pitt&sherry

Effluent Wastewater Management Plan

Teys Australia Beef Abattoir

Prepared for

Teys Australia Southern Pty Ltd

Client representative

Marnie Mannering

Date

4 September 2020

Rev 03

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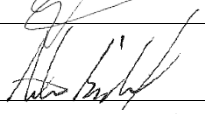
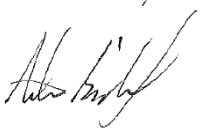
Prepared by — E Parry		**Date — 04/09/2020**
Reviewed by — A Bishop		**Date — 04/09/2020**
Authorised by — A Bishop		**Date — 04/09/2020**

Revision History

Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
00	EWMP after Mod 5	E Claus	E Claus	C Hollingworth	01/11/11
01	Updated Draft EWMP (Mod 11)	E Parry	A Bishop	A Bishop	12/08/20

02	Final Draft EWMP	E Parry	A Bishop	A Bishop	03/09/20
03	Final EWMP	E Parry	A Bishop	A Bishop	04/09/20

Acronyms, abbreviations and definitions

Acronym, abbreviation or definition	Meaning
AEP	Annual Exceedance Probability
CFA	Cargill Farm Area
CEMP	Construction Environmental Management Plan
CoC	Condition of Consent
Council	Wagga Wagga City Council
DPIE	Department of Planning, Industry and Environment
Effluent	Means for the purpose of this licence waste water from collection or treatment systems associated with processing industries involving livestock, agriculture, wood, paper or food, that is conveyed from the place of generation by means of pipe, canal or other conventional irrigation method
ESU	Effluent System Upgrade
EWMP	Effluent Wastewater Management Plan
EMS	Environmental Management Strategy
EPA	Environment Protection Authority
EPC	Engineering, Procurement and Construction
EPL	Environmental Protection Licence (no. 2262)
HSE	Health, Safety and Environment
MW	Megawatt
NHVR	National Heavy Vehicle Regulator
NSW	New South Wales
OEMP	Operational Environmental Management Plan
O&M	Operations and Maintenance
RMS	Roads and Maritime Services
Secretary	Secretary of the Department of Planning, Industry and Environment

1. Introduction

This Effluent Wastewater Management Plan (EWMP) was prepared for Teys Australia Beef Processing Facility at Bomen, near Wagga Wagga in NSW. The facility was established in the late 1940s to process cattle into finished beef products for domestic consumption and export. The site currently operates under a State Significant Development Consent (DA 220-07-2002-i), which permits the abattoir to process up to 1,600 head of cattle per day.

A part of the operations, wastewater effluent from the beef process is treated and used for irrigation among other things.

1.1 Purpose of this Plan

The EWMP sits under the Operation Environmental Management Plan for the entire site. This EWMP outlines a range of background information and presents management information describing how the operations of the effluent irrigation systems will be managed to ensure that the system is sustainable in the long term and protects human health and the environment. It has been prepared to meet the requirements of the Development Consent.

This revision of the EWMP draws significant information from the previous version prepared in 2011 by Claus Environmental Engineering and has been updated to reflect amendments to the site infrastructure, improvements in wastewater treatment and effluent quality, contemporary irrigation and cropping practices, and monitoring data.

1.2 Planning Approval

The Development Application (DA 220-07-2002-i) for Teys Australia (formerly known as Cargill) was granted consent by the Minister for Planning on 27 February 2003. The Development Consent was granted under Section 80 of the *Environmental Planning and Assessment Act 1979* and contained Conditions of Consent (CoC).

Since consent was granted, 11 applications to modify the Development Consent have been submitted to the Minister of Planning. Teys Australia have previously received consent through DA220-07-2002-i MOD 5 to provide effluent water for irrigation of a lucerne crop in designated approved irrigation areas – known as Cargill Farm Area (CFA) High and CFA Low. The most recent modification application (DA220-07-2002-I-Mod-11) sought approval to grow turf crop and operate turf farming activities in CFA High and CFA Low areas and was approved by the Department of Planning, Industry and Environment (DPIE) on 22 April 2020.

The abattoir also required an additional approval from the Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997* as livestock processing activities is a scheduled activity. The Site operates under the conditions of Environmental Protection Licence (EPL) No. 2262.

1.3 Relevant Conditions of Consent

This Plan has been prepared to meet the requirements of the modified condition 7.4 of the Development Consent which requires an updated Effluent Wastewater Management Plan. Table 1 below outlines where the Conditions of Consent (CoC) requirements have been met in this plan.

Table 1 CoC 7.4

CoC	Requirements	Location in plan
7.4	As part of the Operation Environmental Management Plan for the development, required under condition 7.3 of this consent, the Applicant shall prepare and implement the following Management Plans:	

CoC	Requirements	Location in plan
	a revised Effluent Wastewater Management Plan. The Plan must:	
	i) be undertaken in consultation with EPA and DPIE Water and approved by the Secretary, prior to undertaking any irrigation of effluent on the CFA Low area as described in the EA for DA 220-07-2002-I - MOD 5;	Previous EWMP
	ii) be consistent with EPA's Environmental Guidelines Use of Effluent by Irrigation;	This plan
	iii) identify the areas that have the potential to be impacted by the development's wastewater (such as through irrigation or from spills and/or leaks);	Sections 2 & 8
	iv) include detailed baseline data, and benchmark the existing soil, surface and groundwater conditions in these areas (identified in iii) above);	Section 5
	v) provide a water balance accounting for all wastewater streams and describing the quantity and quality of the effluent wastewater;	Section 6
	vi) identify the soil, surface water, groundwater and wastewater impact assessment criteria and Council's Trade Wastes Limits;	Section 9.1
7.4 c)	vii) include a detailed description of the proposed irrigation system, including the infrastructure, flow rates, crop cycling and soil moisture monitoring and management (ensuring the field capacity of the soil is not exceeded and to minimise risk of deep drainage of nutrients);	Section 4, 9 & 10
	viii) describe the monitoring strategy to be implemented for the effluent to be irrigated, the effluent to be discharged to sewer, soil, surface water and groundwater, including details of the: • Monitoring locations; • Sampling frequency; • Sampling methods;	Section 10
	ix) include justification for the proposed monitoring strategy and demonstrating that this monitoring would provide sufficient information to determine the annual nutrient and salt balance and ensure compliance with the trigger levels for nitrogen and phosphorus;	Section 10.6
	x) describe how the monitoring results will be assessed and reported;	Section 10.8
	xi) outline the contingency measures that would be implemented in high rainfall events and/or should monitoring identify any exceedance of the impact assessment criteria.	Section 10.7
7.4 (c)	Within three months of the date of approval of DA220-07-2002-I-Mod-11, the Applicant must update the development's Effluent Wastewater Management Plan (EWMP) to the satisfaction of the Secretary. The updated EWMP must:	
	a) be prepared in accordance with the requirements of Condition 7.4 of this consent;	This plan
	b) be prepared in consultation with the EPA and DPIE Water; and	Section 11

CoC	Requirements	Location in plan
	c) include a detailed description of the development's effluent irrigation system, including:	Section 3 & 4
	i. irrigation infrastructure and flow rates;	Section 3.6 & 4.3
	ii. crops to be irrigated to (including crop cycling procedures); and	Section 4.1
	iii. soil moisture monitoring and management (ensuring the field capacity of the soil is not exceeded and to minimise risk of deep drainage of nutrients).	Section 9 & 10
7.4(d)	The Applicant must implement the most recent version of the EWMP approved by the Secretary for the duration of the development.	

Other CoCs which apply specifically to the management of effluent on the site are identified in Table 2 below and incorporated in to the EWMP.

Table 2 Applicable effluent CoCs

CoC	Requirements
1.5(b)	The Applicant must ensure that no more than: a) 40 ML of effluent wastewater is irrigated a year on the CFA High area; and b) 300 ML of effluent wastewater is irrigated a year on the CFA Low area, unless otherwise agreed to in writing by the EPA and the Secretary.
1.5(c)	Irrigation must not commence on the CFA Low area until: a) the ESU is operational and producing high quality effluent (as described in DA 220-07-2002-i MOD 5); and b) the Applicant has notified the Secretary in writing of its intention to begin irrigating on this land. *Note: For the purposes of this condition, high quality effluent refers to effluent wastewater which meets the low to medium strength nutrient values described in 'Environmental Guidelines: Use of effluent by irrigation' (DEC, 2004).*
1.5(d)	The Applicant must refrain from irrigating on the land referred to in condition 1.5(c) above during likely flooding events. *Note: the determination of a likely flooding event' must be based on weather forecasting.*
1.5(e)	The Applicant must limit and/or cease irrigation on the land. referred to in conditions 1.5(b) to 1.5(c) above at the Secretary's or the EPA's request, to the satisfaction of the Secretary.
5.8	The abattoir and activities carried out therein must not pollute surface or groundwater except as permitted by the EPA.
5.13	The parameters of wastewater applied to land shall not exceed the volume or concentration limits for the point as specified in Table 1.

<table>
<tr><th>CoC</th><th>Requirements</th></tr>
<tr><td></td><td>Table 1 – Parameters for Wastewater Irrigation<table><tr><td>Parameter</td><td>Units of Measure</td><td>Limit</td></tr><tr><td>Quantity</td><td>kL/year</td><td></td></tr><tr><td>BOD</td><td>mg/L</td><td>200</td></tr></table></td></tr>
<tr><td>5.14</td><td>Wastewater shall only be applied to the areas as described in the Development Application 220-07-2002-i and the EIS prepared by HLA-Envirosciences Pty Ltd and dated July 2002 as modified by DA 220-07-2002-i MOD 5 and DA220-07-2002-I-Mod-11.</td></tr>
<tr><td>5.15</td><td>Spray from irrigation practices on site shall not drift beyond the boundary of the premises to which it is applied.</td></tr>
<tr><td>5.16</td><td>Wastewater utilisation areas shall effectively utilise the waste water applied to those areas. This includes the use for pasture or crop production, as well as ensuring the soil is able to absorb the nutrients, salts, hydraulic load and organic materials in the solids or liquids. Monitoring of land and receiving waters to determine the impact of waste water application may be required by the EPA.</td></tr>
<tr><td>5.17</td><td>The Applicant shall ensure that irrigation practices at the site do not conflict with the continuing use of the Riverina Water service reservoir.</td></tr>
<tr><td>5.18</td><td>Prior to the commencement of operation, the Applicant shall, in consultation with the Department of Land and Water Conservation, install at the site:
i) two piezometers in the vicinity of the effluent treatment ponds; and
ii) two piezometers in the vicinity of the effluent irrigation area (as indicated ‘CFA High’)
The location of these piezometers shall be designed to detect any leakage or accessions to the watertable, and shall be monitored in accordance with the Effluent Wastewater Management Plan (condition 7.4).</td></tr>
<tr><td>6.4</td><td>The Applicant must ensure the development complies with any effluent irrigation and pollutant monitoring requirements specified in the EPL applicable to the site.</td></tr>
</table>

1.4 Relevant EPL conditions

The EPL (no. 2262) for the site has multiple conditions which apply to effluent management which are presented in Table 3. All EPL conditions must be complied with. The EPL conditions related to monitoring are outlined in Section 10.

Table 3 Applicable EPL conditions

Condition	Requirement
L5.1	No condition of this licence identifies a potentially offensive odour for the purposes of Section 129 of the *Protection of the Environment Operations Act 1997*.
L5.2	The licensee must not cause or permit the emission of offensive odour beyond the boundary of the premises.

Condition	Requirement
O4.1	Effluent application must not occur in a manner that causes surface runoff.
O4.2	Spray from effluent application must not drift beyond the boundary of the premises.
O4.3	Livestock access to any effluent application area must be denied during irrigation and until the applied effluent has dried.
O4.4	The licensee must retain the utilisation area.
O4.5	At least 14 days prior to a utilisation area being rendered unavailable for use, the EPA must be advised in writing of this intention.
O4.6	The quantity of effluent/solids applied to the utilisation area must not exceed the capacity of the area to effectively utilise the effluent/solids. For the purpose of this condition, 'effectively utilise' includes the use of the effluent/solids for pasture or crop production, as well as the ability of the soil to absorb the nutrient, salt, hydraulic load and organic material.
E1.1	Supply of effluent for the purposes of turf irrigation at Lot 100 DP 1095889, 59 Hillary Street, North Wagga Wagga must be undertaken in accordance with the requirements specified in the approved Environmental Management Plan required by condition 5C of DA11/0327

2. Site Description

On-site wastewater irrigation from the abattoir occurs in two separate areas located to the south west of the abattoir. These areas are referred to as CFA High and CFA Low. Figure 1 shows an aerial photo of the Teys site including the CFA High and CFA Low irrigation areas, and the abattoir.

The majority of abattoir-related buildings and hardstand areas are located in the north-eastern part of the site. The wastewater treatment ponds are located to the south-west of the main abattoir complex near the centre of the site.

2.1 CFA High

The CFA High irrigation area consists of 7.3 ha of land located immediately southwest of the abattoir and adjacent the wastewater treatment ponds. The CFA High area has been in operation for about the last 20 years, though its size was reduced marginally in about 2012 to allow for construction of a new transfer pond and the new anaerobic treatment ponds and the biological nutrient removal system. Figure 2 shows an aerial photo of the irrigation area and the locations of the ponds.

The nearest residential receivers to the CFA High area, are located approximately 500 m to the south. There is a vegetation buffer along the eastern boundary of the area and the railway corridor is located approximately 40 metres to the south east.

2.2 CFA Low

The CFA Low irrigation area consists of 35.1 ha of land located about 800 m southwest of CFA High. This land has been a part of the Beef Processing Facility site since Cargill Australia (currently Teys Australia) purchased the property in 1991. The land has been used for grazing since that time and most likely before that as well. Some irrigation was carried out in the period 1998 to 2000 following the granting of Council Development Consent No 215 / 97 on 13 February 1998. The DA lapsed on 13 February 2000. Figure 3 shows an aerial photo of the CFA Low irrigation area.

There is a vegetation buffer along the western and southern edge of CFA Low. The railway corridor borders the eastern boundary of CFA High. The nearest residential receivers to the CFA Low (three residences) are located approximately 60 m to the east of the irrigation area, across the Main Southern railway line. CFA Low is located approximately 1 km north of the Parkan Pregan Lagoon and approximately 350 metres north east of the Bomen Lagoon. The Murrumbidgee River is located approximately 1.6 km southwest of the CFA Low site.

2.3 59 Hillary St

Treated effluent may be supplied to Lot 100 DP 1095889, 59 Hillary Street, North Wagga Wagga (referred to as O'Rourke's) for the purposes of irrigation. RivTurf (turf farm operators) currently have consent through Council to irrigate this area and are in the process of installing the irrigation line. No irrigation has been carried out on this land to date. Irrigation would be undertaken in accordance with the requirements specified in the approved Environmental Management Plan required by condition 5C of DA11/032.

This land is not managed under this EWMP.

Figure 1 Map of Teys Australia Facilities

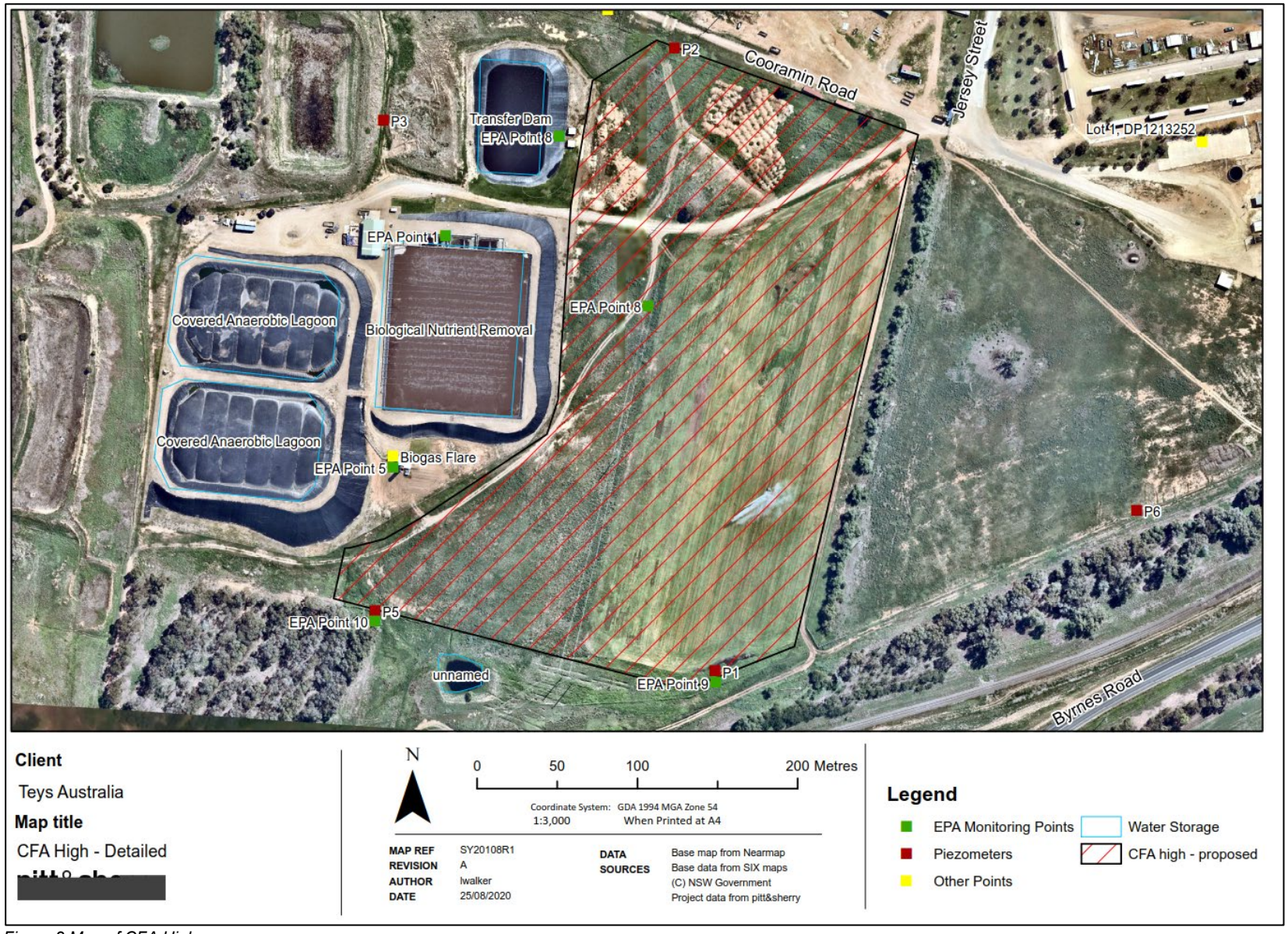


Figure 2 Map of CFA High

Figure 3 Map of CFA Low

3. Overview of wastewater treatment process

The wastewater streams from the beef processing facility are treated using primary treatment processes to reduce concentrations of organic material, oil and greases, paunch material and gross and suspended solids prior to subsequent biological treatment.

The Effluent System Upgrade (ESU) established in 2012 improved the performance of the waste water treatment system and captures any gaseous emissions from the anaerobic ponds. The ESU includes:

- A covered anaerobic system (consisting of 2 HDPE-covered and lined anaerobic ponds operating in parallel).
- A biogas collection system equipped with an enclosed gas flare to burn off biogas captured from the covered anaerobic system.
- a Biological Nutrient Removal (BNR) extended aeration system.
- A dewatering system comprising of a belt filter press to process the waste activated sludge from the BNR system.
- Transfer Dam (aerobic) as an equalization pond, in order to equalize and distribute flows to achieve a uniform and constant discharge to the irrigation system and the Council sewer.

