VISY PULP & PAPER TUMUT NSW

FARM AND ENVIRONMENTAL MONITORING REPORT

2022/2023

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1.0 Introduction

DM McMahon Pty Ltd have prepared this report on behalf of Visy Pulp & Paper Pty Ltd (Visy). The report presents a summary and analysis of environmental monitoring conducted at Gadara Park. Gadara Park is an approximately 2,124-hectare farm that surrounds the Visy mill. The Visy mill footprint on the farm is approximately 60 hectares.

The environmental monitoring program is conducted as specified in the Visy mill's Site Development Application, and in line with the Visy mill's NSW Environment Protection Authority (EPA) Environmental Protection Licence.

Gadara Park is an established cattle and sheep enterprise focused on prime beef and lamb production. Visy have a grazing rights agreement with JR Farming and Management Solutions, who presently run approximately 1,000 head of cattle and approximately 5,000 ewes and lambs. Gadara Park utilises the treated wastewater from the mill to irrigate 110 hectares using five centre pivot irrigators and a soft hose travelling irrigator. The irrigation areas produce hay, silage and fodder crops that are fed to the cattle and lambs, as part of Gadara Park's commercial prime beef and lamb production enterprise. Mill by-products have also been used as soil ameliorants in previous years for improved agricultural production as part of a Soil Amendment Trial.

The monitoring assesses the potential impacts of plant, farm, and irrigation operations on the environment. This report was commissioned by Visy as part of their annual Compliance and Monitoring report.

Limits for water quality have been drawn from the Visy EPA Licence No. 10232. Where no limit has been given in the licence, the Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality (2018) or other relevant guidelines have been used.

Various sources have been used for establishing desirable ranges for soil analysis. The sources are mainly from published CSIRO and NSW Agriculture literature. Due to the wide range of test parameters, a single source could not be found that covered all analyses.

This report is a collation and interpretation of all monitoring activities and provides an annual summary of mill and farm activities.

2.0 Monitoring program 2022/23

Since November 2003, DM McMahon Pty Ltd has conducted monitoring at Gadara Park as specified in the Visy EPA Licence No. 10232. This includes, but is not limited to, groundwater, surface waters, irrigation water, sludge, and soils.

The monitoring program includes:

Groundwater
Quarterly groundwater level monitoring
Quarterly groundwater sampling and analysis

Surface water
Monthly surface water sampling and analysis (during irrigation season)

Wastewater and sludge
Wastewater sampling and analysis six times per year
Monthly sludge sampling and monitoring

Soil under irrigation
Biannual soil sampling and analysis
Nutrient balance and forward management plan

By-product application
Monthly sampling and analysis
Ongoing beneficial re-use assessment

Farm assessment
Farm agronomy
Crop planning for irrigation
Pasture improvement
Soil analysis
Nutrient budgeting

The following Table 1 shows the monitoring schedule of 2022/23 including sampling activity and frequency. Monitoring of sludge from the wastewater treatment plant, wastewater from the decant line, and mill by-products is undertaken monthly, while activities such as surface water testing are undertaken during the summer irrigation season. Groundwater sampling and analysis is undertaken quarterly. Soil sampling is undertaken biannually to coincide with the start of the winter and summer cropping programs. Soil sampling is used as a farm management tool as well as for environmental monitoring.

Table 1: *Monitoring program for all waters, soils, by-products and pasture at Gadara Park 2022/23*

Date	Activity
JULY 2022	
5.7.2022	By-products
5.7.2022	Storm waters
5.7.2022	WWTP-sludge from SBT
13.7.2022	Groundwater quality
AUGUST 2022	
2.8.2022	By-products
2.8.2022	Storm waters
2.8.2022	WWTP-Sludge from SBT
2.8.2022	Decant Point 10
SEPTEMBER 2022	
2.9.2022	By-products
2.9.2022	Storm waters
2.9.2022	WWTP-sludge from SBT
2.9.2022	Decant Point 10
OCTOBER 2022	
5.10.2022	By-products
5.10.2022	Storm waters
5.10.2022	WWTP sludge from SBT
12.10.2022	Soil monitoring sites
20.10.2022	Groundwater quality
20.10.2022	Surface waters
NOVEMBER 2022	
2.11.2022	By-products
2.11.2022	Storm waters
2.11.2022	WWTP-sludge from SBT
2.11.2022	Surface waters
2.11.2022	Decant Point 10
DECEMBER 2022	
5.12.2022	By-products
5.12.2022	Storm waters
5.12.2022	WWTP-sludge from SBT
5.12.2022	Surface waters
JANUARY 2023	
9.1.2023	Groundwater quality
9.1.2023	Surface waters
10.1.2023	By-products
10.1.2023	Storm waters
10.1.2023	WWTP-sludge from SBT
FEBRUARY 2023	
2.2.2023	By-products
2.2.2023	Storm waters
2.2.2023	WWTP sludge from SBT
2.2.2023	Surface waters
2.2.2023	Decant Point 10
MARCH 2023	
2.3.2023	By-products
2.3.2023	Storm waters
2.3.2023	WWTP sludge from SBT
2.3.2023	Surface waters

