.4	176.2	147.4	163.1	201.4	245.6	287.1	271.9	254.2	2517.8
Net evap	-19.7	-13.0	76.5	167.6	165.9	138.5	157.3	200.5	241.9	273.4	220.0	134.2	1743.1
Net evap/day	-0.6	-0.5	2.5	5.6	5.4	4.6	5.1	6.5	8.1	8.8	7.3	4.3	4.8

Diagnostics

Pond system information

Pond System Configuration: 1 closed (sludge-free) storage tank

Effluent Type: - 15703.61 m3/year or 42.99 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.26 non-zero flow days/year.

Constituent	Concentration (mg/L)	Load (kg/year)
Total nitrogen	27.85 (5.82 - 30.00)	437.34 (433.88 - 439.13)
Total phosphorus	9.28 (1.94 - 10.00)	145.78 (144.63 - 146.38)
Total dissolved salts	950.61 (198.76 - 1024.00)	14927.95 (14809.78 - 14989.11)
Volatile solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

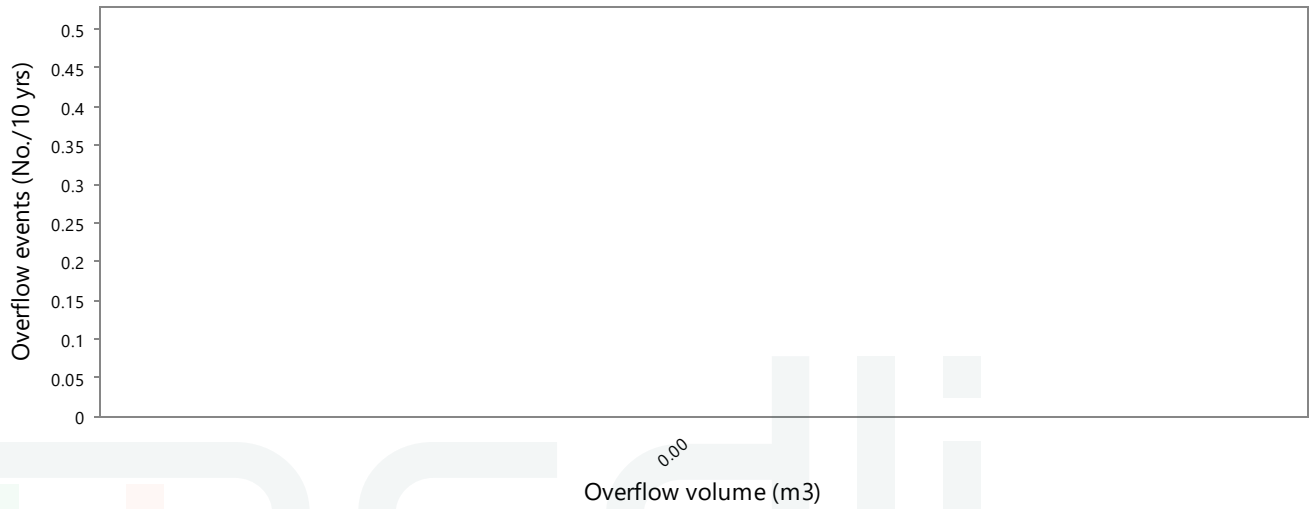
Ammonia-N loss from pond system water surface area: 0.00 kg/m2/year

Last pond (wet weather store): 2400.00 m3

Metric	Value
Theoretical hydraulic retention time (days)	55.82
Volume of overflow (m3/year) Average (minimum-maximum)	0.00 (0.00 - 0.00)
Volume of overflow per day (m3/day) Average (minimum-maximum)	0.00 (0.00 - 0.00)
No overflow days - Average per year (Total in run period)	0.00 (0)
No. overflow events per 10 years exceeding threshold of 0.480 m3* (events/10 years)	0.00
Average overflow event recurrence interval (years)	0.00
Average duration of overflow (days)	0.00
Probability of at least 90% effluent reuse (%)	100.00
Effluent reuse (propn. of inflow + net rain gain that is irrigated/removed with sludge) (fraction)	1.00
Average salinity (dS/m)	1.09
Salinity on final day of simulation (dS/m)	1.07

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

Volume distribution of the overflow events



Diagnostics

Scenario information

Area irrigated: 4 ha total area

Loading to whole irrigation area: (assuming 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	15687.42	3921.85
Total nitrogen applied (kg)	437.02	109.25
Total phosphorus applied (kg)	145.67	36.42
Total salts applied (kg)	14916.81	3729.20

Shandying

Metric	Value
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)
Minimum shandy water is used	No