3.1 Anaerobic Pond

After the primary treatment process the effluent is transferred to the anaerobic ponds. Two covered anaerobic ponds with a combined working capacity of 28ML operate in parallel. The anaerobic system substantially reduced odour emissions associated with the anaerobic treatment process.

The methane-rich biogas is captured within the synthetic HDPE covers and flared-off on site using an enclosed flaring system. Reduced sulphide compounds and other odorous gases are destroyed by the flaring process. The flare includes a gas monitoring device and is set up and operated to meet Group 6 emission limits under the Protection of the Environment (Clean Air) Regulation 2002. Biogas is also combusted through an onsite mixed gas boiler.

Superior biological treatment of the effluent prior to its discharge to the downstream BNR process facilitates consistent operation of the BNR system and improved final discharge quality.

3.2 Biological Nutrient Removal (BNR) System

The final treatment within the ESU is a Biological Nutrient Removal (BNR) system with a capacity of 32 ML which utilises a BIOLAC activated sludge process. This is specified to ensure compliance with the nutrient acceptance limits outlined in the Council Liquid Trade Waste Policy. The activated system was installed in a refurbished and synthetically lined pond, with a 1.5 mm HDPE liner. This system is an advanced aeration technique which enables nitrification and denitrification processes by providing anoxic and aerobic zones to provide conditions suitable for biological nutrient removal processes. The system achieves vastly improved performance compared to previous practices and provides a final discharge of more consistent quality in accordance with the Trade Waste Acceptance Limits. The quantity of biological sludge generated in the process is reduced by the long sludge age of the process. Excess biological sludge removed from the BNR is sent to a dewatering plant which produces final sludge at approximately 10 -15% dry solids. Biosolids are composted offsite currently along with paunch material.

3.3 Transfer dam

The transfer dam is 5ML in size and acts as an equalization pond, in order to equalize and distribute flows to achieve a

uniform and constant discharge to the irrigation areas and the sewer.

3.4 Effluent quality

Effluent quality from the treatment system is monitored on a weekly basis to assess performance. A summary of effluent quality over the period June 2019 to June 2020 (inclusive) is shown in Table 4. Graphs of total nitrogen, ammonia and total phosphorus concentrations are provided in Figure 4 and Figure 5.

Table 4 Treated effluent results from June 2019 to June 2020

Treated Effluent	Average	50 percentile	80 percentile	90 percentile	Max	Min
pH	7.5	7.5	7.6	7.6	7.8	7.2
Conductivity (µS/cm)	1169.7	1180.0	1230.0	1320.0	1730.0	375.0
Total Dissolved Solids (TDS) (mg/L)	742.3	725.0	754.0	823.5	952.0	631.0
Total Suspended Solids (mg/L)	45.3	25.0	32.0	76.4	317.0	4.0
Biochemical Oxygen Demand (BOD) (mg/L)	13.4	8.5	12.0	17.0	77.0	4.0
Chemical Oxygen Demand (COD) (mg/L)	109.4	66.0	120.2	292.8	579.0	20.0
Phosphorus, Total (mg/L)	28.3	25.9	37.4	46.0	60.3	6.5
TN (mg/L) calculated	23.8	12.3	28.6	62.6	115.1	4.0
Ammonia as N (mg/L)	13.0	4.9	9.8	44.6	81.0	0.9
Total Kjeldahl Nitrogen (mg/L)	20.6	11.0	19.2	62.4	115.0	4.0
Nitrate (mg/L)	3.3	0.7	3.8	7.6	24.1	
Sulphate (mg/L)	24.9	25.4	30.9	32.2	37.3	7.7
Sulphide - Total (mg/L)						0.1
MBAS	0.1	0.1	0.2	0.2	0.3	0.1
Oil and Grease (mg/L)	8.6	6.0	11.4	13.6	22.0	4.0

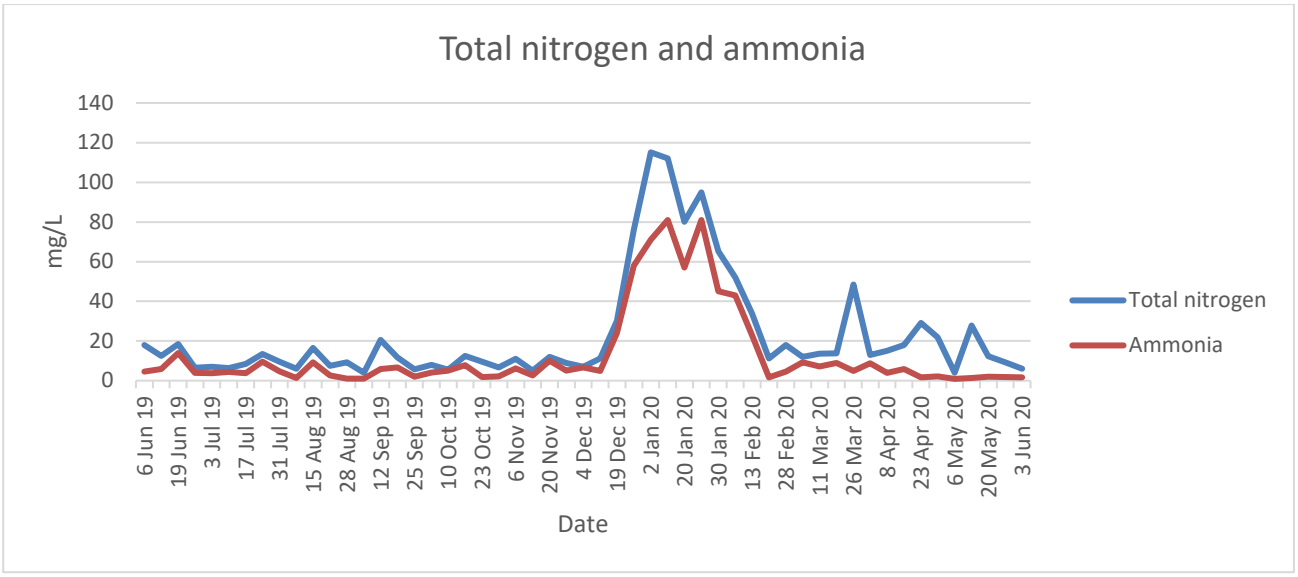


Figure 4 Total nitrogen and ammonia levels in the treated effluent between June 2019 to June 2020

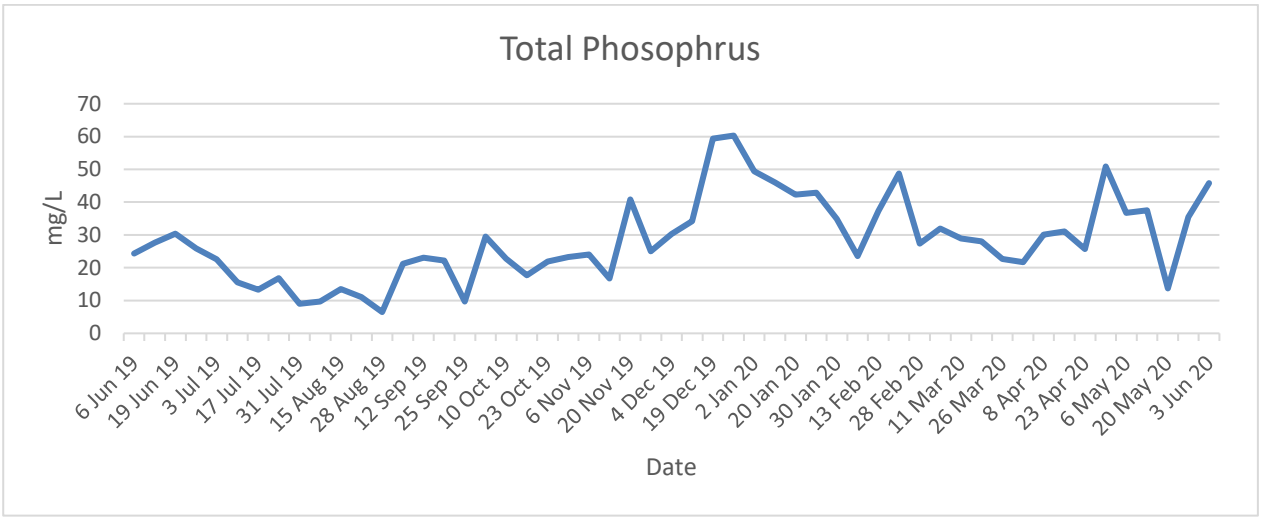


Figure 5 Phosphorus levels in the treated effluent between June 2019 to June 2020

3.5 Effluent strength

With reference to Table 3.1 in the EPA's *Environmental Guidelines Use of Effluent by Irrigation,* the effluent can be classified according to its strength for several key constituents, as follows:

- Total Nitrogen – Low Strength
- Total phosphorus – High Strength
- BOD_5 – Low Strength
- TDS – Medium Strength

3.6 Effluent quantity

Of the total wastewater stream produced by the abattoir only a small proportion is managed by irrigation within the CFA High and CFA Low sites. Much of the wastewater is reused in the stockyards or is disposed to the sewer as trade waste. A review was undertaken of wastewater usage and disposal data for the period June 2019 through to June 2020. Table 5 presents the wastewater volumes disposed annually by each method.

Table 5 Wastewater disposal and reuse volumes by destination, June 2019 to June 2020

	Limit imposed by development conditions	**Annual quantity (ML)**	**Average Daily quantity (ML)**	**Maximum daily quantity (ML)**
Stockyards Reuse	-	400	1.0	2.7
Sewer disposal (trade waste)	2.2 ML/day	660	1.7	2.3
Irrigation – CFA High	40 ML/year	25	0.2 *	1.2
Irrigation – CFA Low	300 ML/year	88	0.9 *	2.8

** Average based on irrigation days only (excluding winter months)*

The data confirms that a significant majority of the annual wastewater load is disposed to sewer or reused in the cattle yards. Only a small percentage of the annual wastewater load is reused as irrigation.

4. Irrigation System

4.1 Crop

Teys Australia have previously received consent through DPIE under DA220-07-2002-i MOD 5 to utilise treated effluent water for irrigation of lucerne crop in designated approved irrigation areas CFA High and CFA Low.

With the nature of the region and different business opportunities, Teys Wagga have altered the operations onsite to facilitate operation of a turf farming business. The operation of the turf farming on CFA High and CFA Low using irrigation of treated effluent is undertaken under a share farming agreement with RivTurf . Currently, these operations produce certified Buffalo, Kikuyu and RivTurf varieties. Teys also has approval to farm Lucerne on CFA High and CFA Low.

RivTurf has advised that they would on average produce 1.5 – 2 crop cycles (turf cuts) per year. The turf root system is primarily limited to the upper 50mm of soil. When turf is cut care is taken to only remove the minimum amount of soil possible. S root mat is retained within the soil to produce the next crop. The retained root system helps stabilise the soil and resist erosion until the vegetation cover is restored.

Due to the shallow root system irrigation is carefully controlled to prevent waterlogging and deep drainage. Management activities such as moisture control and aeration of the soil are limited to the shallow topsoil zone that the turf utilises. Irrigation decisions are made to assist wetting and drying of the soil. This cycling encourages strong root development.

4.2 Irrigation infrastructure

The irrigation system for CFA High is essentially the same as has operated at Cargill Beef (now Teys) for over 20 years. The effluent is pumped from the effluent of the ESU via a small pump house. A series of underground pipes have been laid across the irrigation areas generally down slope from the Transfer Dam. The underground pipes are fitted with standpipes in the middle of the irrigation area and travelling irrigators can be attached to the standpipes. The irrigators are moved at regular intervals depending on weather, temperature and the stage of the crop.

Travelling irrigators are used, such as Southern Cross or Trailco irrigators, with a 3 inch hoses and a "big gun" which put out approximately 65L per second, at a radius of 35m. The irrigation regime is typically to apply 3-4mm irrigation depth per run with at least two days between runs.

Two part circle pivot irrigators are proposed to be installed to apply water to the CFA Low area. The pivot irrigation system would apply up to 8mm of water to the area within 12 hours. Both pivots operating simultaneously would have a flow rate of approximately 50 L/s.

Two unnamed dams are located to the south of CFA High which collect runoff from that irrigation area (see Figure 2). A berm and trench system has been constructed around the CFA Low irrigation area to divert clean runoff away from the area and contain runoff from within the irrigation area itself. Diversion berms have been in place for many years that reduce the clean water catchment flowing to the trench to about 36 hectares. The trench and berms are shown in Figure 6.

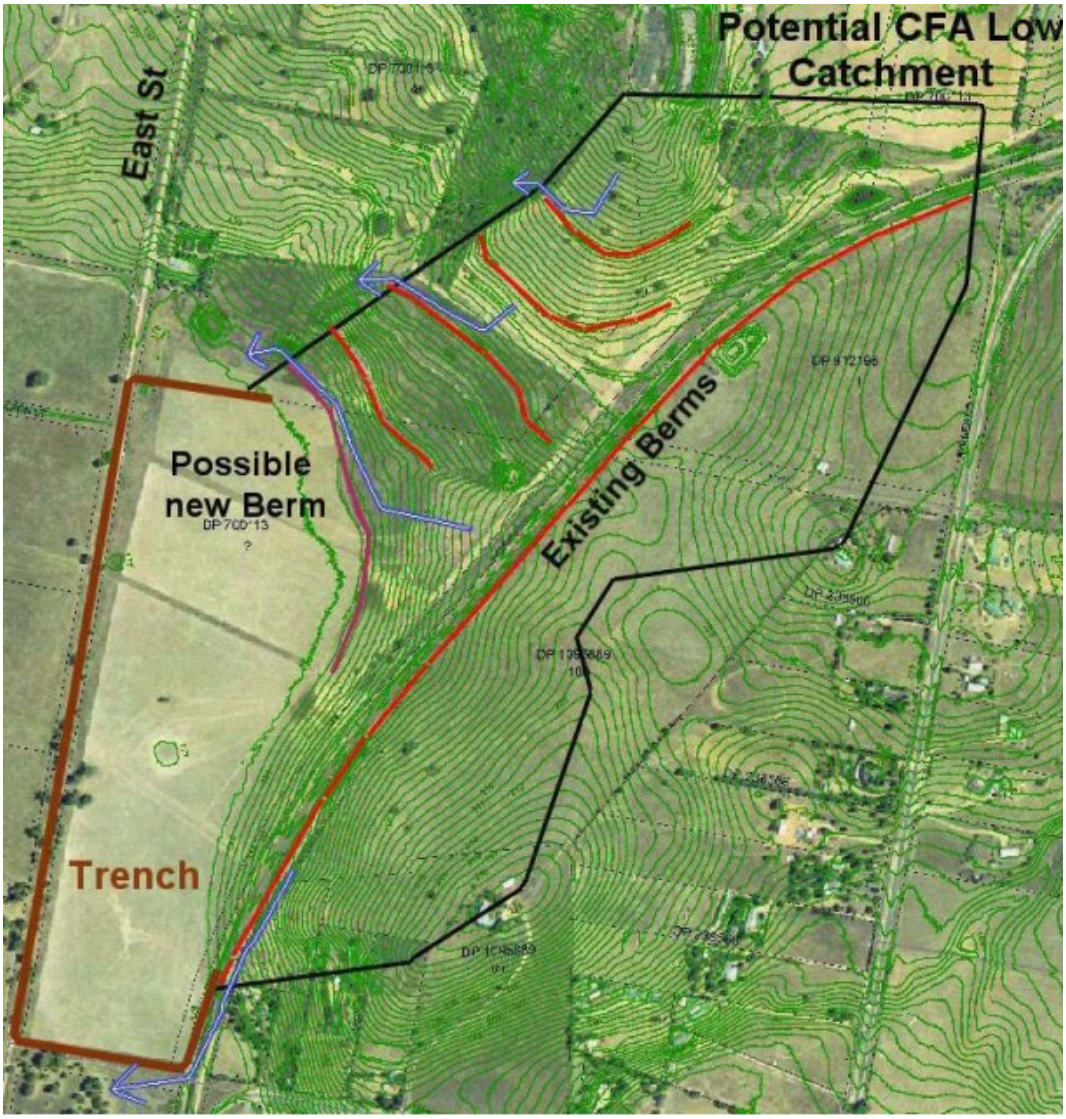


Figure 6 Location of runoff trench and berms around CFA Low

4.3 Irrigation volumes

In accordance with the Development Consent, Teys has approval to apply no more than the following volumes of effluent waste water per year:

- 40 ML on the CFA High area
- 300 ML on the CFA Low area.

Irrigation is scheduled according to weather patterns, the ability of the soil to absorb the irrigation water, and crop demand. Irrigation is planned in such a way as to promote the efficient growth, harvesting and maintenance of the crop to meet operational requirements. Between April 2019 and April 2020, approximately 25 ML of effluent wastewater was applied to CFA high and 88 ML was applied to CFA Low. Historically, no effluent irrigation has been undertaken during the winter months, between about May and August. There is a desire to undertake more year-round irrigation with the change to turf farming, subject to meeting performance and management criteria.

Irrigation is applied only as and when required. Teys undertake regular soil moisture testing and irrigation is only applied where the soil moisture content as measured by the soil moisture probes, is between 5% and 25%. Manual testing of soil

moisture content is undertaken prior to irrigation, as is the manual assessment of wind speed, including direction, so as to avoid contamination outside the Teys boundary. A portable moisture probe is used to assess the soil moisture so that irrigation volumes can be sustainably optimised.

A description of the water balance, nutrients loading and salinity loading is provided in section 6.

5. Baseline Data

Monitoring of soil conditions, surface water and groundwater quality in CFA High and CFA Low has been undertaken over many years. This section of the EWMP details baseline data collected during 2019.

As soil and water monitoring has been undertaken for many years, the baseline data collected prior to use of effluent water to grow lucerne on the land in 2011 and establishment of the ESU in 2012, is provided in Appendix B and C. This data is provided to give further context and a benchmark for the soil, surface and groundwater conditions in these areas, such that any changes over time can be monitored and addressed.

5.1 Soil Data – CFA High

Soil monitoring data was collected on the 22nd and 26th of November 2019 by Aitken Rowe Testing Laboratories. The sampling locations are shown in Figure 7. A summary of the results is included in Table 6.

Figure 7 Locations of six boreholes sampled in November 2019 by Aitken Rowe Testing Laboratories as per Aitken Rowe report dated 24 January 2020 (Reg E19-042).

Table 6 Average of Soil analysis from six boreholes in CFA High sampled on November 2019

Soil Constituent	0-0.5m depth	1m-1.5m depth
Exchangeable Calcium (mg/kg)	520	707
Conductivity (dS/m)	0.18	0.11
Exchangeable Sodium Percentage	26.5	67.00
Exchangeable Magnesium (mg/kg)	138	208.58
Nitrate as N (mg/kg)	4.00	2.00
Total Nitrogen (mg/kg)	493	222

Soil Constituent	0-0.5m depth	1m-1.5m depth
Phosphorus Sorption (mg/kg)	73.5	332.5
Phosphorus Buffer Index (L/kg)	55.3	53.0
Extractable Phosphorus (Colwell) (mg/kg)	319.8	91.0
Total Phosphorus (mg/kg)	276	78.67
pH	7.47	7.70
Exchangeable Potassium (mg/kg)	293	193
Exchangeable Sodium (mg/kg)	355	482
Total Kjeldahl Nitrogen (mg/kg)	489	220
Total Organic Carbon (mg/kg)	5237	1873

A comparison of the key analytes for phosphorus in the 2014 to 2019 soil sampling data (see Figure 8) shows that both phosphorus sorption and total phosphorus averages in the soil has been decreasing gradually.