APRIL 2023	
5.4.2023	By-products
5.4.2023	Storm waters
5.4.2023	WWTP sludge from SBT
5.4.2023	Decant Point 10
5.4.2023	Surface waters
6.4.2023	Groundwater quality
11.4.2023	Soil monitoring sites
MAY 2023	
1.5.2023	By products
1.5.2023	Storm waters
1.5.2023	WWTP sludge from SBT
1.5.2023	Surface waters
JUNE 2023	
1.6.2023	By products
1.6.2023	Storm waters
1.6.2023	WWTP sludge from SBT
1.6.2023	Decant Point 10

2.1 Monitoring suites

Table 2 shows the parameters that are tested for each monitoring activity. The parameters tested in the monitoring suites are dictated by the Environment Protection Licence No. 10232, although some additional monitoring is undertaken to aid farm management. Soil monitoring, for example, has additional nutrient analysis conducted to assist in nutrient budgeting for the cropping program. From the additional testing, nutrient budgets are calculated and reviewed every season to ensure maximum sustainable crop production.

A glossary with all abbreviations of chemical parameters can be seen in Sections 16 and 17.

Table 2: *Suite details – Testing suites for sampling schedule*

Monitoring activity	Frequency	Parameters
By-product monitoring	Monthly	As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, Na, Bo, EC, Mo, pH, Se & moisture
Soil monitoring environmental	Annually	AS, Al, P (Available) EC, Ex Al, Ex Ca Ex Mg, Ex K, Ex Na, Nitrate, N (Total), OC, pH, PBI
Soil monitoring agriculture	Biannually	P(Bray), PBI, Ammonia, Ca, Mg, Na, K, Al, S, Cl, Boron
Hay / silage	As required	ME, Moisture, DM, CP, NDF, DMD, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn
Groundwater monitoring	Quarterly	Depth, pH
Groundwater monitoring	Biannually	Depth, pH, EC, Nitrate
Decant Point 10	Six times per year	BOD, N, O & G, pH, P (Total) SAR, TDS, TSS, Zn
Sludge monitoring	Monthly during application	Mn, TSS, BOD, SAR, N (Total), P (Total), TDS, pH, EC, Cl, O & G
Surface water monitoring	Monthly during application	pH, TDS. BOD, TSS, Zn, P (Total), N (Total), Mn, EC, FC, O & G

3.0 Seasonal conditions 2022/23

Rainfall, temperature, and precipitation data was obtained through SILO (QLD Govt., 2023) with the data being interpolated from a point on the subject site. The SILO database has information on temperature, rainfall, and evaporation date from 1889 to the current day. The seasonal conditions compared to the long-term averages from 1889 can be seen in Figures 1 to 4.