Irrigation issues

Metric	Value
Number of days without irrigation (days/year)	54.70

Diagnostics

Paddock information

Paddock: - New paddock, 4 ha

Irrigation: New irrigation method with 0% ammonium loss during irrigation

Irrigation Rules
Irrigation triggered every 1 days and when rainfall is less than or equal to 0.00 mm
Irrigate a fixed amount of 3.50 mm
Irrigation window from 1/1 to 30/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil water balance (mm): Brown Tenosol - Site Specific, 69.80 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	227.5	184.9	119.4	27.8	10.4	8.9	5.8	0.9	3.6	13.6	52.0	120.0	774.7
Efflt. irrg.	36.0	34.4	40.3	32.2	31.5	30.2	31.3	31.0	30.1	31.4	31.3	32.5	392.2
Soil evap	1.6	1.1	1.3	0.7	0.6	0.6	0.6	0.6	0.6	0.6	1.2	1.4	11.1
Transpn.	114.9	104.2	112.0	75.2	49.8	38.0	39.9	35.9	32.9	44.4	62.9	100.0	810.0
Rain runoff	25.4	11.2	8.1	4.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	49.4
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	61.6	86.2	88.3	33.6	7.1	2.0	0.3	0.0	0.0	0.0	0.6	15.4	295.1
Delta SW	59.9	16.5	-50.0	-53.6	-15.7	-1.5	-3.6	-4.6	0.2	0.0	18.5	35.3	1.3

Soil nitrogen balance: (Concentrations are flow-weighted)

Metric	Value
Average annual nitrogen added in seed (kg/ha/year)	0.02
Average annual nitrogen added from irrigation (kg/ha/year)	109.25
Av. annual soil N removed by uptake (harvest + lost) (kg/ha/year)	114.35 (114.29, 0.06)
Av. annual soil nitrogen removed by denitrification (kg/ha/year)	2.20E-03
Average annual soil nitrogen leached (kg/ha/year)	0.13
Soil organic-N kg/ha (Initial - Final)	278.25 - 28.93
Soil inorganic-N kg/ha (Initial - Final)	10.94 - 0.01
Average nitrate-N concentration of deep drainage (Max annual concentration)	
Across all years (mg/L)	0.04 (1.28)
Excluding first year of data (mg/L)	0.01 (0.01)

Soil phosphorus balance: (Concentrations are flow-weighted)

Metric	Value
Average annual phosphorus added in seed (kg/ha/year)	3.60E-03
Average annual phosphorus added from irrigation (kg/ha/year)	36.42
Av. annual soil P removed by uptake (harvest + lost) (kg/ha/yr)	25.72 (25.72, 1.57E-04)
Average annual soil phosphorus leached (kg/ha/year)	2.55E-03
Dissolved phosphorus (kg/ha) (Initial - Final)	3.87E-04 - 0.21
Adsorbed phosphorus (kg/ha) (Initial - Final)	54.71 - 589.27
Average phosphate-P concentration in rootzone (mg/L)	0.05
Average phosphate-P concentration of deep drainage (Max annual concentration)	
Across all years (mg/L)	8.65E-04 (1.59E-03)
Last year only (mg/L)	1.40E-03 (N.D.*)
Design soil profile storage life based on average infiltrated water phosphorus concn. of 3.26 mg/L (years)	499.24