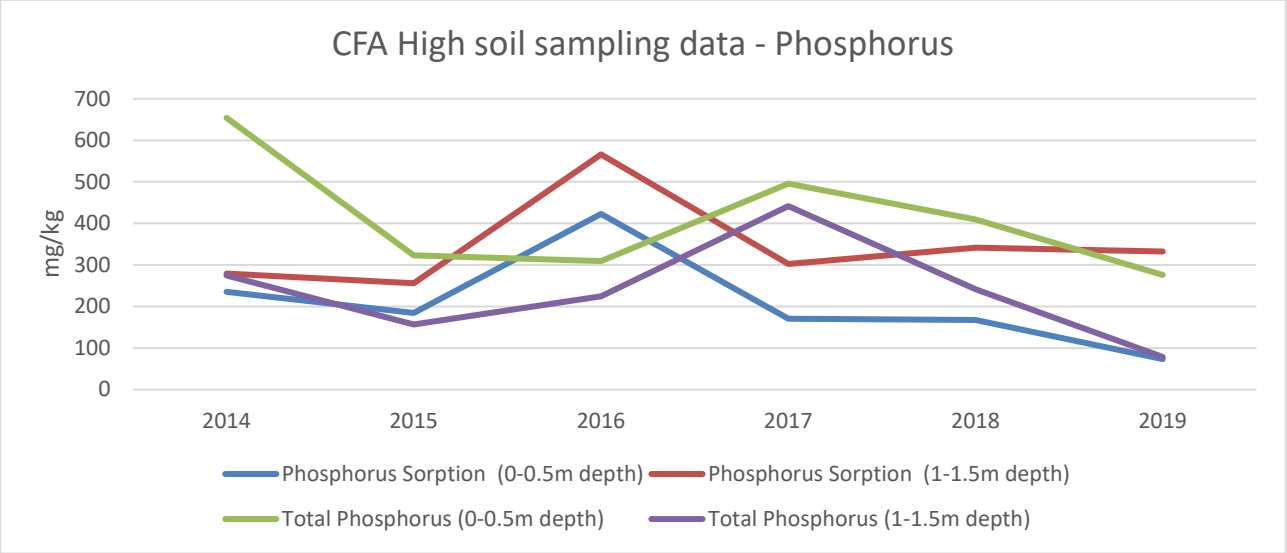


Figure 8 Average soil sampling data for phosphorus between 2014 and 2019

The electrical conductivity levels and nitrate levels for the average soil sampling data between 2013 and 2019 are shown in Figure 9. These parameters represent two key threats to groundwater quality. Both analytes experienced an increase up to 2017, however since then have been decreasing. It is noted that these data present the average across all monitoring locations and do not describe changes that may have occurred at individual locations.

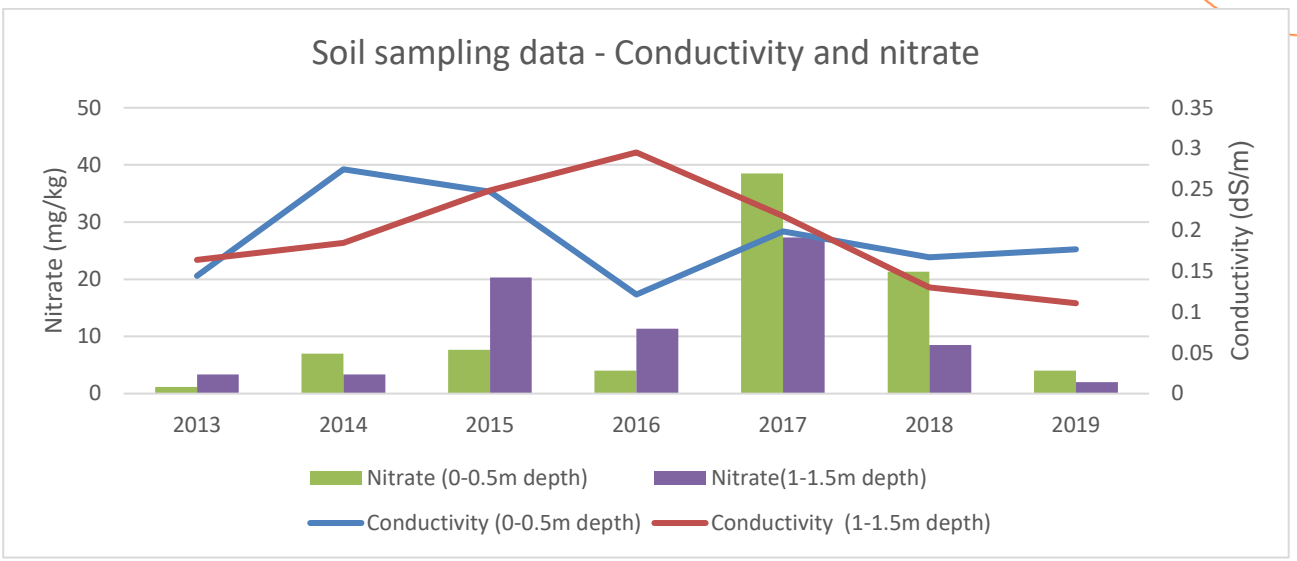


Figure 9 Average soil sampling data for conductivity and nitrate between 2013 and 2019

5.2 Soil Data – CFA Low

Soil sampling on the CFA Low site was conducted on the 22nd and 26th of November 2019 by Aitken Rowe Testing Laboratories. A summary of some of the key analytes are shown in Table 7. The sampling locations are shown in Figure 10.

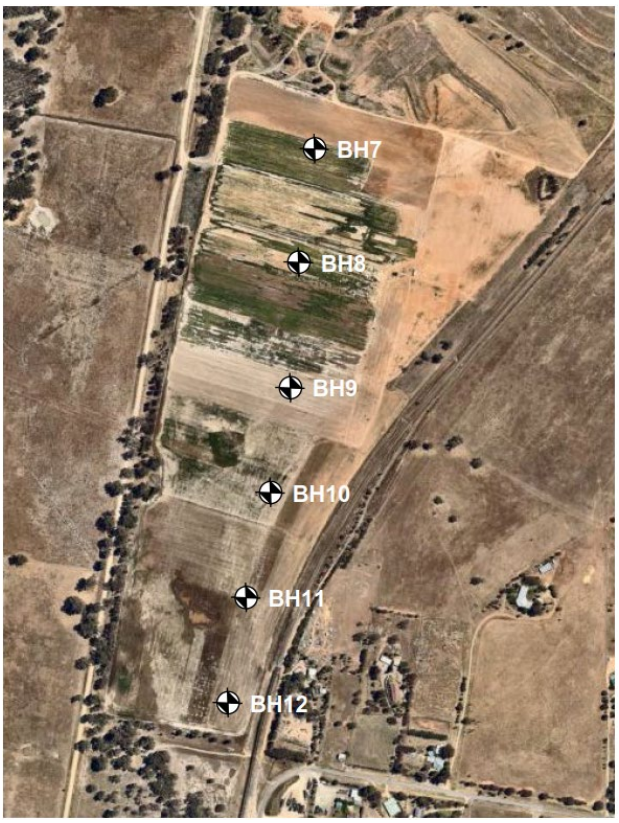


Figure 10 Locations of six boreholes sampled in November 2019 by Aitken Rowe Testing Laboratories as per Aitken Rowe report dated 24 January 2020 (Reg E19-042).

Table 7 Average of Soil analysis from six boreholes in CFA Low sampled on November 2019

Soil Constituent	0-0.5m depth	1m-1.5m depth
Exchangeable Calcium (mg/kg)	867	1473
Conductivity (dS/m) (1:5 soil/water)	0.20	0.51
Exchangeable Sodium Percentage	29.9	47.0
Exchangeable Magnesium (mg/kg)	566	1170
Nitrate as N (mg/kg)	27.17	5.33
Total Nitrogen (mg/kg)	986	347
Phosphorus Sorption (mg/kg)	207	273
Phosphorus Buffer Index (L/kg)	60.2	52.3
Extractable Phosphorus (Colwell) (mg/kg)	146	29
Total Phosphorus (mg/kg)	117.8	69.3
pH	7.72	9.03
Exchangeable Potassium (mg/kg)	280	214
Exchangeable Sodium (mg/kg)	1302	3722
Total Kjeldahl Nitrogen (mg/kg)	958	342
Total Organic Carbon (mg/kg)	10977	6150

Some observations on the results with reference to Hazelton and Murphy (2016) are:

- pH is near neutral in topsoils but more alkaline at depth.
- electrical conductivity is higher in the deeper soils than topsoils, which is common in many soils due to leaching. A soil texture multiplier can be used to convert EC (1:5) to ECe and is useful for comparing against conventional soil salinity ratings. Using a soil texture multiplier factor of 10, ECe values are typically <2 dS/m, which is non-saline.
- Cation exchange capacity tends to be low to very low;
- Exchangeable sodium percentage is typically very high which would indicate a tendency to be strongly sodic. This is likely due to the very low CEC levels, with sodium representing a high proportion of available cations.
- Total nitrogen levels tend to be high.
- Phosphorus buffer index tends to be Low to Very Low;
- Available phosphorus and total phosphorus tend to be Very High;

Care will need to be taken with these soils, particularly to avoid long term sodicity impacts and leaching of nutrients, particularly nitrogen and phosphorus.

A comparison of the key analytes for phosphorus in the average 2014 to 2019 soil sampling data (see Figure 11) shows that both phosphorus sorption and total phosphorus in the soil has been decreasing gradually.

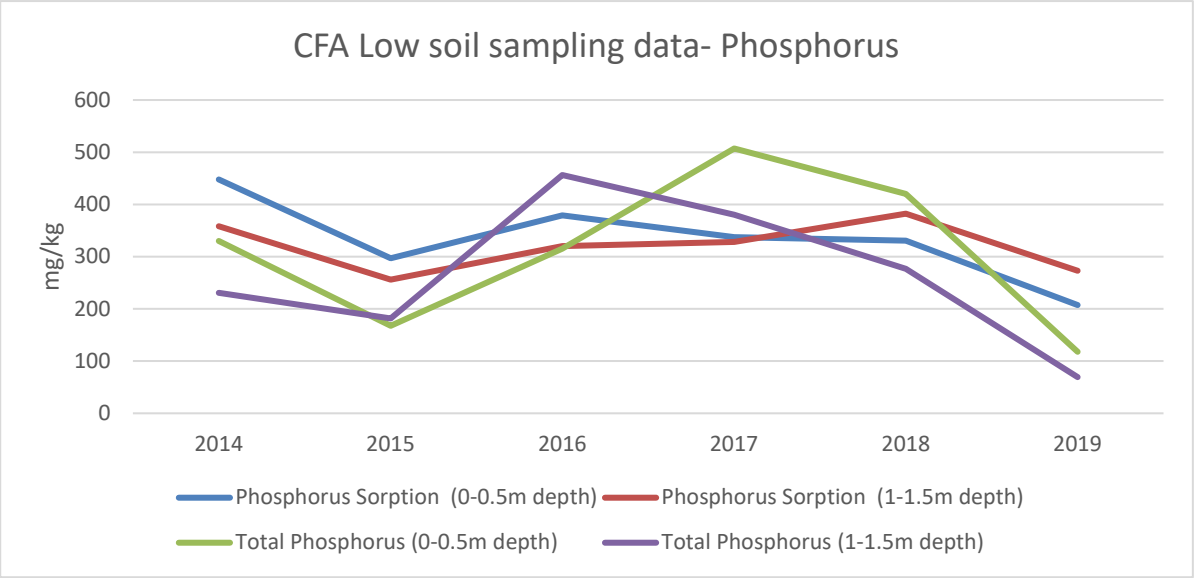


Figure 11 Average soil sampling data for phosphorus between 2014 and 2019

The conductivity levels and nitrate levels for the average soil sampling data between 2013 and 2019, which are the biggest threat to the groundwater quality are shown in Figure 9. Nitrate levels experienced an increase up to 2018 particularly up to a depth of 0.5m, however since then have been decreasing. Conductivity of the soil has been decreasing gradually and then more steeply after 2018.

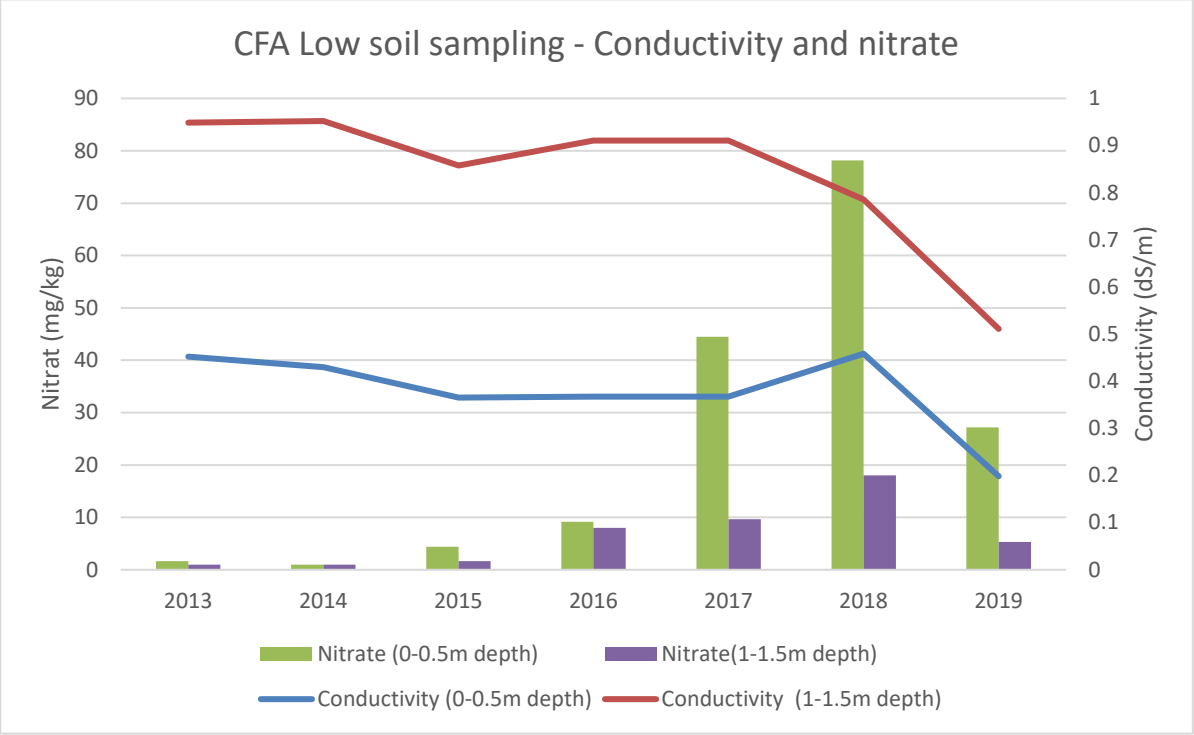


Figure 12 Average soil sampling data for conductivity and nitrate between 2013 and 2019

5.3 Surface Water Conditions – CFA High

There is no running surface water in or near the CFA High irrigation area or downstream of the irrigation area. The only times that surface water runs off the open space around the irrigation area is when there is very heavy rainfall.

There is a gentle crest in the middle of the irrigation area so runoff from the northern half of the irrigation area flows to the north and runoff from the southern half flows south. Earth channels and dams have been constructed on the north and south sides to collect runoff water. These are managed to ensure that there is always sufficient capacity to ensure that runoff does not escape the site except in very large storm events. The dams have been designed to contain the 1 in 10 year storm event under very conservative runoff coefficient assumptions. Experience over the past 15 years has shown that the storms that would have been expected to fill up the dams have not, so it is likely that the design has overestimated the runoff coefficient and the dams can handle a much larger than 1 in 10 year storm.

Stormwater from the car park, earth cattle yards and eastern irrigation areas flows via a grassed channel to a series of two silt trap earth dams. These dams have been designed for a 1 in 10 year storm event (Council 1999). Overflow from the second basin is conveyed via a series of earth channels to grassed paddocks on the southern side of the processing facility where is it distributed. That is, stormwater is managed on-site for rainfall events of 1 in 10 year recurrence intervals or less. If the capacity of the sediment basins is exceeded during a storm event, overflow spills onto the Murrumbidgee floodplain.

5.4 Surface Water Conditions – CFA Low

There are no permanent or ephemeral water courses running through the CFA Low site or nearby. The Parkon Pregan Lagoon, part of the Murrumbidgee River System is about 1.6 kilometres to the southwest of the southwest corner of the CFA Low Land. The Parkon Pregan Lagoon is the nearest permanent surface water.

The site is very flat and permanently vegetated, so even in heavy rain there are rarely significant surface water flows off site.

The CFA Low site is within the flood plain of the Murrumbidgee River, so the issue of flooding the site must be considered carefully. Section 8.2 of this report addresses flooding impacts for the CFA Low irrigation area.

5.5 Groundwater Conditions – CFA High

Groundwater is monitored regularly around the CFA High irrigation area to ensure that the wastewater can continue to be applied sustainably and to provide the information needed to change the irrigation procedures, if required.

The locations of the piezometers are shown in Figure 13. Since the irrigation area has changed due to the requirement to build the transfer pond and the biological nutrient removal treatment plant, Piezometer P4 is no longer maintained. The consent condition (5.18) requirement to have 4 monitoring bores, 2 near the ponds and 2 around the irrigation area is still met, though, even without P4.

Figure 13 Approximate locations (shown in Red) of piezometers within and around the CFA High irrigation area.

A summary of the 2019 CFA High Groundwater Results is provided in Table 8. Samples were collected on 22 November 2019. Samples were collected from P1, P2 and P5 within the CFA High irrigation area. Piezometer P3 and P6 is not representative of the irrigation area so their data is not included in the averages. The standing water levels Below Ground Level (BGL) at time of sampling for each are as follows;

- P1 – 10.3m BGL
- P2 – 7.0m BGL
- P5 – 6.5m BGL

Table 8 Groundwater results from Piezometers P1, P2 and P5. These are the Piezometers within the CFA High Irrigation Area

Constituent	P1	P2	P5	Average
Calcium (dissolved) (mg/L)	56	50.2	27.1	44.4
Chloride (mg/L)	145	132	59	112
Conductivity (µS/cm)	1470	1290	645	1135
Magnesium (dissolved) (mg/L)	25.5	11.7	5.99	14.4
Nitrate as N (mg/L)	22	22	24	22.7
Total Nitrogen(mg/L)	38	24	24	28.7
Nitrate/Nitrite as N(mg/L)	23	22	24	23
Total Phosphorus (mg/L)	13.6	1.74	0.25	5.2

Constituent	P1	P2	P5	Average
pH	7.3	7.3	7.3	7.3
Potassium (dissolved) (mg/L)	88.5	15.1	34.6	46.1
Sodium Adsorption Ratio	6	9	5	6.7
Sodium (dissolved) (mg/L)	203	263	108	191
Total Dissolved Solids (mg/L)	909	832	521	754
Total Kjeldahl Nitrogen (mg/L)	15	2	<2	8.5

Figure 14 and Figure 15 summarise the key analytes over the 2013 and 2019 groundwater sampling for CFA High. Total Nitrogen and Nitrate have been decreasing steadily.

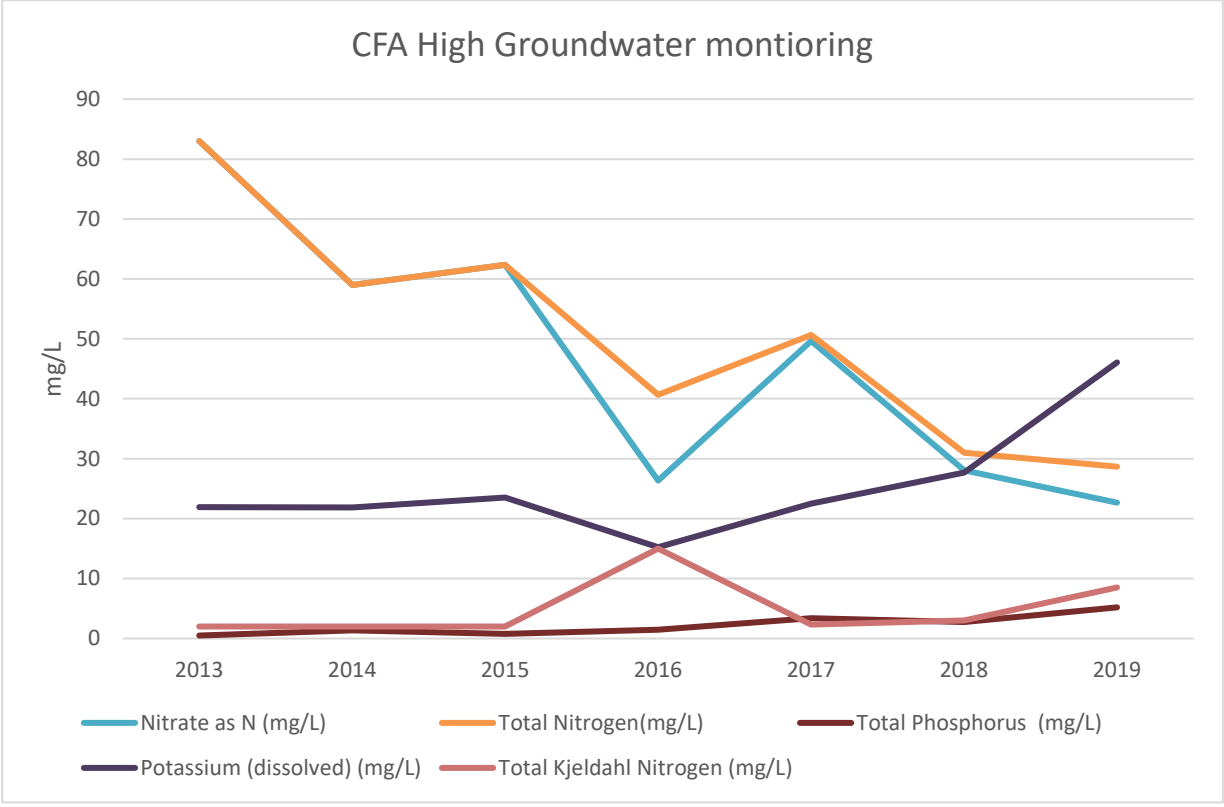


Figure 14 Average groundwater sampling data (P1,P2 & P5) between 2013 and 2019- key analytes

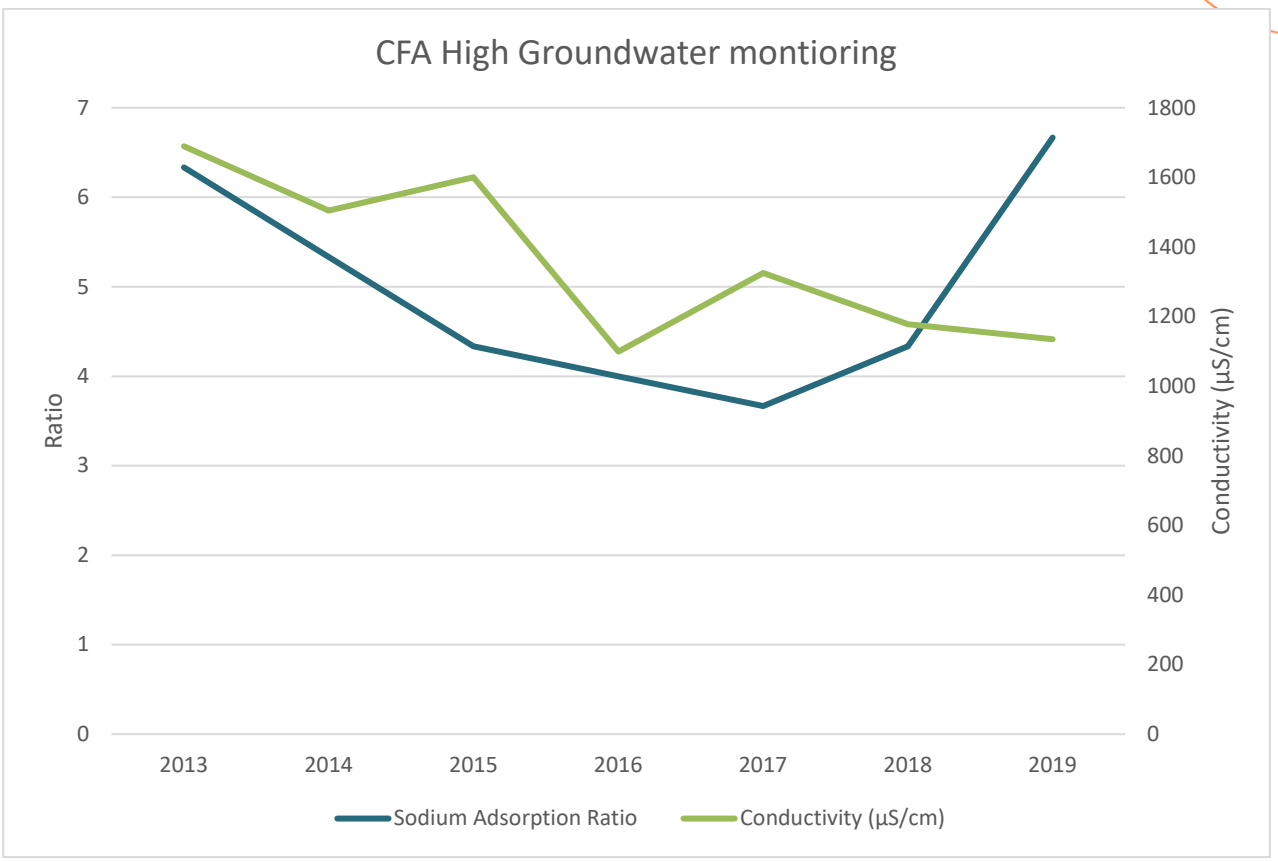


Figure 15 Average groundwater sampling data (P1,P2 & P5) between 2013 and 2019 – Conductivity and Sodium Adsorption Ratio

5.6 Groundwater Conditions – CFA Low

Groundwater bores were drilled at CFA Low in 1995. Two of the bores did not reach Groundwater, but the third, in the centre of the site, found groundwater 6.9m deep. The results of the water sample collected from that bore are shown in Table 9. The locations of the piezometers are shown in Figure 16 and the standing water levels BGL at time of sampling for each are as follows:

- P7 – 8.0m BGL
- P8 – 8.0m BGL
- P9 – 8.0m BGL

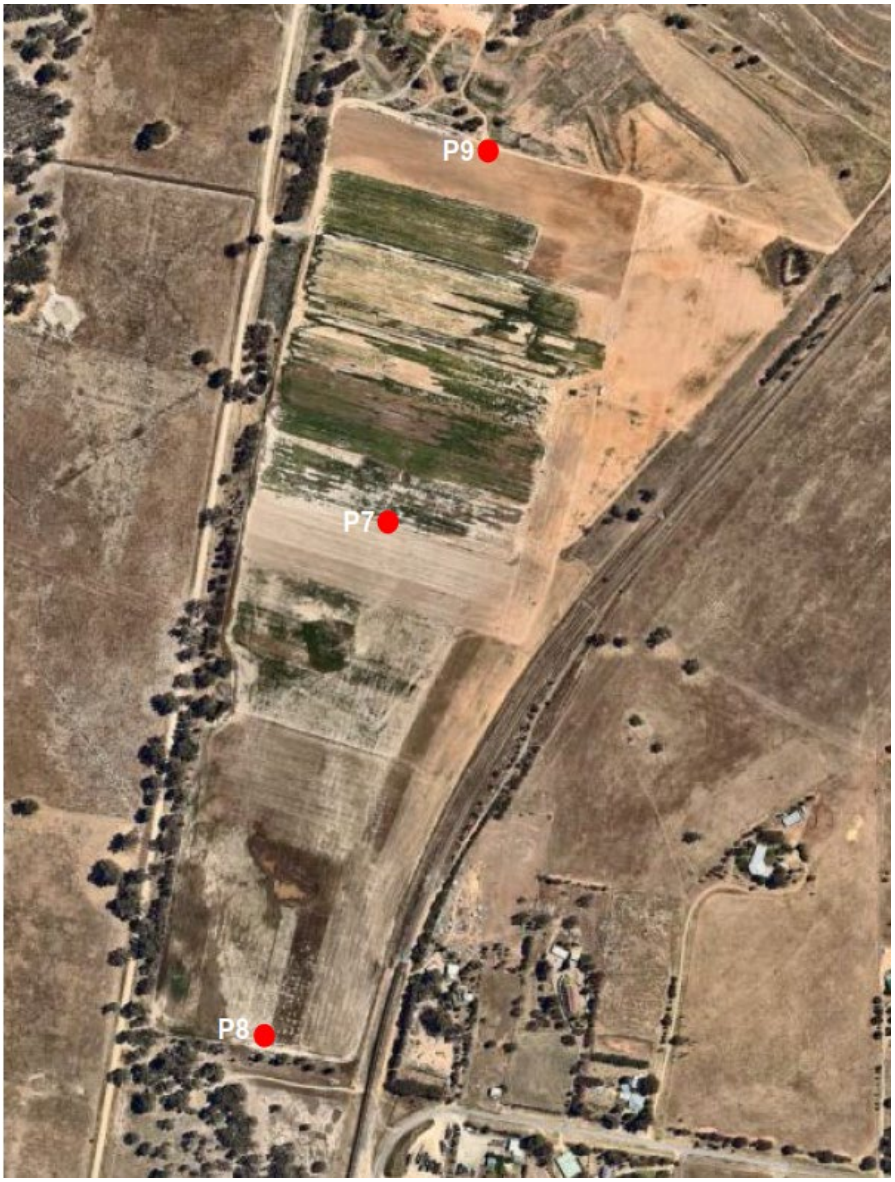


Figure 16 Approximate locations (shown in Red) of piezometers within the CFA Low irrigation area.

Table 9 CFA Low Groundwater monitoring results from 21 October 2011

Constituent	P7	P8	P9	Average
Calcium (dissolved) (mg/L)	44.8	46	43.9	45
Chloride (mg/L)	370	142	318	277
Conductivity (µS/cm)	2380	888	2160	1809
Magnesium (dissolved) (mg/L)	30.5	17.6	26	25
Nitrate as N (mg/L)	<1	<1	7	3
Total Nitrogen(mg/L)	2	2	10	4.7
Nitrate/Nitrite as N(mg/L)	<1	<1	7	7.0

Constituent	P7	P8	P9	Average
Total Phosphorus (mg/L)	0.66	0.53	1.46	0.9
pH	7.8	7.5	7.8	7.7
Potassium (dissolved) (mg/L)	3.9	4.7	4.6	4.4
Sodium Adsorption Ratio	12	4	12	9.3
Sodium (dissolved) (mg/L)	425	136	401	321
Total Dissolved Solids (mg/L)	1340	489	1220	1016
Total Kjeldahl Nitrogen (mg/L)	2	2	3	2.3

The results from the CFA Low Monitoring indicate that the salinity below CFA Low is higher than CFA High. The conductivity is slightly higher than is recommended for good irrigation water. Total nitrogen levels are generally low but appear to be increasing in P9. Figure 17 and Figure 18 summarise the key analytes over the 2013 and 2019 groundwater sampling for CFA Low.

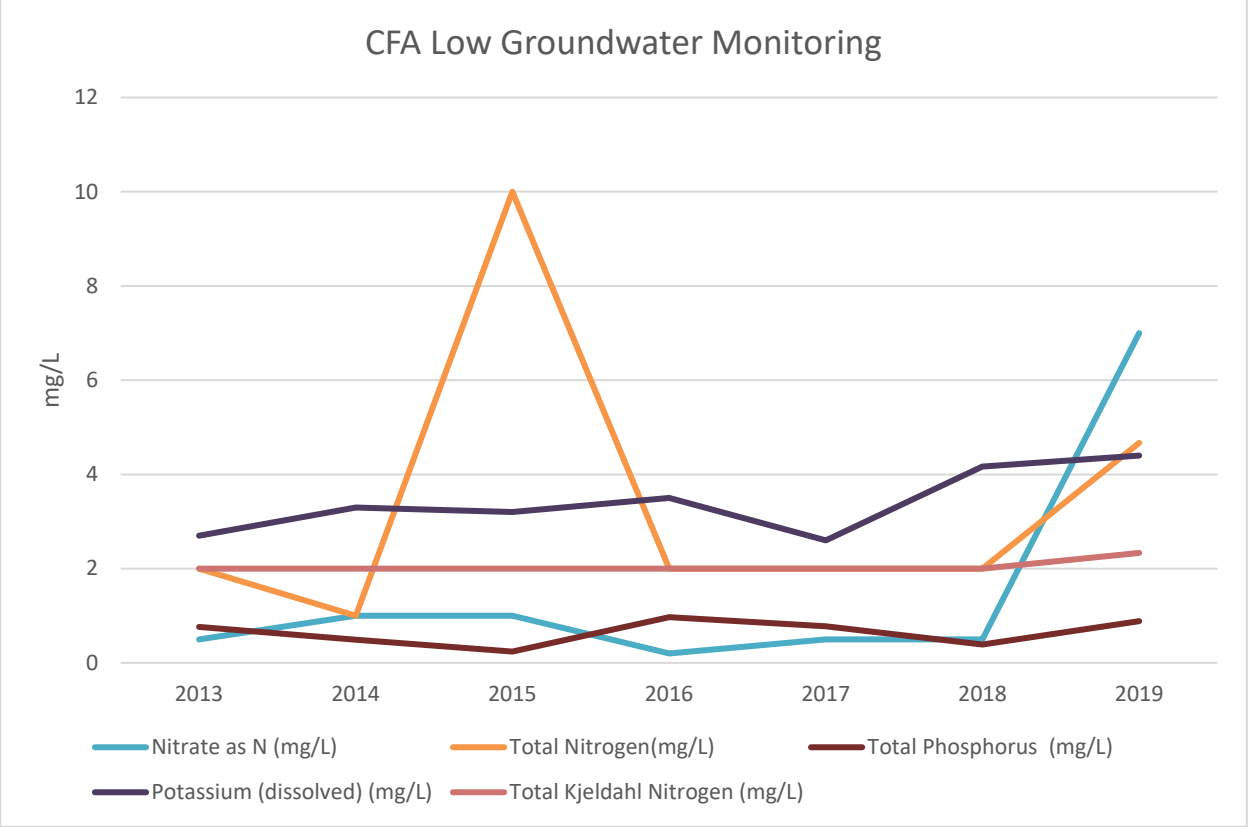


Figure 17 Average groundwater sampling data (P7,P8 & P9) between 2013 and 2019- key analytes

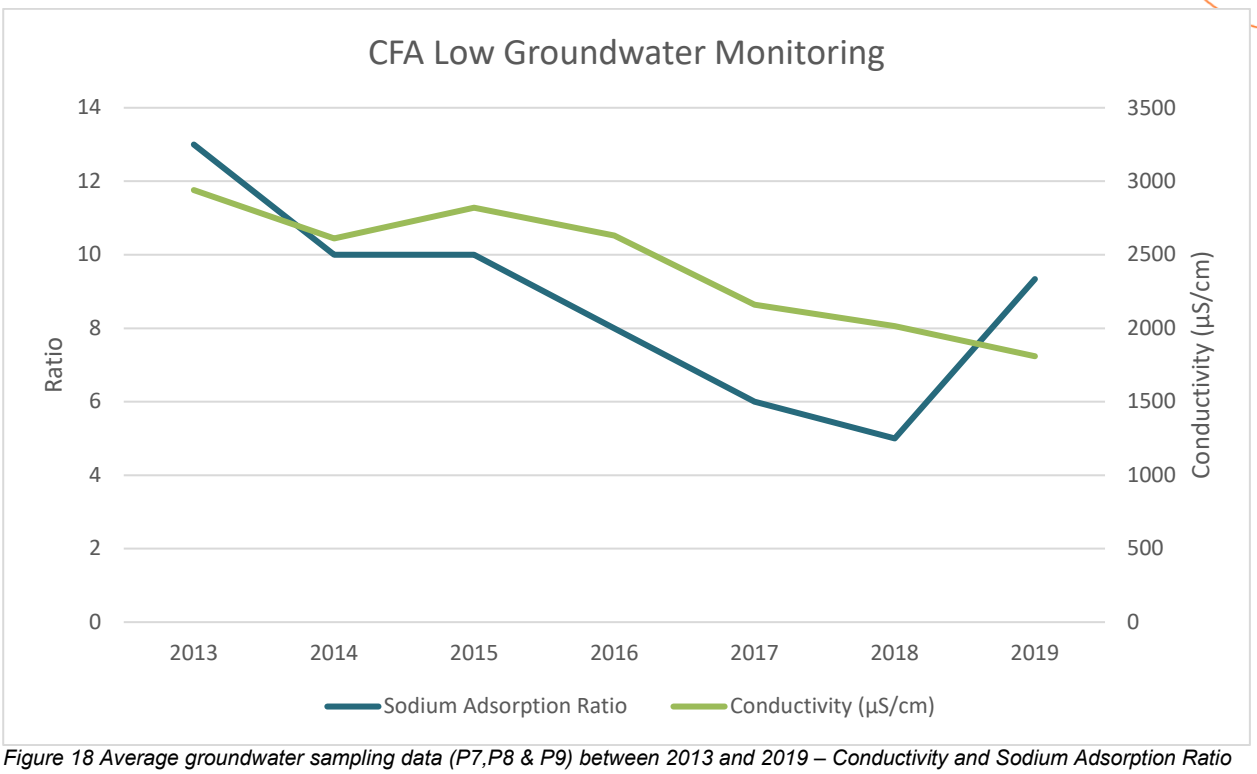


Figure 18 Average groundwater sampling data (P7,P8 & P9) between 2013 and 2019 – Conductivity and Sodium Adsorption Ratio

6. Water Balance

6.1 Method

The water balance presents an annual review of climatic data including monthly average rainfall and pan evaporation, and crops factors for typical crop varieties, and estimates the available irrigation capacity for each month. The general water balance process is described below:

The evaporation and precipitation averages for each month were based on historical climate data from the nearest weather station, the Bureau of Meteorology Station: 072150 Wagga Wagga AMO. The crop factor used for the calculations is based on pasture crop due to its similarity to turf varieties and was sourced from the DEC Environmental Guidelines, Use of Effluent by Irrigation (2004). Zero Percolation is assumed to ensure that groundwater is protected.