* Not determined

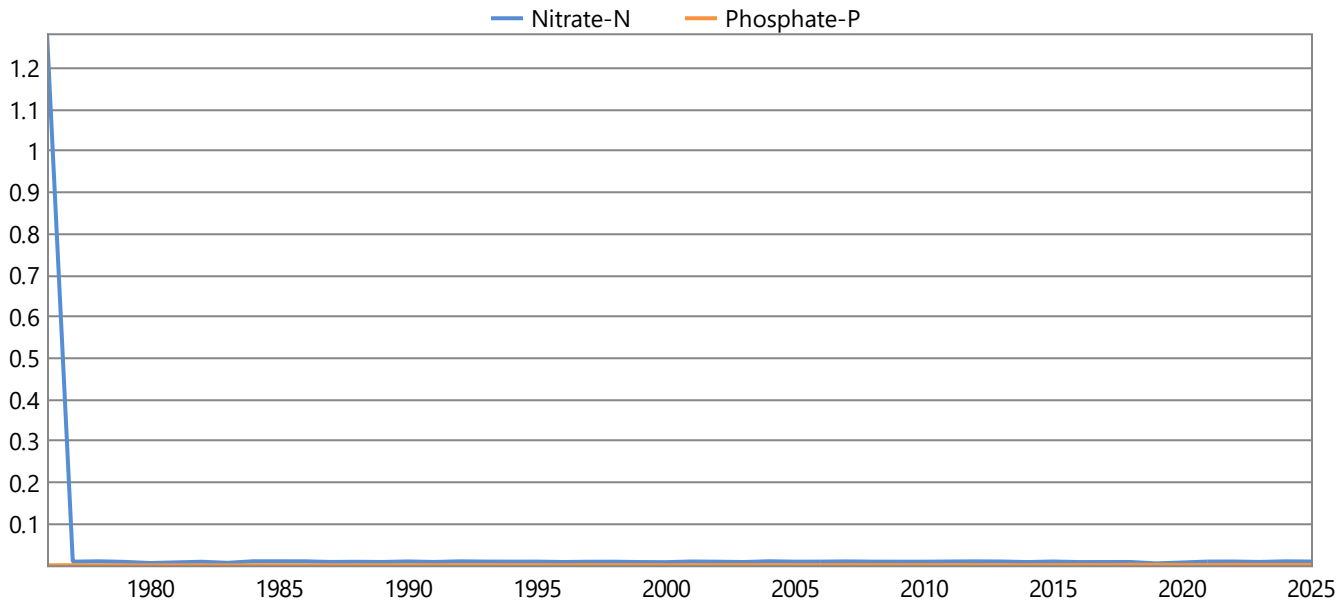
Diagnostics

Paddock information

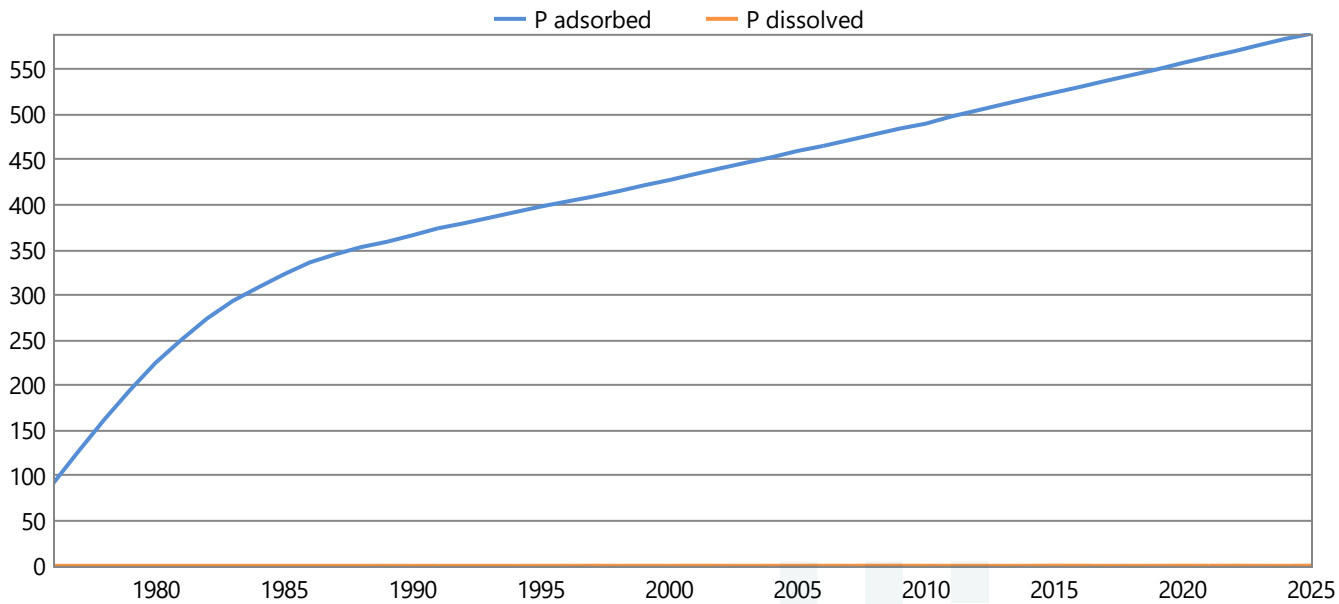
Paddock: New paddock, 4 ha

Irrigation: New irrigation method with 0% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual phosphate-P in soil (kg/ha)



Diagnostics

Paddock information

Paddock: New paddock, 4 ha

Planting Regime: Continuous Rhodes grass pasture

Average plant performance (minimum - maximum)

Metric	Value
Average annual shoot dry matter harvestable yield (kg/ha/year)	10188.79 (7659.10 - 11943.79)
Average annual shoot dry matter lost (kg/ha/year)	6.00 (0.00 - 300.00)
Average monthly plant (green) cover (fraction)	0.71 (0.69 - 0.72)
Average monthly crop factor (fraction)	0.64 (0.62 - 0.65)
Dead cover (if Mthly Covers) or Tot. cover left after harvest (fraction)	1.00
Average monthly root depth (mm)	811.96 (803.60 - 820.00)
Average number of normal harvests per year (no./year)	1.76 (0.00 - 2.00)
Average number of normal harvests for last five years only (no./year)	1.80
Average number of forced harvests per year (no./year)	0.02 (0.00 - 1.00)
Average number of forced harvests for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.82 (0.77 - 0.84)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.05 (0.00 - 0.15)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.08 (0.00 - 0.21)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.44 (0.04 - 0.76)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop per year. Excludes bare fallow days (days)	2.96

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.

Metric	Value
Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.55
Salt added by rainfall (kg/ha/year)	139.27
Average annual salt added & leached at steady state (kg/ha/year)	3868.47
Average leaching fraction based on 10 -year running averages (fraction)	0.48
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.53
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	2.23
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 information

Messages generated when the scenario was run
WARNING: Plant phosphorus deficiency. No soil phosphorus has been available for plant uptake for 1.25% of days of simulation.
UNCONDITIONAL FINISH