The following calculations were made to determine the water balance for each irrigation area:

Evapotranspiration = Evaporation x Crop Factor

Irrigation estimate (mm) = Evapotranspiration – Precipitation

Irrigation estimate (ML) = Irrigation Potential (mm) x Area (ha) x 10,000 m^2/ha

Irrigation Potential (ML) = Proportional distribution of total ML based on irrigation estimate for that month.

Irrigation Planned (mm) = Irrigation Planned (ML) / (hectares x 10,000 m^2/ha x 0.001 m/mm)

The water balances for each irrigation area are described below. On a day-to-day basis care needs to be taken with soil moisture to ensure that the water and nutrients in the wastewater are being recycled and not simply running off the land or leaching to groundwater.

6.2 CFA High Water Balance

Table 10 below shows the water balance calculations to determine the theoretical irrigation volumes that can be applied to the 7.3 ha CFA High irrigation area.

Table 10 Water balance for CFA High

Month	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Evaporation (mm)	316.2	252	210.8	120	65.1	39	37.2	58.9	90	155	216	291.4	
Precipitation (mm)	40.1	40.2	45	40.5	50.6	50.5	54.1	50.6	48.8	55.8	46.5	46.1	
crop factor- pasture	0.7	0.7	0.7	0.6	0.5	0.45	0.4	0.45	0.55	0.65	0.7	0.7	
Percolation	0	0	0	0	0	0	0	0	0	0	0	0	
Evapotranspiration	221.3	176.4	147.6	72.0	32.6	17.6	14.9	26.5	49.5	100.8	151.2	204.0	
Irrigation potential (mm)	181.2	136.2	102.6	31.5	0.0	0.0	0.0	0.0	0.7	45.0	104.7	157.9	759.7
Irrigation estimate (ML)	13.2	9.9	7.5	2.3	0.0	0.0	0.0	0.0	0.1	3.3	7.6	11.5	55.5
Irrigation potential (ML)	9.54	7.17	5.4	1.66	0	0	0	0	0.04	2.37	5.51	8.31	40.0
Irrigation planned (mm)	130.7	98.2	74.0	22.7	0.0	0.0	0.0	0.0	0.5	32.5	75.5	113.8	547.9

The irrigation estimate exceeded the maximum approved amount of effluent allowed to be applied to CFA High as determined by the Development Consent. The irrigation potential values show the likely maximum amount to be applied to CFA High each month based on the maximum of 40 ML/year. As the months May though to August showed precipitation was higher than evapotranspiration, the water balance indicates no irrigation for those months. It is likely that minimal irrigation would be required during the winter months but this does not necessarily preclude irrigation which may be achievable during winter drought.

Between April 2019 and April 2020, approximately 25 ML of effluent wastewater was applied to CFA high which is well below the maximum amount allowed. Based on this historical data ,it is unlikely that Teys will need to use the maximum allowable amount of effluent. Monitoring of effluent volumes will need to continue to ensure that a sustainable amount of effluent is applied to the land and the Development consent volume is not exceeded.

Irrigation scheduling should ensure that the irrigation rates applied are capable of being infiltrated by the soil without runoff, do not cause soil moisture to exceed the desirable range, and are matched to the crop demand.

6.3 CFA Low – Water Balance

Table 11 below shows the water balance calculations to determine the theoretical irrigation volumes that can be applied to the 35.1 ha CFA Low irrigation area.

Table 11 Water balance for CFA Low

Month	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Evaporation (mm)	316.2	252	210.8	120	65.1	39	37.2	58.9	90	155	216	291.4	
Precipitation (mm)	40.1	40.2	45	40.5	50.6	50.5	54.1	50.6	48.8	55.8	46.5	46.1	
crop factor- pasture	0.7	0.7	0.7	0.6	0.5	0.45	0.4	0.45	0.55	0.65	0.7	0.7	
Percolation	0	0	0	0	0	0	0	0	0	0	0	0	
Evapotranspiration	221.3	176.4	147.6	72.0	32.6	17.6	14.9	26.5	49.5	100.8	151.2	204.0	
Irrigation estimate (mm)	181.2	136.2	102.6	31.5	0.0	0.0	0.0	0.0	0.7	45.0	104.7	157.9	759.7
Irrigation estimate (ML)	63.6	47.8	36.0	11.1	0.0	0.0	0.0	0.0	0.2	15.8	36.7	55.4	266.7
Irrigation potential (ML)	71.6	53.8	40.5	12.4	0.0	0.0	0.0	0.0	0.3	17.7	41.3	62.3	299.9
Irrigation planned (mm)	204.0	153.3	115.4	35.3	0.0	0.0	0.0	0.0	0.9	50.4	117.7	177.5	854.4

The irrigation estimate was found to be below the maximum approved amount of effluent allowed to be applied to CFA Low as determined by the Development Consent. The irrigation potential values show the likely maximum amount to be applied to CFA Low each month based on the maximum of 300 ML/year. As the months May though to August showed precipitation was higher than evapotranspiration, no irrigation was considered for those months.

Between April 2019 and April 2020, approximately 88 ML of effluent wastewater was applied to CFA Low which is significantly below the maximum amount allowed. Based on this historical data ,it is unlikely that Teys will need to use the maximum allowable amount of effluent.

7. Soil Capacity and nutrient balance

The capacity for the soil to adsorb and retain nutrients at a sustainable level during the farming of turf and other crops using effluent wastewater is calculated in this section. The calculations assume the crop to be irrigated is Kikuyu turf. Key assumptions used in the nutrient balance are provided in Table 12.

Table 12 Key assumption values for the capacity calculations

Parameters	CFA High	CFA Low	Description / Source
Soil depth for nutrient assimilation (m)	1.00	1.00	Estimated depth of soil available for P-sorption
Soil density (kg/m^3)	1,300	1,300	Assumed
Land Area for irrigation (ha)	7	35	Established irrigation areas
Effluent Irrigation Volume - Maximum Permitted (ML/year)	40	300	Based on Development Consent
Effluent Irrigation Volume - 2019 Actual (ML/year)	25	88	Based on recorded volumes from 2019

7.1 Phosphorus capacity

The capacity for the soil to adsorb and recycle phosphorus can be estimated using the example of a phosphorus sustainability calculation in section 4.3 of the DEC Environmental Guidelines, Use of Effluent by Irrigation (2004). The calculations of phosphorus capacity and the assumptions are shown in Table 13.

Table 13 Estimated phosphorus soil capacity during operation

Phosphorous capacity	CFA High	CFA Low	Source
Soil Phosphorus sorption capacity (mg/kg)	188	225	2019 average soil testing results
Phosphorus sorption capacity (critical)	63	75	One third of theoretical P-sorption capacity - DEC Environmental Guidelines, Use of Effluent by Irrigation (2004)
Total P concentration in applied effluent (mg/L)	28	28	12-month average concentration from recent effluent monitoring results
Total P adsorbed by soil before leaching (kg)	5,947	34,418	Calculated as P sorption capacity (critical) x soil density x soil depth x area
Total P applied in effluent per year (kg) – Max volume	1,132	8,490	Calculated based on maximum effluent volume
Total P applied in effluent per year (kg) – 2019 Actual	708	2,490	Calculated based on 2019 Actual Application volume

Phosphorous capacity	CFA High	CFA Low	Source
Total P removed by crop (kg/ha/year)	60	60	Table 4.2 Use of Effluent by Irrigation, DEC, October 2004
Total P removed by crop for total irrigation area (kg)	438	2,118	Calculated
P-balance based on Maximum permitted effluent volume:			
P remaining after crop uptake (kg/year)	694	6,372	Calculated
Sustainable life of irrigation field for P-sorption (years)	8.6	5.4	Calculated
P-balance based on 2019 effluent volume:			
P remaining after crop uptake (kg/year)	270	372	
Sustainable life of irrigation field for P-sorption (years)	22	92	

The application of phosphorus is not sustainable over the long term if applied at the maximum permitted rates based on the consent. Phosphorus is a key limiting factor in the application of effluent. Monitoring for phosphorus quantities in the effluent and soil will need to be continued throughout operation to ensure the phosphorus capacity is not exceeded. Reduction of phosphorus concentrations in effluent, could permit greater irrigation volumes and a longer life of system.

7.2 Nitrogen capacity

The estimated nitrogen application to the irrigation areas based on the maximum effluent volume are outlined in Table 14.

Table 14 Estimated nitrogen soil capacity during operations

Nitrogen capacity	CFA High	CFA Low	Source
Total nitrogen concentration in applied effluent (mg/L)	24	24	From recent effluent monitoring
Total N in applied effluent (Max effluent volume) (kg/year)	952	7,140	Calculated.
Total N in applied effluent to area (kg/ha/year)	130	202	Calculated
Total N removed by Crop (kikuyu) (kg/ha/year)	520	520	Table 4.2 page 42 of Use of Effluent by Irrigation, DEC, October 2004
Total N removed per area by kikuyu (kg/year)	3,796	18,356	Calculated

Nitrogen capacity	CFA High	CFA Low	Source
Total N removed from soil (kg/year)	-2,844	-11,216	Calculated

Based on the nitrogen application rates and predicted nitrogen uptake rate by the crop, nitrogen is not a limiting factor. The balance suggests there would not be an excess of nitrogen applied to the land. There is in fact a small nitrogen deficit based on the factors used in this balance, and this deficit may need to be addressed through supplementary fertilisation to maintain optimum crop growth. Irrigation scheduling should be undertaken with consideration of nitrogen loading rates such that these are matched to the plant demand which varies with stage of the crop cycle and with growth rates, which vary with season and climate.

Nitrate is the greatest concern when considering risks of groundwater pollution. The nitrate concentration in the groundwater and soil (refer Section 5) indicate nitrate may have leached to deeper soils and groundwater particularly around CFA High as a result of historical effluent irrigation or possibly some other unknown source. The source of the high nitrate concentrations should be investigated.

7.3 Organic Material

A review of the application rates of organic material is outlined in Table 15. The calculations show that the proposed mass of organic material to be applied to the irrigation area is well within the capacity of the land, and below 2% of the theoretically sustainable application rate based on the EPA Guidelines. Organic loading rates are not a limiting factor for the soils based on the quality of effluent and area of land over which this is being irrigated.

Table 15 Estimated organics soil capacity during operations

Organic Material	CFA High	CFA Low	Source
Total BOD in applied effluent (mg/L)	13.4	13.4	From recent effluent monitoring
Oil & grease in applied effluent (mg/L)	8.6	8.6	From recent effluent monitoring
Total Organic material (mg/L)	22	22	Calculated (Total BOD + Oil and grease)
Sustainable rate of organic application (kg/ha/month)	1,500	1,500	DEC Environmental Guidelines, Use of Effluent by Irrigation (2004)
Total kg of organic material that can be sustainably accepted by the soil (kg/year)	98,550	476,550	Assuming a conservative nine month irrigation period.
Total kg organic material applied per year (kg/year)	880	6,600	Calculated
Percent of sustainable total (%)	0.9	1.4	Calculated

7.4 Salinity

The DEC Environmental Guidelines, Use of Effluent by Irrigation (2004), suggests that soil salinity levels of <2 dS/m (ECe) are acceptable and should result in negligible impacts to plant growth.

The 2019 monitoring results for salinity in soil and groundwater is shown in Table 16 and Table 17.

Table 16 Average soil salinity results for 2019

Key Analytes	CFA High		CFA Low	
	0-0.5 m	1.0-1.5m	0-0.5 m	1.0-1.5m
Conductivity (dS/m)	0.2	0.1	0.2	0.6

Table 17 Average groundwater salinity results for 2019

Key Analytes	CFA High	CFA Low
Conductivity (dS/m)	3.2	1.8
Total Dissolved Solids (mg/L)	2946	1016

The electrical conductivity of the soils at both CFA Low and CFA High indicate soils are non-saline to slightly and should have little or no impact on plant growth.

The electrical conductivity of groundwater below the CFA High and CFA Low sites is typically quite high and indicates the groundwater is saline. The groundwater below the irrigation areas must be carefully monitored because it is relatively high. Should the groundwater level increase, the salinity could present a significant limitation to plant health.

The Effluent salinity rating is low and suitable for moderately sensitive plants (see table 3.4 in the DEC Environmental Guidelines, Use of Effluent by Irrigation (2004)). Effluent salinity should continue to be monitored to ensure it remains within a safe range to plant growth.

7.5 Sodicity

Clay particles in soil are very small and therefore have a very high surface area to mass ratio. Combined with the net negative charge, the surface of clay particles are very reactive. Sodicity refers to the impact that a high percentage of Sodium ions (Na+) attached to the clay particles and changing the overall surface charge of the clay particles can have on the overall soil structure. Sodium ions, though, are not the only ions that can have an impact on the surface of clay particles in soil. Calcium (Ca+2) and Magnesium (Mg+2) can also have an impact and are reflected in the Sodium Adsorption Ratio (SAR). Acidity reflected in pH, the concentration of positively charged Hydrogen ions can also have an impact.

Clay soils with a normal mix of ions tend to stick together when wet. Clay soils with an abundance of Sodium ions don't bind together as well and become dispersive resulting in surface sealing and loss of soil structure.

Dispersive soils clog more easily because they fill the pore spaces between the other soil particles. This is sometimes called crusting. Soils impacted by sodicity are also more likely to erode because the clays do not bind together.

Australian soil scientists generally agree that soils with an Exchangeable sodium percentage (ESP) of greater than 5 are at risk of showing the adverse structural impacts associated with sodicity (DEC 2004). The 2019 soil results for sodicity are shown in Table 18.

Table 18 Average ESP results for 2019 soil testing

Parameter	CFA High	CFA Low

ESP (0-0.5m depth)	27	30
ESP (1-1.5m depth)	67	47

At face value the soils appear to be strongly sodic. However, it is important to note that the guidelines don't say that the soils WILL develop the adverse structural impacts associated with sodicity. The guidelines say that these soils are AT RISK. In the case of the CFA High and CFA Low soils it does not seem like the adverse structural impacts are realised. Anecdotal reports from Teys staff saying that the CFA High irrigation area soils do not exhibit the signs of sodic soils These signs being soils that are hard and cloddy when dry, tending to show a crust and draining poorly. Soil sodicity should be a key focus for monitoring over time.

7.6 Soil pH

Both soil pH and the pH of the effluent are within the guidelines for healthy soils. The average pH of the (0 to 0.5m) soil samples was 7.5 for CFA High and 7.7 for CFA low in 2019. The average pH of the treated effluent was 7.5. These are all in the healthy range and should have no impact on plant growth.

8. Potential Impacts

The most significant potential impact on the CFA land is the long term pollution of groundwater due to over irrigating or due to high levels of nutrients in the soil leaching through to the groundwater over time.

Another significant potential impact is odours from the spraying of wastewater. High organic content in wastewater under anaerobic conditions can cause strong odours. This risk has been reduced due to the improved treatment capacity of the wastewater treatment facilities (ESU), which reduced the organic content of the wastewater to levels where odours are less likely.

Another risk is contaminated runoff from the irrigation area flowing to a sensitive surface water stream or river. This could occur through irrigation during wet weather, through over irrigation, through a pipeline leak or through a break in a pipeline. The risk is limited by the extremely flat nature of the surrounding landscape, the distances to receiving waters and the management procedures put in place by Teys as described in this Plan.

There is some risk of spray drift to neighbouring properties in high winds. This risk must be managed on the understanding that the wind speed and direction may be different on the CFA High and CFA Low irrigation areas.

8.1 Potential for Contaminated runoff from the CFA Low area

There are 3 potential incidents whereby contaminated water could escape the CFA Low irrigation area and cause off site pollution.

- Broken pipe or leak from irrigation supply pipe combined with a failure of the trench in a location that allowed the irrigation water to flow off site.
- Rainfall runoff from the catchment mixing with freshly irrigated or spilled irrigation water and escaping through a failure of the trench around CFA Low.
- Flooding from the Murrumbidgee River mixes with the irrigated or spilled irrigation water and is carried off site by the Murrumbidgee floodwaters

The flooding potential is further discussed below.

8.2 Flooding of the CFA Low

The Wagga Wagga Revised Murrumbidgee River Floodplain Risk Management Study and Plan 2018 contains a full assessment of the existing flood risk in the catchment, including flood hazard across the study area, overfloor flooding of residential, commercial and industrial properties, identification of known flooding issues and hotspots, and emergency response during a flood event. The Study refers to the Annual Exceedance Probability (AEP) of flooding to varying depths, which identifies the probability of a particular flood event occurring in any year. Based on the 2018 studies, a majority of the CFA Low site would flood during an 1% AEP or higher event. The likely depth of flooding is shown in Table 19 and the predicted flood modelling for a 10% AEP is shown in Figure 19.

Table 19 Potential flooding to CFA Low (WMA Water 2018)

Annual Exceedance Probability (AEP)	Depth (metres)
10%	1-2 (for majority of the site) 2-5 (south west corner of the site)
5%	2-5

Annual Exceedance Probability (AEP)	Depth (metres)
2%	2-5
1%	2-5
Probable Maximum Flood (design flood)	>5

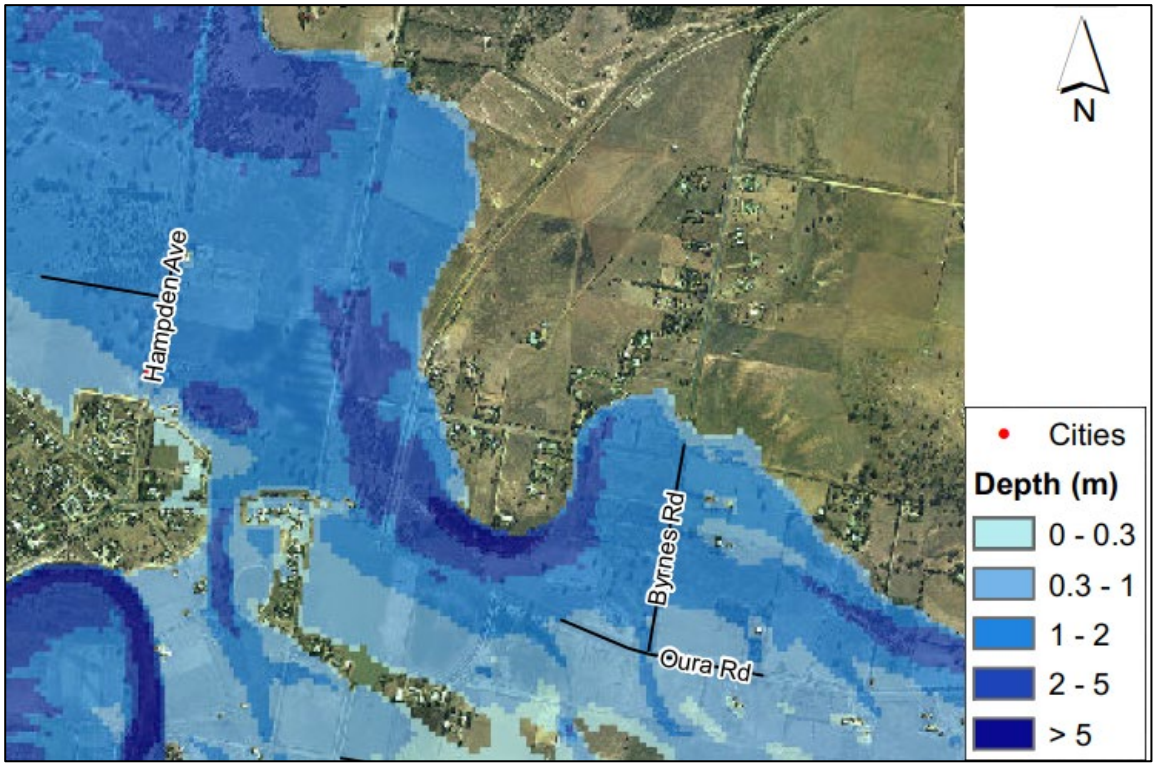


Figure 19 10% AEP flood modelling for the Bomen area (WMA Water 2018)

The risk of mixing wastewater with floodwater from the Murrumbidgee River is limited because it would be rare for CFA Low to be irrigated in any kind of rainfall event and even rarer for any pipe breakage to take place. Even if a pipe were broken, if the pumps are not turned on, the treated wastewater will not be pumped to CFA Low. Teys also has a policy of closing the valve that feeds the irrigation every night when the pumps are turned off, to provide extra certainty that there will not be an unexpected leak.

8.3 Riverina Water Service

Teys monitors its offsite impacts regularly and has had no impact on the Riverina Water Service Reservoir. Teys is not aware of any concerns raised by Riverina Water Service since the irrigation was initiated.

9. Management Measures

9.1 Impact assessment Criteria

In accordance with the EPL, the quantity of effluent applied to the irrigation areas must not exceed the capacity of the area to effectively utilise the effluent. The term 'effectively utilise' includes the use of the effluent/solids for pasture or crop production, as well as the ability of the soil to absorb the nutrient, salt, hydraulic load and organic material.

9.1.1 Soil Impact Assessment Criteria

Table 2.2 of the DEC Guidelines describes Nil or Slight Limitations, Moderate Limitations and Severe limitations for Typical soil characteristics for effluent irrigation systems. Many of these factors have previously been carefully reviewed and evaluated as part of the assessment procedures that Teys goes through as a part of their determination of the best irrigation strategy each season. Some of these assessments (Salinity measured as conductivity, Exchangeable sodium percentage, soil pH and phosphorus sorption) are discussed in Section 7.

Teys will also refer to the risk assessment guidelines in Appendix of the NWQMS Guidelines (2006).

9.1.2 Surface Water Impact Assessment Criteria

The EPL (No. 2262) requires that at the discharge to the utilisation area the BOD concentration must be less than 200 mg/L. The only other requirements of the EPL are to comply with section 120 of the *Protection of the Environment Operations Act*.

Teys has designed their irrigation system such that there will not be any discharge from the CFA High area except in greater than 1 in 10 year rainfall events. In the case of heavy rainfall the water from the runoff is so heavily diluted that the risk of strong pollution being discharged off site is greatly reduced. The CFA Low irrigation area design also protects the downstream catchments in the event of a 10 year rainfall event, assuming the trench is maintained in good condition.

9.1.3 Council Trade Waste Limits

The Council Trade Waste Limits are the same for the Teys irrigation because the plan is for some of the wastewater to be irrigated and some to be disposed to Council's sewerage system. Table 20 outlines the trade waste limits which apply. The Acceptable Limits mean that above these limits Teys is in breach of the Trade Waste Agreement. The Deemed Limits mean that Teys is still compliant but there is an excess mass charge.

Table 20 Council trade waste limits

Constituent	Acceptable Limits	Deemed Limits
Maximum Daily Discharge (ML/day) *	2.2	2.2
Maximum Instantaneous Discharge (L/hour) *	92,000	92,000
pH	7.0 to 9.0	7.0 to 9.0
Biochemical Oxygen Demand (BOD) (mg/L)	300	300
Chemical Oxygen Demand (COD) (mg/L)	900	NA
Total Phosphorus (mg/L)	30	10

Constituent	Acceptable Limits	Deemed Limits
Total Kjeldahl Nitrogen (mg/L)	100	50
Ammonia as N (mg/L)	50	35
Total Suspended Solids (mg/L)	300	300
Sulfate (mg/L)	500	50
Total Dissolved Solids (TDS) (mg/L)	1500	1000
Oil and Grease (mg/L)	50	50
Temperature (°C)	<38	<38
Detergents as MBAS (mg/L)	50	50
Colour NA	No visible	No visible

**The Trade Waste Approval retains capacity to exceed these limits under certain circumstances.*

9.2 Strategies for Reducing Nitrate Impacts

Under aerobic conditions ammonia and organic nitrogen can be converted to Nitrate. Nitrate does not bind strongly to soil particles so it may be leached through the soil to groundwater. The drinking water limit for Nitrate-N is 22.6 mg/L.

To minimise risks of nitrate leaching the strategies include:

- Reducing total nitrogen and nitrate concentration in effluent. This has largely been achieved as a result of the improved effluent treatment bought about by the biological nutrient removal system as part of the ESU.
- Applying nitrogen at rates that are equal or less than the crop requirements, and targeting application during active growth periods.
- Irrigating when soils are not saturated. October to April is the time of year when evaporation exceeds precipitation by the greatest amount and as such the risk of leaching is least.

9.3 Strategies for Reducing Phosphorus Impacts

Phosphorus can be absorbed to soils however the soils' phosphorus sorption capacity is finite and once exceeded, increased leaching of phosphorus to groundwater can occur. The Teys effluent contains phosphorus concentrations that generally exceed plant uptake rates and this places a high reliance on soils to adsorb the remaining phosphorus.

Effluent application rates should be managed in accordance with the nutrient balance, to ensure that the life of the irrigation area is sustained and the area is not overloaded with phosphorus. Continued soil monitoring of P-sorption capacity will be important to monitor changes and effluent application rates should continue to be managed with an understanding of the phosphorus load and field capacity to assimilate phosphorus without leaching occurring.

9.4 Strategies for Reducing Salinity Impacts

The conductivity and Sodium Adsorption Ratio for both CFA High and CFA Low soils are very low and should have no impact on the growth and production of the turf. The Salinity of the effluent should be maintained at less than 2.5 dS/m (2500 uS/cm) to avoid high salinity within the shallow root zone. The effluent is relatively low in salinity which suggests salinity impacts within soils is manageable.

Salinity in groundwater beneath the irrigation areas is relatively high and should continue to be monitored. Table A4.14 of the National Water Quality Management Strategy, Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006 (NWQMS Guidelines 2006) lists several strategies for reducing salinity in groundwater.

Table A4.14 recommends “If possible, rely on rainfall for leaching.” Teys will minimise irrigation during the relatively cooler months (May through September) each year when soils moisture deficit is at its least, or even in surplus. This will allow any rainfall with very low salinity (conductivity = 0.3 dS/m = 300 uS/cm) to percolate through the soil and leach salts away from the surface soil profile. This is also appropriate during the irrigation season when heavy rains can leach salts through the system because there is no irrigation during wet periods.

Teys will continue to monitor soil, groundwater and effluent irrigation water to determine if there are any trends with respect to salinity. Monitoring results from 2018 through 2019 have shown that conductivity of the soil has dropped in both the 0.5m deep samples and the 1.0-1.5m deep samples. The Soil sampling results also show that the soil salinity levels are relatively low, so the current management techniques are working successfully.

9.5 Irrigation Scheduling

Irrigation scheduling decisions should be made according to the prevailing weather conditions, crop moisture demand and soil moisture. Due to the shallow rooting nature of turf (root depths to about 500mm), irrigation rates should be kept relatively low to maximise retention of moisture within the root zone and prevent deep drainage. Once effluent drains below the root zone there is an increased risk of percolation of nutrients to groundwater. Irrigation scheduling decisions should always be based on the needs of the crop, with irrigation rates matched to the crop needs to ensure effective reuse of the water and nutrients. Irrigation should never be undertaken on a philosophy of “disposal” as this tends to over-irrigate with flow-on environmental risks.

As a general guide, irrigation depths should be kept less than about 5 mm/day typically, and at the most 10mm/day. This will depend on factors such as soil moisture deficit and weather. During hot windy days in summer high irrigation rates may be required to provide adequate moisture to the crop to prevent stress. During wet weather, or if significant rain is forecast, irrigation should be suspended. Management decisions around irrigation must be informed by regular soil moisture monitoring and by monitoring weather forecasts. Irrigation should be rotated frequently between different areas to avoid overloading of individual areas.

Historically winter irrigation has not been undertaken. This decision has been based on the water balance which indicates that for the months of May through to September there is negligible water deficit and even a water surplus. However, the water balance is based on long term average climate data and does not account for year to year seasonal variability.

Winter irrigation can be undertaken during dry winters when there is a crop moisture demand and subject to soil moisture remaining in deficit. As growth rates and evapotranspiration are much lower in winter compared to summer, winter irrigation rates would need to proportionately lower so as to avoid waterlogging of the soil. Suggested winter irrigation rates around 2 mm/day may be sufficient. Longer resting times between irrigation cycles may be required to maintain a soil moisture deficit.

9.6 Assessment of soil moisture prior to irrigation

It is important that the irrigation system operators irrigate when the soil is in a good condition to accept the irrigation water, that is, when the soil is in moisture deficit. This ensures that water and nutrients enter and are retained in the soil, so as to be plant available. If the soil is too wet when the irrigation water is applied, the wastewater is more likely to run off causing nutrients to runoff and not be taken up by the soil and crop. The risk of deep drainage and leaching of nutrients to groundwater also increases when soil moisture is high.

Teys irrigates from Monday to Sunday and irrigation operations are overseen and managed by an experienced operator. The Operator uses a checklist (Appendix A) to help determine if irrigation is appropriate each day. The checklist includes a range of factors used to assess irrigation suitability, such as recent rainfall, moisture content of the soil at sensitive locations, wind direction and speed, and the storage capacity available in the down slope runoff collection basins. Teys use a portable moisture probe to assess soil moisture. Irrigation is only applied where the soil moisture content is between 5% and 25%.

When the weather data or soil moisture data is conflicting or in doubt, the operator checks the weather data from the meteorological station and consults with the environmental manager.

9.7 Control of runoff

General practices to avoid runoff include:

- Under normal irrigation, the wastewater is spread evenly over the soil to maximise moisture infiltration and minimise the risk of significant ponding or concentration of flows that may lead to runoff.
- The valve that feeds the irrigation is closed every night when the pumps are turned off, to avoid leaks.
- The pumping system is fitted with automatic flow sensors that can shut down the pumps if there is a sudden increase in flowrate that might be due to a leak.
- Irrigation infrastructure is regularly inspected for leaks or damage.
- Irrigation is not undertaken in wet weather or if wet weather is forecast within the next day.
- Irrigation is only applied where the soil moisture content is between 5% and 25%.
- Runoff dams are managed to ensure sufficient capacity exists to catch runoff in the event it occurs. If the dam is fuller than 30% water is pumped back to stockyards and reprocessed through treatment plants. This operation is manually controlled by the operator.

9.8 Control of spray drift

Spray from irrigation practices on site shall not drift beyond the boundary of the premises to which it is applied. A primary control of spray drift is the selection of appropriate irrigation equipment. Effluent irrigators should produces coarse droplets and avoid fine misting.

Operator monitoring is key in the control of spray drift. Irrigation is only carried out with a trained operator on site. The operator checks the data from the on-site weather station that records wind speed with live data and historic data down to every 10 min intervals available . Teys maintains an on-site weather station that the operator can use near the back gate of the Beef Processing Plant.

The operator uses a checklist when deciding whether to initiate irrigation (see Appendix A). When the wind is considered by the operator as so strong that there is potential for drift beyond the boundaries of the site, the irrigation is turned off. As a general rule, when wind speeds reach 15 km/h irrigation would need to be carefully supervised and if spray drift is apparent, irrigation would be ceased.

The weather station records wind speed and direction so the weather station data can also be viewed in the environmental manager's office. The environmental manager can be in contact with the operator via two way radio if the wind is too strong and in a direction that may impact the nearest residents.

9.9 Odour control

The weather including wind direction will be considered as outlined in the irrigation checklist (appendix A) to ensure odour impacts are unlikely to occur. Furthermore ff an odour complaint has been received which is likely to be caused by application of effluent, irrigation will cease and the cause of the issue investigated.

9.10 Signage

Signage is to be maintained around the perimeter of the irrigation area to inform that effluent reuse is in operation.

Fencing along the boundary fence with East St indicates private property and new gates are in the process of being installed. New AusGap signage on the gates will outline that effluent water is being used onsite.

10. Monitoring

10.1 EPL monitoring conditions

All effluent irrigation and pollutant monitoring will be carried out in accordance with the EPL. The relevant monitoring requirements from the EPL are described in Table 21.

Table 21 EPL monitoring requirements

<table>
<tr><th>Cond.</th><th>Requirement</th></tr>
<tr><td>P1</td><td>Location of monitoring/discharge points and areas</td></tr>
<tr><td>P1.3</td><td>The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.
<table>
<tr><th>No.</th><th>Type of Monitoring Point</th><th>Type of Discharge Point</th><th>Location Description</th></tr>
<tr><td>1</td><td>Discharge to utilisation area. Effluent quality monitoring</td><td>Discharge to utilisation area. Effluent quality monitoring</td><td>Spray irrigation to utilisation area labelled "Licensed Irrigation Area" on Drawing 1232 titled "Wagga Wagga Abattoir Storm Water & Sewerage Discharge" submitted to the EPA with Licence Information Form on 9/12/99</td></tr>
<tr><td>4</td><td>Soil monitoring</td><td></td><td>CFA High irrigation area as shown on map attached to licence variation application dated 9 December 2011. Four representative samples to be collected.</td></tr>
<tr><td>6</td><td>Soil monitoring</td><td></td><td>CFA Low irrigation area as shown on map attached to licence variation application dated 9 December 2011. Four representative samples to be collected.</td></tr>
<tr><td>7</td><td>Monitoring of effluent discharged to Lot 100 DP 1095889, 59 Hillary Street, North Wagga Wagga for the purposes of turf growing.</td><td>Monitoring of effluent discharged to Lot 100 DP 1095889, 59 Hillary Street, North Wagga Wagga for the purposes of turf growing.</td><td>Discharge point at the boundary of the Teys premises prior to discharge to Lot 100 DP 1095889 59 Hillary Street, North Wagga Wagga</td></tr>
<tr><td>8</td><td>Monitoring of effluent volume</td><td>Monitoring of effluent volume</td><td>Monitoring of effluent volume for CFA Low irrigation area</td></tr>
<tr><td>9</td><td>Piezometer 1 CFA High</td><td></td><td>Piezometer 1 CFA High Irrigation</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Cond.</th><th>Requirement</th></tr>
<tr><td>P1</td><td>Location of monitoring/discharge points and areas</td></tr>
<tr><td></td><td>
<table>
<tr><td></td><td>Irrigation Area</td><td></td><td>Area</td></tr>
<tr><td>10</td><td>Piezometer 5 CFA High Irrigation Area</td><td></td><td>Piezometer 5 CFA High Irrigation Area</td></tr>
<tr><td>11</td><td>Piezometer 7 CFA Low irrigation area</td><td></td><td>Piezometer 7 CFA Low irrigation area</td></tr>
<tr><td>12</td><td>Piezometer 8 CFA Low irrigation area</td><td></td><td>Piezometer 8 CFA Low irrigation area</td></tr>
<tr><td>14</td><td>Piezometer 9 CFA Low Irrigation Area</td><td></td><td>Piezometer 9 CFA Low Irrigation Area. Installed to a depth of 15.5m. Titled "Piezo 1 - North" in email attachment DOC18/44257-02.</td></tr>
<tr><td>15</td><td>Piezometer 10 CFA Low Irrigation Area</td><td></td><td>Piezometer 10 CFA Low Irrigation

rea. Installed to a depth of 15.5m. Titled "Piezo 2 - South" in email at DOC18/44257-02.</td></tr>
</table>
</td></tr>
<tr><td>L1.1</td><td>Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.</td></tr>
<tr><td>L2.1</td><td>For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.</td></tr>
<tr><td>L2.2</td><td>Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.</td></tr>
<tr><td>L2.3</td><td>To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\s.</td></tr>
<tr><td>L2.5</td><td>Water and/or Land Concentration Limits

Point 1,7

<table>
<tr><td>Pollutant</td><td>Units of Measure</td><td>100 percentile concentration limit</td></tr>
<tr><td>BOD</td><td>milligrams per litre</td><td>200</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Cond.</th><th>Requirement</th></tr>
<tr><td>P1</td><td>Location of monitoring/discharge points and areas</td></tr>
<tr><td></td><td>Point 7

<table><tr><td>Pollutant</td><td>Units of Measure</td><td>100 percentile concentration limit</td></tr><tr><td>Conductivity</td><td>microsiemens per centimetre</td><td>1500</td></tr><tr><td>Total Phosphorus -unfiltered sample</td><td>milligrams per litre</td><td>30</td></tr></table></td></tr>
<tr><td>L3.1</td><td>For each discharge point or utilisation area specified below (by a point number), the volume/mass of:

a) liquids discharged to water; or;

b) solids or liquids applied to the area;

must not exceed the volume/mass limit specified for that discharge point or area.

<table><tr><td>Point</td><td>Unit of Measure</td><td>Volume/Mass Limit</td></tr><tr><td>7</td><td>megalitres per year</td><td>120</td></tr><tr><td>8</td><td>megalitres per year</td><td>300</td></tr></table></td></tr>
<tr><td colspan="2">M1 Monitoring records</td></tr>
<tr><td>M1.1</td><td>The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.</td></tr>
<tr><td>M1.2</td><td>All records required to be kept by this licence must be:

a) in a legible form, or in a form that can readily be reduced to a legible form;

b) kept for at least 4 years after the monitoring or event to which they relate took place; and

c) produced in a legible form to any authorised officer of the EPA who asks to see them.</td></tr>
<tr><td>M1.3</td><td>The following records must be kept in respect of any samples required to be collected for the purposes of this licence:

a) the date(s) on which the sample was taken;

b) the time(s) at which the sample was collected;

c) the point at which the sample was taken; and

d) the name of the person who collected the sample.</td></tr>
</table>

Cond.	Requirement
P1	**Location of monitoring/discharge points and areas**

M2 Requirement to monitor concentration of pollutants discharged

M2.1 For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency, specified opposite in the other columns:

M2.2

Water and/ or Land Monitoring Requirements

Point 1

Pollutant	Units of measure	Frequency Sampling	Method
Biochemical oxygen demand	milligrams per litre	Monthly	Composite sample

Point 4, 6

Pollutant	Units of measure	Frequency Sampling	Method
Conductivity	deciSiemens per metre	Yearly	Composite sample
Exchangeable calcium	milligrams per kilogram	Yearly	Composite sample
Exchangeable magnesium	milligrams per kilogram	Yearly	Composite sample
Exchangeable potassium	milligrams per kilogram	Yearly	Composite sample
Exchangeable sodium	milligrams per kilogram	Yearly	Composite sample
Exchangeable sodium percentage	percent	Yearly	Composite sample
Extractable phosphorus	milligrams per kilogram	Yearly	Composite sample
Nitrate	milligrams per kilogram	Yearly	Composite sample
Nitrogen (total)	milligrams per kilogram	Yearly	Composite sample
pH	pH	Yearly	Composite sample
Phosphorus (total)	milligrams per kilogram	Yearly	Composite sample
Phosphorus Sorption Capacity	milligrams per kilogram	Yearly	Composite sample

Cond.	Requirement
P1	**Location of monitoring/discharge points and areas**

Total organic carbon	milligrams per kilogram	Yearly	Composite sample

Point 7

Pollutant	Units of measure	Frequency Sampling	Method
Biochemical oxygen demand	milligrams per litre	Monthly during discharge	Grab sample
Conductivity	Microsiemens per centimetre	Monthly during discharge	Grab sample
Total Phosphorus - unfiltered sample	milligrams per litre	Monthly during discharge	Grab sample

POINT 9,10,11,12,14,15

Pollutant	Units of measure	Frequency Sampling	Method
Electrical Conductivity	Microsiemens per centimetre	Yearly during discharge	In situ
Nitrate	milligrams per litre	Yearly during discharge	Grab sample
pH	pH	Yearly during discharge	In situ
Standing Water Level	Metres (Australian Height Datum)	Yearly during discharge	In situ

M3 Testing methods - concentration limits

M3.1	Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.

M4 Weather monitoring

M4.1	For each monitoring point specified in the table below the licensee must monitor (by sampling and obtaining results by analysis) the parameters specified in Column 1. The licensee must use the sampling method, units of measure, averaging period and sample at the frequency, specified opposite in the other columns.

Parameter	Units of Measure	Frequency	Averaging	Sampling

<table>
<tr><th>Cond.</th><th>Requirement</th></tr>
<tr><td>P1</td><td>Location of monitoring/discharge points and areas</td></tr>
<tr><td></td><td>
<table>
<tr><td></td><td></td><td></td><td>Period</td><td>Method</td></tr>
<tr><td>Air temperature</td><td>°C</td><td>Continuous</td><td>1 hour</td><td>AM-4</td></tr>
<tr><td>Wind direction</td><td>°</td><td>Continuous</td><td>15 minute</td><td>AM-2 & AM-4</td></tr>
<tr><td>Wind speed</td><td>m/s</td><td>Continuous</td><td>15 minute</td><td>AM-2 & AM-4</td></tr>
<tr><td>Sigma theta</td><td>°</td><td>Continuous</td><td>15 minute</td><td>AM-2 & AM-4</td></tr>
<tr><td>Rainfall</td><td>mm</td><td>Continuous</td><td>15 minute</td><td>AM-4</td></tr>
<tr><td>Relative humidity</td><td>%</td><td>Continuous</td><td>1 hour</td><td>AM-4</td></tr>
</table>
</td></tr>
<tr><td>M4.2</td><td>The licensee must establish a permanent meteorological station complying with the Approved methods for sampling and analysis and the Australian Standard AS2923 – 1987, at the facility.

The location of the site chosen for the station and details of equipment, measurement and maintenance/service procedures and schedules to be installed and maintained must be submitted in writing to the EPA and approved in writing by the EPA before any sampling or analysis is carried out. The meteorological monitoring station must be calibrated at least once every 12 months. The EPA is to be provided with the data on request in a Microsoft ® Office software compatible format.</td></tr>
<tr><td></td><td>Include phone and pollution complaint record requirements?</td></tr>
<tr><td colspan="2">M7 Requirement to monitor volume or mass</td></tr>
<tr><td>M7.1</td><td>For each discharge point or utilisation area specified below, the licensee must monitor:

a) the volume of liquids discharged to water or applied to the area;

b) the mass of solids applied to the area;

c) the mass of pollutants emitted to the air;

at the frequency and using the method and units of measure, specified below.

Point 7
<table>
<tr><td>Frequency</td><td>Unit of Measure</td><td>Sampling Method</td></tr>
<tr><td>Continuous during discharge</td><td>litres</td><td>Magnetic flow meter</td></tr>
</table>
Point 8
<table>
<tr><td>Frequency</td><td>Unit of Measure</td><td>Sampling Method</td></tr>
</table>
</td></tr>
</table>

Cond.	Requirement		
P1	**Location of monitoring/discharge points and areas**		
	Continuous during discharge	litres	Magnetic flow meter

10.2 Monitoring locations

The monitoring locations for the site are described in Table 22. The key monitoring locations for CFA High are shown in Figure 20 and for CFA are shown in Figure 21 below.

Table 22 Description of monitoring point locations

EPA no.	Type of monitoring point	Type of discharge point	Easting	Northing	Latitude	Longitude
5		Biogas Flare	536815.83	6118147.68	-35.078764	147.403839
13	Boiler Stack		537351.79	6118502.26	-35.075547	147.409703
1	Discharge to utilisation area. Effluent quality monitoring		536841.31	6118293.75	-35.077446	147.404113
4	Soil Monitoring		Various samples - randomly selected each year			
6	Soil Monitoring					
8	Monitoring of effluent volume	Monitoring of effluent volume	536908.5	6118360.68	-35.07684	147.404847
8	Monitoring of effluent volume	Monitoring of effluent volume	536966.38	6118245.89	-35.077873	147.405487
9	Piezometer 1 CFA High Irrigation Area	GW monitoring point	537019.58	6118036.18	-35.079762	147.406082
	Piezometer 2 CFA High Irrigation Area	GW monitoring point	536971.8	6118414.43	-35.076353	147.405539
10	Piezometer 5 CFA High Irrigation Area	GW monitoring point	536813.82	6118058.09	-35.079572	147.403822
	Piezometer 3 CFA High Irrigation Area	GW monitoring point	536802.11	6118362.00	-35.076832	147.403680

EPA no.	Type of monitoring point	Type of discharge point	Easting	Northing	Latitude	Longitude
	Piezometer 6 CFA High Irrigation Area	GW monitoring point	537259.23	6118141.22	-35.078806	147.408704
11	Piezometer 7 CFA Low Irrigation Area	GW monitoring point	535888.56	6117267.41	-35.086735	147.393707
12	Piezometer 8 CFA Low Irrigation Area	GW monitoring point	535759.26	6116702.21	-35.091836	147.392313
14	Piezometer 9 CFA Low Irrigation Area	GW monitoring point	536007.59	6117675.05	-35.083055	147.394995
	Effluent Discharge to Tradewaste		536940.99	6118437.18	-35.076149	147.4052

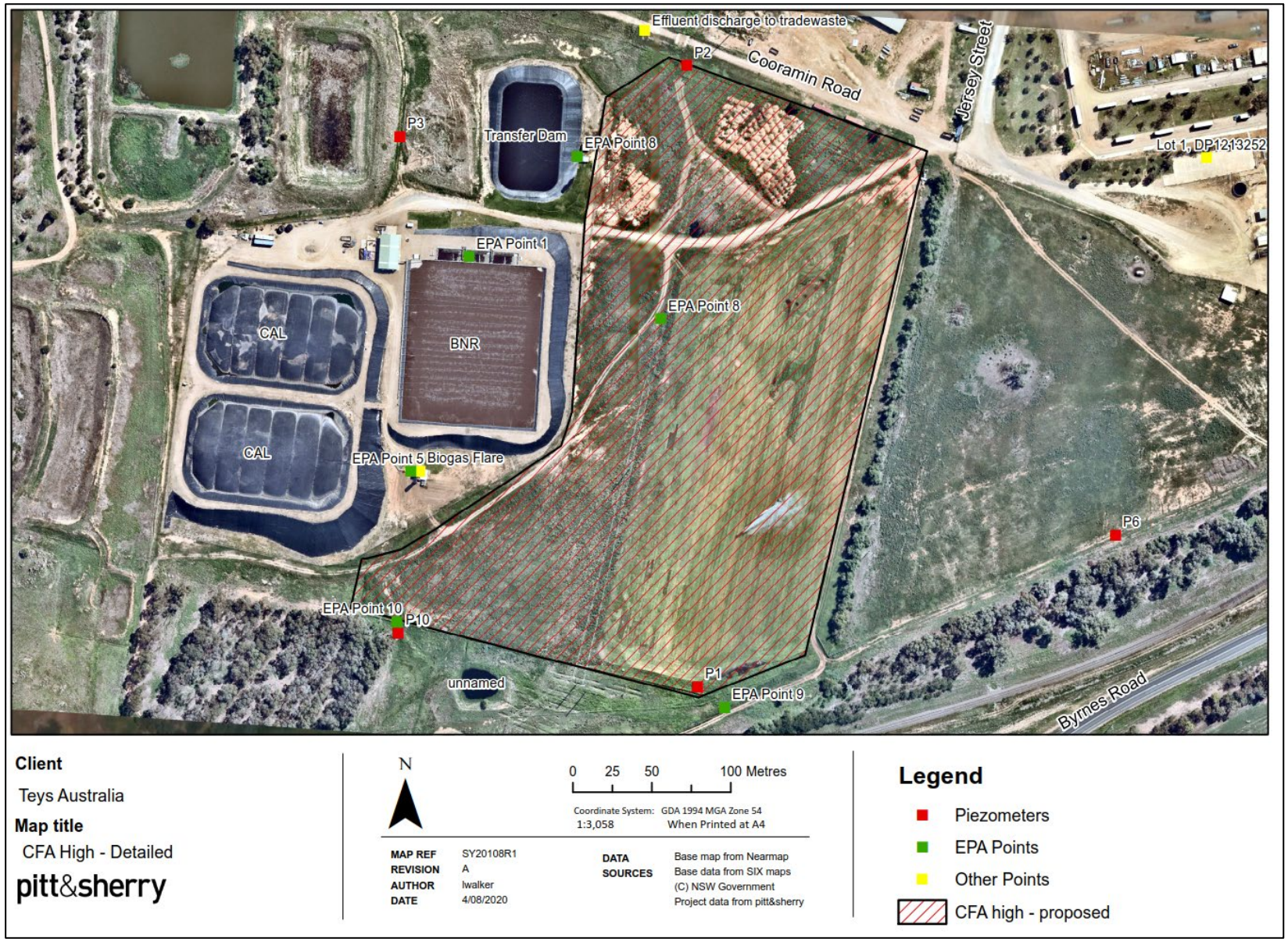


Figure 20Monitoring locations for CFA High

Figure 21 Monitoring locations for CFA Low

10.3 Effluent monitoring

The effluent to be discharged to the sewer and the effluent to be irrigated are the same. Both come from the effluent from Transfer Dam. The sampling of this effluent is based on the requirements of the Trade Waste Approval with Council. Composite samples are collected from the discharge from Transfer Dam and sent to the lab at least once a week. The samples are analysed for BOD, COD, Total Suspended solids, pH, Total Oil and Grease, Ammonia, Total Kjeldahl Nitrogen, Total Phosphorus, Sulfides, Sulfates and Total Dissolved Solids.

10.4 Groundwater monitoring

Groundwater under the irrigation areas is sampled once per year from the piezometers.

Groundwater is sampled for depth to groundwater, Ammonia, Calcium, Chloride, Electrical Conductivity, Magnesium, Total Kjeldahl Nitrogen, Nitrate, Total Phosphorus, pH, Potassium, Sodium Adsorption Ratio (calculated), Sodium (dissolved) and Total Dissolved Solids.

10.5 Soil condition monitoring

Soils within both irrigation areas are sampled once per year at six bore hole locations in CFA High and five borehole locations in CFA low. See section 10.2 for the borehole locations.

Soils are sampled for Available Phosphorus, Total Phosphorus, Cation Exchange Capacity, Exchangeable Sodium, Exchangeable Sodium percentage, Exchangeable Calcium, Exchangeable Potassium, Exchangeable Magnesium, Nitrate, Total Nitrogen, Electrical Conductivity, Total Organic Carbon and pH. In 2009, the Phosphorus Buffer Index was also analysed, as this is now more commonly used that the Phosphorus Absorption Capacity.

10.6 Monitoring strategy justification

Teys monitors the soil, effluent and groundwater according to the requirements of the regulatory authorities (Council and EPA) issuing the approvals for irrigation of the wastewater. These requirements have provided the analysis that has been done in the previous sections of this document and many previous assessments to develop the irrigation strategy that is now in place. Teys has always found the data sufficient for that purpose.

Teys has also had the advantage of observing and monitoring the irrigation area over a very long period. At the same time, the effluent applied to the irrigation area has had a similar concentration of nutrients, organics and salinity over a long period. The ability of the soil to maintain fertility over this long period is a strong justification for the adequacy of the monitoring program

10.7 Contingency Measures

Monitoring results will be assessed by the Teys Environmental Manager, as soon as they are available from the Lab. Effluent results are sent to Wagga Wagga City Council as soon as they are available from the lab. In the case of the effluent sampling which is done every week, the Environmental Manager will review the data for long term trends. If a single result does seem to be exceptional the Environmental Manager will usually wait for the next group of results to come in from the lab to verify that a potential trend is starting rather than take action that may be premature. External expertise will also be sought when required.

If the monitoring results show that the irrigation system is causing some environmental harm, showing a trend that might indicate environmental harm or showing a trend that is very difficult to understand relative to previous results, the first step will be to notify the EPA officer assigned to Teys and seek guidance regarding further action.

In the case where there is potential for environmental damage to occur due to the irrigation of effluent, Teys would stop irrigating prior to notifying the EPA.

Teys Australia will maintain a Trade Waste Agreement to allow discharge to the Council sewer when required.

10.8 Reporting

All the monitoring results are reported annually to the EPA and DPIE in the EPL Annual Return and in the consent conditions Annual Environmental Management Report (AEMR). The AEMR may be submitted to the Secretary at the same time as the Annual Return is submitted to EPA.

The Annual Return required to be submitted to the EPA under the EPL must comprise of:

1. a Statement of Compliance,
2. a Monitoring and Complaints Summary,
3. a Statement of Compliance - Licence Conditions,
4. a Statement of Compliance - Load based Fee,
5. a Statement of Compliance - Requirement to Prepare Pollution Incident Response Management Plan,
6. a Statement of Compliance - Requirement to Publish Pollution Monitoring Data; and
7. a Statement of Compliance - Environmental Management Systems and Practices.

In accordance with Condition 8.3 of the Development Consent, Teys Australia will submit an AEMR:

a) identify the standards and performance measures that apply to the project;

b) describe the works carried out in the last 12 months;

c) describe the works that will be carried out in the next 12 months;

d) include a summary of the complaints received during the past year, and compare this to the complaints received in previous years;

e) include a summary of the monitoring results for the project during the past year;

f) include an analysis of these monitoring results against the relevant:

- impact assessment criteria/limits;
- monitoring results from previous years; and
- predictions for the effluent system upgrade and other documents

g) listed in condition 1.2 of schedule 2;

h) identify and discuss all exceedances of approval and licence conditions and

i) other applicable standards and performance measures;

j) identify any trends in the monitoring results over the life of the project;

k) identify any non-compliance during the previous year; and

l) describe what actions were, or are being, taken to ensure compliance.

11. Consultation

During the preparation of this EWMP, the EPA and DPIE Water were consulted.

A phone discussion was held with EPA officers on the 4 August 2020 and 10 August 2020. Furthermore the EPA provided preliminary advice in a letter dated 10 August 2020 (see Appendix D). The EPA does not review Environmental Management Plans so this plan was not provided for review. The key comments from the EPA and how they were addressed is shown in Table 23.

Table 23 EPA consultation outcomes

Comments	Response
Odour has previously been an issue on the site and should be addressed in the plan	Odour control measures are outlined in Section 9.9
The management of effluent must also comply with the requirements of EPL No 2262, issued to Teys for activities carried out at the premises.	The conditions of the EPL have been identified in this plan and the management measures have been prepared to meet those requirements.
recommend the Effluent Wastewater Management Plan incorporate effluent re-use and irrigation best management practices and be prepared in accordance with the NSW EPA Guidelines	This plan has been prepared in accordance with the EPA Guidelines

If necessary, to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans and programs required under this consent must be revised, to the satisfaction of the Secretary. Where revisions are required, the revised document must be submitted to the Secretary for approval within six weeks of the review.

12. References

DEC Environmental Guidelines Use of Effluent by Irrigation, October 2004, DEC 2004/87 (The DEC in 2004 now DPIE)

National Water Quality Management Strategy, Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006

Aitken and Rowe Soil Monitoring Report 11 December 2009, Report No. S09-302

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Bureau of Meteorology (BOM) 2020, *Climate statistics for Australian locations: WAGGA WAGGA AMO 072150* , http://www.bom.gov.au/climate/averages/tables/cw_072150_All.shtml Accessed 4 August 2020

Charles Sturt University Laboratory Analysis Report Number 1008-0028

Colorado State University Fact Sheet no. 0.504 – Managing Sodic Soils
http://www.ext.colostate.edu/pubs/crops/00504.html

Hazelton P & Murphy B 2016, *Interpreting Soil Test Results: What do all the Numbers Mean?,* CSIRO Publishing

McCuen, Richard H., (1989) Hydrologic Analysis and Design, Prentice Hall Publishers, Englewood Cliffs, NJ, USA

M.E. Rogers, M. E., (1998) Salinity Effects on Irrigated Lucerne, presented at the 9th Australian Agronomy Conference, 20-23 July 1998, Charles Sturt University, Wagga Wagga, NSW and recorded in the Proceedings of the conference entitled "Agronomy, growing a greener future?" edited by DL Michalk and JE Pratley.

DPIE 2020 , espade: Soil Essentials report (Site Location Bowmin), https://www.environment.nsw.gov.au/espade2webapp/report/essentials/23150 Accessed 4 August 2020

Sorption of Phosphorus by Soils, how it is measured in Western Australia
http://www.agric.wa.gov.au/objtwr/imported_assets/content/lwe/land/fert/bulletin4591.pdf

WMA Water 2018, *Wagga Wagga Revised Murrumbidgee River Floodplain Risk Management Study and Plan*, Sydney

Irrigators Checklist

Appendix A

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Irrigation Operators Checklist

Operator:

Date: Time:

Record	
Meter Reading prior to start of irrigation	
Meter Reading after today's irrigation completed	
Cubic Metres Irrigated today (ZERO if no irrigation today)	
Soil Moisture Factors	
Yesterday's rainfall (mm)	
	* *If greater than 10mm, no irrigation today.*
Date of most recent rainfall event	
Rain in most recent rainfall event (mm)	
Runoff collection basins less than 30% full	
	* *If greater than 30% initiate full pump down prior to irrigating*
CFA High Soil Moisture Reading	
CFA Low Soil Moisture Reading	
Location 3 Soil Moisture Reading (if required)	
Location 4 Soil Moisture Reading (if required)	
	* *If soil moisture is above 25% for all readings, no irrigation.* * *If some factors conflicting, contact environmental manager.*
Wind Factors (weather station)	
Wind direction	
Wind strength (m/s)	
	* *If calm, irrigation can proceed subject to soil moisture* * *If the wind is strong (over 15km/h) maintain regular supervision* * *If spray drift out of the boundaries is observed or likely cease irrigation*
Weather forecast	
Is a heavy rainfall event forecast in the next 12 hours?	
IRRIGATION TODAY	YES/NO
	After irrigation starts the wind should be checked every hour
Comments	

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Groundwater Monitoring Results 2009-2011

Appendix B

Appendix B – CFA High Groundwater Monitoring Results

Table B-1 – CFA High Groundwater monitoring results from 2 October 2009

Constituent	P1	P2	P3	P5	Average
Conductivity (uS/cm)	2230	2760	8790	3200	**4245**
Nitrogen, total (mg/L)	107	164	34	61	**92**
Nitrate/Nitrite (mg/L)	105	164	34.2	51.8	**89**
pH	7.4	6.6	7.0	6.6	**6.9**
Total Kjeldahl Nitrogen (mg/L)	2	<2	<2	9	**3**
Ammonia (mg/L)	5.1	0.2	<0.2	0.7	**1.5**
BOD (mg/L)	<2	<2	<2	4	**2**
Calcium (mg/L)	45.2	81.9	77.8	86.3	**73**
Chloride (mg/L)	211	351	2410	739	**928**
Magnesium (mg/L)	89.3	48.6	121	48.6	**77**
Ortho-Phosphate (mg/L)	0.32	0.69	0.04	0.28	**0.33**
Phosphorus, Total (mg/L)	25.4	0.74	0.05	1.35	**6.9**
Potassium (mg/L)	11	24.9	24.2	4.4	**16**
Sodium Absorption Ratio (mg/L)	5	7	24	9	**11**
Sodium (dissolved) (mg/L)	239	324	1470	405	**610**
Total Dissolved Solids (mg/L)	1440	1940	5730	1970	**2770**

*Piezometer 4 was inaccessible on 2 October 2009 due to recent sludge applications
Reference: Aitken Rowe Testing Laboratories Report No. S09-303, dated 11 December 2009

Table B-2 – CFA High Groundwater monitoring results from 27 November 2009

Constituent	P1	P2	P2**	P3	P5
Conductivity (uS/cm)	2230	1940	1950	8720	3260
Nitrogen, total (mg/L)	95	66	65	38	49
Nitrate/Nitrite (mg/L)	93.4	65.6	64.6	38	49.4
pH	7.3	6.4	6.8	7.2	6.6
Total Kjeldahl Nitrogen (mg/L)	2	<2	<2	<2	<2

**A duplicate of Piezometer 2 was sampled on 27 November 2009
Reference: Aitken Rowe Testing Laboratories Report No. S09-374, dated 11 December 2009

Appendix B1 – CFA High Groundwater Monitoring Results

Table B-3 – CFA High Groundwater monitoring results from 26 September 2011					
Constituent	P1	P2	P3	P5	Average
Calcium (mg/L)	90.5	65	93.5	23.5	**68**
Chloride (mg/L)	203	225	1780	55	**566**
Conductivity (uS/cm)	2350	2240	8010	979	**3395**
Magnesium (mg/L)	110	39.8	134	12.4	**74**
Nitrate	87	104	36	32	**65**
Nitrogen Total	87	104	38	36	**66**
Ortho-Phosphate (mg/L)	NS	NS	NS	NS	
Phosphorus, Total (mg/L)	0.24	0.37	0.09	0.4	**0.28**
pH	7.5	7.0	7.1	6.6	**7.1**
Potassium (mg/L)	28.8	23.4	32.5	42	**32**
Sodium Absorption Ratio	4	9	31	4	**12**
Sodium (dissolved) (mg/L)	265	379	1990	94.1	**682**
Total Dissolved Solids (mg/L)	1570	1710	5010	680	**2243**
Total Kjeldahl Nitrogen (mg/L)	<2	<2	2	4	**2**

Appendix B2 – CFA Low Groundwater Monitoring Results

Table B-3 – CFA Low Groundwater monitoring results from 21 October 2011				
Constituent	P1	P2	P3	
Ammonia (mg/L)	0.2	NS	NS	
Calcium (mg/L)	74.5	NS	NS	
Chloride (mg/L)	779	NS	NS	
Conductivity (uS/cm)	4030	NS	NS	
Magnesium (mg/L)	87.2	NS	NS	
Nitrate	<2.5	NS	NS	
Nitrogen Total	95	NS	NS	
Ortho-Phosphate (mg/L)	0.01	NS	NS	
Phosphorus, Total (mg/L)	0.09	NS	NS	
pH	7.5	NS	NS	
Potassium (mg/L)	1.6	NS	NS	
Sodium Absorption Ratio	7	NS	NS	
Sodium (dissolved) (mg/L)	352	NS	NS	
Total Dissolved Solids (mg/L)	2340	NS	NS	
Total Kjeldahl Nitrogen (mg/L)	95	NS	NS	

P2 and P3 will be relocated and redrilled to depths where groundwater is present at the north and south ends of the CFA Low irrigation area

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Soil Monitoring Results 2009-2011

Appendix C

Appendix C1 – CFA High Soil Monitoring Results – Sampling on 2 October 2009

Soil Constituent	1A	1B	2A	3A	4A	4B	5A	6A	6B	6C	Avg. A	Avg. B/C
Calcium, exchangeable cmol/kg	1.72	1.67	2.28	1.6	0.82	3.05	2.71	3.54	4.82	5.42	2.11	3.74
Conductivity µS/cm	156	121	206	1265	85	183	212	277	243	267	367	204
Exchangable sodium Percentage	17.5	26.4	22.5	17.7	14.7	32.4	29.1	9.7	22.5	26	18.5	26.8
Magnesium Exchangable (cmol/kg)	0.59	1.48	1.04	0.77	0.37	4.46	1.04	1.5	1.94	2.95	0.89	2.71
Nitrate as N (mg/kg)	31	22	30	9.1	14	28	20	43	48	51	25	37
Nitrogen Total (mg/kg)	470	180	670	530	290	260	330	2900	570	360	865	343
Nitrate/nitrite as N (mg/kg)	31	22	30	9.1	14	28	20	43	48	51	25	37
Phosphorus Buffer Index (L/kg)	82	73.4	61.9	59.5	34.6	106	69.6	87.5	154	170	65.9	125.9
Extractable Phosphorus (Colwell) (mg/kg)	219	6	113	230	119	15	85	264	47	14	172	21
Phosphorus Total (mg/kg)	469	123	349	654	251	204	324	999	273	182	508	196
pH	6.7	7.7	6.4	5.9	6.2	8.3	8	5.7	7.1	7.1	6.5	7.6
Potassium , Exchangeable (cmol/kg)	0.36	0.25	0.59	0.38	0.14	0.57	0.56	1.08	0.63	0.53	0.52	0.50
Sodium, Exchangeable (cmol/kg)	0.56	1.22	1.14	0.59	0.23	3.88	1.77	0.66	2.15	3.13	0.83	2.60
Total Kjeldahl Nitrogen (mg/kg)	440	160	640	520	280	230	310	2900	520	310	848	305
Total Organic Carbon (mg/kg)	4300	840	7700	11000	3700	1200	3200	21000	5500	2000	8483	2385
Depth	0.3	1.2	0.3	0.3	0.3	1.2	0.3	0.3	0.7	1.2		

Reference: Aitken Rowe Testing Laboratories Report No S09-302 dated 11 December 2009

Appendix C1 – CFA High Soil Monitoring Results – Sampling on 30 Sept 2010

CFA High	1A	1B	2A	3A	4A	4B	5A	6A	6B	6C		Avg. A	Avg. B/C
Calcium, exchangeable cmol/kg	0.98	2.31	3.16	1.81	2.45	2.2	3.56	2.54	4.13	7.21		2.42	3.96
Conductivity µS/cm	56	170	62	80	97	214	127	116	158	280		90	206
Exchangable sodium Percentage	10.8%	22.0%	16.1%	20.3%	18.4%	28.3%	17.4%	21.2%	30.2%	21.1%		17.4%	25.4%
Magnesium Exchangable (cmol/kg)	0.026	1.62	1.1	0.51	1.05	2.18	1.45	1.08	1.29	2.66		0.87	1.94
Nitrate as N (mg/kg)	8	36	2	2	9	56	7	11	25	53		6.5	43
Nitrogen Total (mg/kg)	310	294	299	327	756	171	555	570	453	413		470	333
Nitrate/nitrite as N (mg/kg)													
Phosphorus Buffer Index (L/kg)	22.6	66.4	36.3	17.3	30.4	17	37.3	14	34.9	63.6		26.3	45.5
Extractable Phos. (Colwell) (mg/kg)	128	42	63	83	136	18	114	134	77	51		109.7	47
Phosphorus Total (mg/kg)	216	123	183	189	268	63	227	274	190	153		226.2	132
pH	6.7	6.8	7.8	7.4	7.4	7.6	7.6	7.5	7.6	7.4		7.4	7.35
Potassium , Exchangeable (cmol/kg)	0.62	0.78	0.85	0.63	0.94	0.47	1.12	1.24	0.97	1.04		0.90	0.82
Sodium, Exchangeable (cmol/kg)	0.22	1.33	0.98	0.75	1.00	1.92	1.3	1.31	2.77	2.91		0.93	2.23
Total Kjeldahl Nitrogen (mg/kg)	302	258	297	325	747	115	548	559	428	360		463	290
Total Organic Carbon (mg/kg)	3200	1200	2300	2300	6600	700	4200	4800	2800	2000		3900	1675
Depth	0.3	1.2	0.3	0.3	0.3	1.2	0.3	0.3	0.7	1.2		0.3	0.7-1.2
Ca, Mg, K, Na	1.846	6.04	6.09	3.7	5.44	6.77	7.43	6.17	9.16	13.82		5.11	8.95
Na/cations	11.9%	22.0%	16.1%	20.3%	18.4%	28.4%	17.5%	21.2%	30.2%	21.1%		17.6%	25.4%
Sodium Adsorption ratio	0.31	0.95	0.67	0.70	0.76	1.30	0.82	0.97	1.68	1.31		0.70	1.31

Reference: Aitken Rowe Environmental Consultancy Report No S10-333 dated 5 December 2010

Appendix C1 – CFA High Soil Monitoring Results – Sampling on 26 Sept 2011

CFA High Sept 2011	1A	1B	2A	3A	4A	4B	5A	6A	6B	6C		Avg. A	Avg. B/C
Calcium, exchangeable cmol/kg	1.38	2.5	2.12	1.9	1.97	5.21	3.39	3.32	1.56	4.37		2.35	3.41
Conductivity µS/cm	53	341	184	155	88	63	112	78	44	72		112	130
Exchangable sodium Percentage	10.30%	26.10%	23%	17.10%	11.90%	17.40%	9.60%	7.40%	4.70%	15.80%		0.1	0.2
Magnesium Exchangable (cmol/kg)	0.51	1.5	2.27	1.37	1.2	5.42	1.63	1.6	0.52	1.9		1.43	2.34
Nitrate as N (mg/kg)	4	41	14	10	5	5	17	6	5	5		9	14
Nitrogen Total (mg/kg)	800	314	302	485	423	323	763	896	212	294		612	286
Nitrate/nitrite as N (mg/kg)													
Phosphorus Buffer Index (L/kg)	26	35	16	19	19	26	22	23	8	24		20.8	23.3
Extractable Phos. (Colwell) (mg/kg)	227	31	41	106	101	109	145	160	152	42		130	84
Phosphorus Total (mg/kg)	550	155	303	395	321	274	384	468	458	164		404	263
pH	6.6	6.3	7.1	7.1	7.4	8.1	6.6	7	6.9	7.7		7.0	7.3
Potassium , Exchangeable (cmol/kg)	0.52	0.57	0.38	0.48	0.47	0.92	0.76	0.9	0.52	0.94		0.59	0.74
Sodium, Exchangeable (cmol/kg)	0.28	1.61	1.43	0.77	0.49	2.44	0.62	0.46	0.13	1.35		0.68	1.38
Total Kjeldahl Nitrogen (mg/kg)	796	273	288	475	418	318	746	890	207	289		602	272
Total Organic Carbon (mg/kg)	9500	900	1600	3800	2400	1200	4600	6000	3000	1300		4650	1600
Depth	0.3	1.2	0.3	0.3	0.3	1.2	0.3	0.3	0.7	1.2		0.3	0.7-1.2
Ca, Mg, K, Na	2.69	6.18	6.2	4.52	4.13	13.99	6.4	6.28	2.73	8.56		5.04	7.87
Na/cations	10.4%	26.1%	23.1%	17.0%	11.9%	17.4%	9.7%	7.3%	4.8%	15.8%		13.2%	16.0%
Sodium Adsorption ratio	0.29	1.14	0.97	0.60	0.39	1.06	0.39	0.29	0.13	0.76		0.49	0.77

Reference: Aitken Rowe Environmental Consultancy Report No S11-353 dated 28 October 2011

Appendix C3 – CFA Low Soil Monitoring Results – Sampling on 1 April 2010

	1A	1B	2A	3A	3B	4A	5A	5B	5C	Avg. A	Avg. B/C
Calcium, exchangeable cmol/kg	9.28	21.3	8.6	7.64	8.86	8.23	6.26	8.22	4.68	8.00	8.71
Conductivity µS/cm	186	994	250	206	1120	227	213	176	221	216	584
Magnesium Exchangable (cmol/kg)	6.54	13.6	6.74	7.36	12.2	7.5	7.9	10	12	7.2	9.5
Nitrate as N (mg/kg)	23	17	6	<1	<1	<1	<1	<1	<1	6	4
Nitrogen Total (mg/kg)	939	356	1250	848	322	827	977	416	226	968	226
Nitrate/nitrite as N (mg/kg)										0	0
Phosphorus Buffer Index (L/kg)	75.2	57.4	85.2	64.3	60.5	57.5	60.9	50.9	49.7	69	42
Extractable Phosphorus (Colwell) (mg/kg)	117	29.5	159	40.8	40.1	50.7	28.9	20.3	32.2	79	25
Phosphorus Total (mg/kg)	390	317	561	242	234	236	126	122	144	311	174
pH	7.6	9.3	7.7	8	9.4	8.4	7.7	9.1	9.5	7.9	7.1
Potassium , Exchangeable (cmol/kg)	0.59	0.53	0.51	0.47	0.49	0.33	0.34	0.5	0.56	0.45	0.40
Sodium, Exchangeable (cmol/kg)	3.59	9.3	4.17	3.27	11.1	4.6	3.66	8.34	10.7	3.86	7.78
Total Kjeldahl Nitrogen (mg/kg)	916	339	1240	848	322	827	977	416	226	962	222
Total Organic Carbon (mg/kg)	16000	7400	15000	9300	6500	11000	9700	6500	6700	12200	5150
Depth	0.3	1.2	0.3	0.3	1.2	0.3	0.3	0.7	1.2		
Ca, Mg, K, Na	20	44.73	20.02	18.74	32.65	20.66	18.16	27.06	27.94	22.77	23.33
Na/cations	18.0%	20.8%	20.8%	17.4%	34.0%	22.3%	20.2%	30.8%	38.3%	23.5%	20.3%
Sodium Adsorption ratio	1.28	2.23	1.51	1.19	3.42	1.64	1.38	2.76	3.71	1.40	3.03

Reference: Aitken Rowe Testing Laboratories Report No S10-100 dated 3 May 2010

Appendix C2 – CFA Low Soil Monitoring Results – Sampling on 27 September 2011

CFA LOW-27 Sept 2011	1A	1B	2A	3A	4A	4B	5A	6A	6B	6C		Avg. A	Avg. B/C
Calcium, exchangeable cmol/kg	7.59	12.4	8.76	6.93	8.2	5.86	8.64	9.86	9.02	6.81		8.33	8.52
Conductivity µS/cm	150	1600	123	55	232	963	313	318	582	751		199	974
Exchangable sodium Percentage	25.6%	48.6%	20.7%	21.8%	24.0%	51.5%	23.7%	25.7%	38.80%	45.70%		23.6%	46.2%
Magnesium Exchangable (cmol/kg)	6.53	11.7	8.1	6.2	6.27	11.6	7.7	9.32	9.69	10.2		7.4	10.8
Nitrate as N (mg/kg)	7	6	6	5	5	4	7	5	4	4		6	5
Nitrogen Total (mg/kg)	1230	314	1410	1190	883	354	1230	1340	526	309		1214	376
Nitrate/nitrite as N (mg/kg)													
Phosphorus Buffer Index (L/kg)	33	48	37	31	21	4	39	37	15	20		33	22
Extractable Phos (Colwell) (mg/kg)	100	41	59	61	35	34	111	66	26	27		72	32
Phosphorus Total (mg/kg)	531	380	435	389	294	302	459	363	223	221		412	282
pH	7.1	8.9	6.7	7.1	7.3	8.7	6.8	6.7	8.6	8.9		7.0	8.8
Potassium , Exchangeable (cmol/kg)	0.51	0.57	0.58	0.46	0.31	0.53	0.56	0.57	0.52	0.54		0.50	0.54
Sodium, Exchangeable (cmol/kg)	5.02	23.4	4.55	3.79	4.67	19.2	5.26	6.84	12.2	14.8		5.02	17.40
Total Kjeldahl Nitrogen (mg/kg)	1220	308	1400	1190	878	350	1220	1330	522	305		1206	371
Total Organic Carbon (mg/kg)	14000	4600	15000	11000	9300	5700	10000	12000	5900	4500		11883	5175
Depth	0.3	1.2	0.3	0.3	0.3	1.2	0.3	0.3	0.7	1.2		0.3	0.7-1.2
Ca, Mg, K, Na	19.65	48.07	21.99	17.38	19.45	37.19	22.16	26.59	31.43	32.35		21.20	37.26
Na/cations	25.5%	48.7%	20.7%	21.8%	24.0%	51.6%	23.7%	25.7%	38.8%	45.7%		23.6%	46.2%
Sodium Adsorption ratio	1.89	6.74	1.57	1.48	1.74	6.50	1.84	2.21	3.99	5.07		1.79	3.67

Reference: Aitken Rowe Environmental Consultancy Report No S11-357 dated 28 October 2011

pitt&sherry

EPA Letter

Appendix D

DOC20/604041-1

The Principal Environmental Consultant
Pitt & Sherry (Operations) Pty Ltd
33 Fitzmaurice Street
WAGGA WAGGA NSW 2650

By email: abishop@pittsh.com.au

Dear Mr Bishop

Re Teys Australia Beef Abattoir – Revision of Effluent Wastewater Management Plan

I refer to your letter dated 27 July 2020 to the Environment Protection Authority (EPA) seeking preliminary advice about the content of the Effluent Wastewater Management Plan, being prepared for Teys Australia Southern Property Pty Ltd (Teys) for their premises located at Dampier Street, Wagga Wagga.

The EPA encourages the development of Environmental Management Plans to ensure that licensees have determined how they will meet their statutory obligations and environmental objectives as specified by any Project Approval and their Environment Protection Licence (EPL).

As discussed with you on 10 August 2020, we recommend the Effluent Wastewater Management Plan incorporate effluent re-use and irrigation best management practices and be prepared in accordance with the NSW EPA Guidelines: '*Use of Effluent by Irrigation*' (DEC 2004). A copy of these guidelines is available at https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/epa/effguide.pdf.

Please note, the management of effluent must also comply with the requirements of EPL No 2262, issued to Teys for activities carried out at the premises.

We note your intent to send a draft version of the management plan to us for review. Please note, the EPA does not review Environmental Management Plans as the role of the EPA is to set conditions and criteria for environmental protection and management, not to be directly involved in the development of strategies to comply with such conditions and criteria.

If you have any further enquiries about this matter please contact Nick van Lijf by telephoning 02 6969 0700 or by electronic mail at riverina.farwest@epa.nsw.gov.au.

Yours sincerely

10 August 2020

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Effluent Wastewater Management Plan

Contact

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