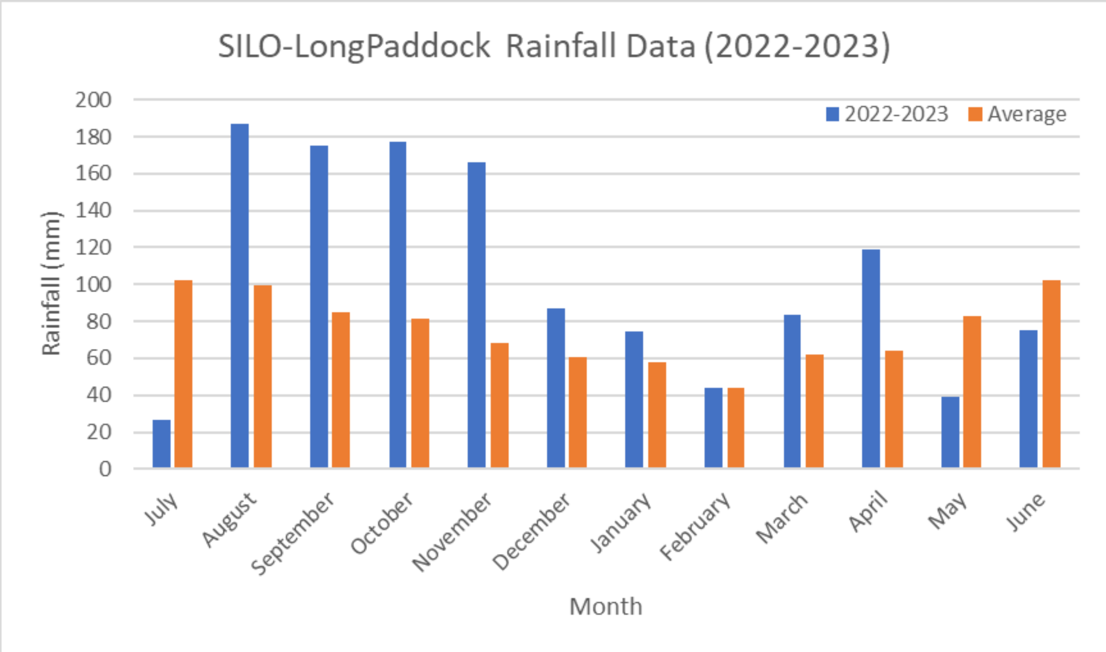


Figure 1: *Monthly rainfall 2022 to 2023 compared to long term average.*

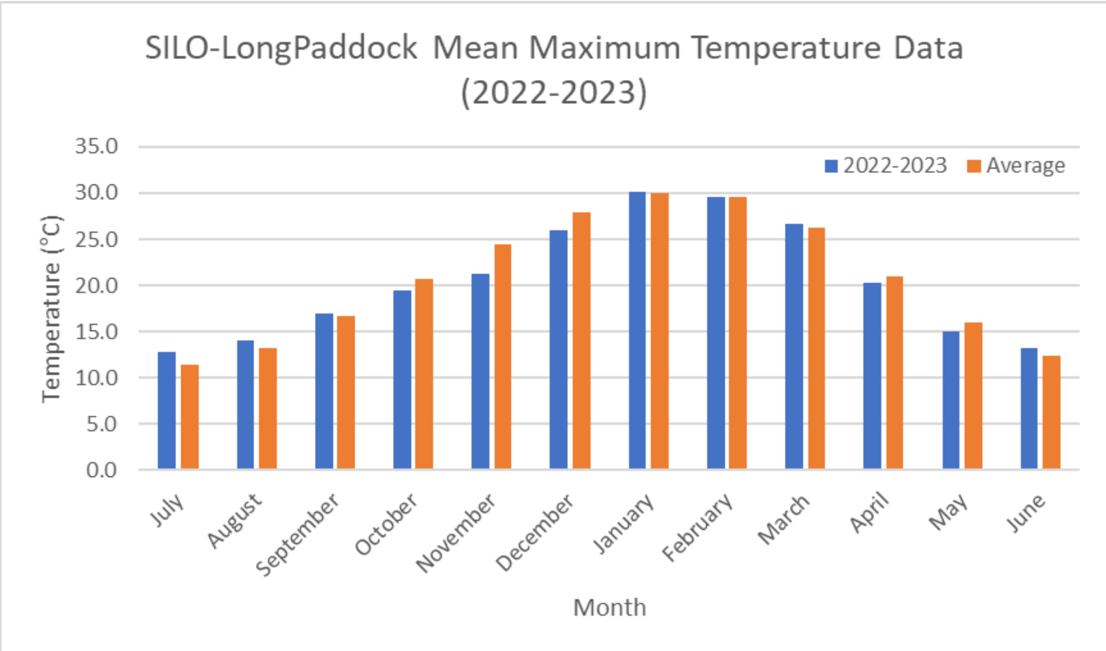


Figure 2: *Monthly maximum temperatures 2022 to 2023 compared to long term average.*

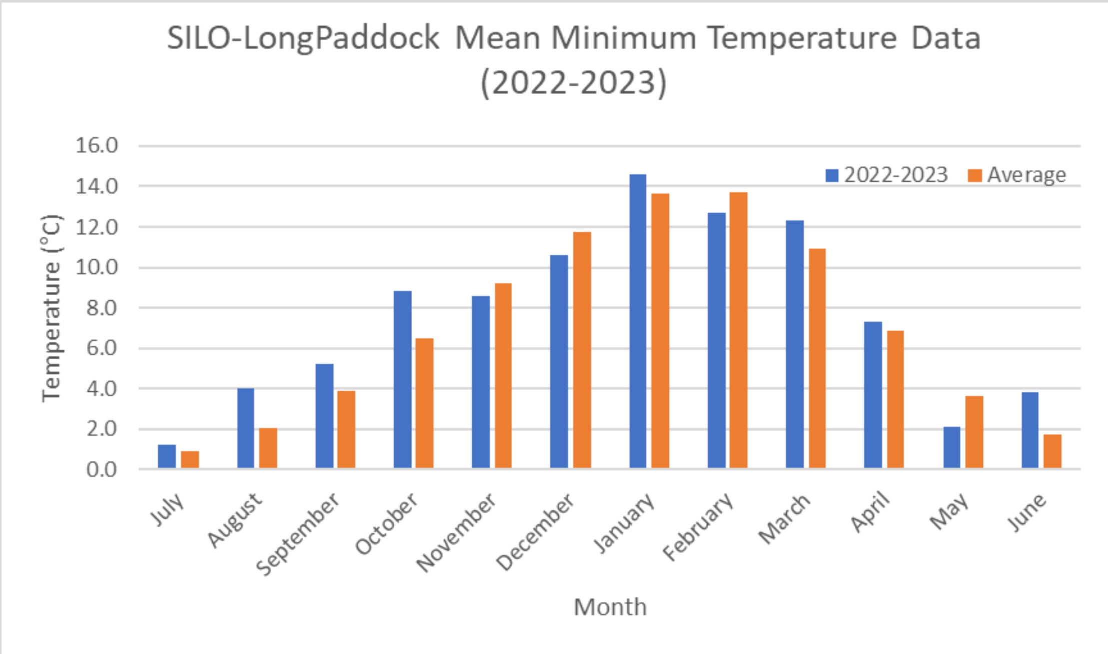


Figure 3: *Monthly minimum temperatures 2022 to 2023 compared to long term average.*

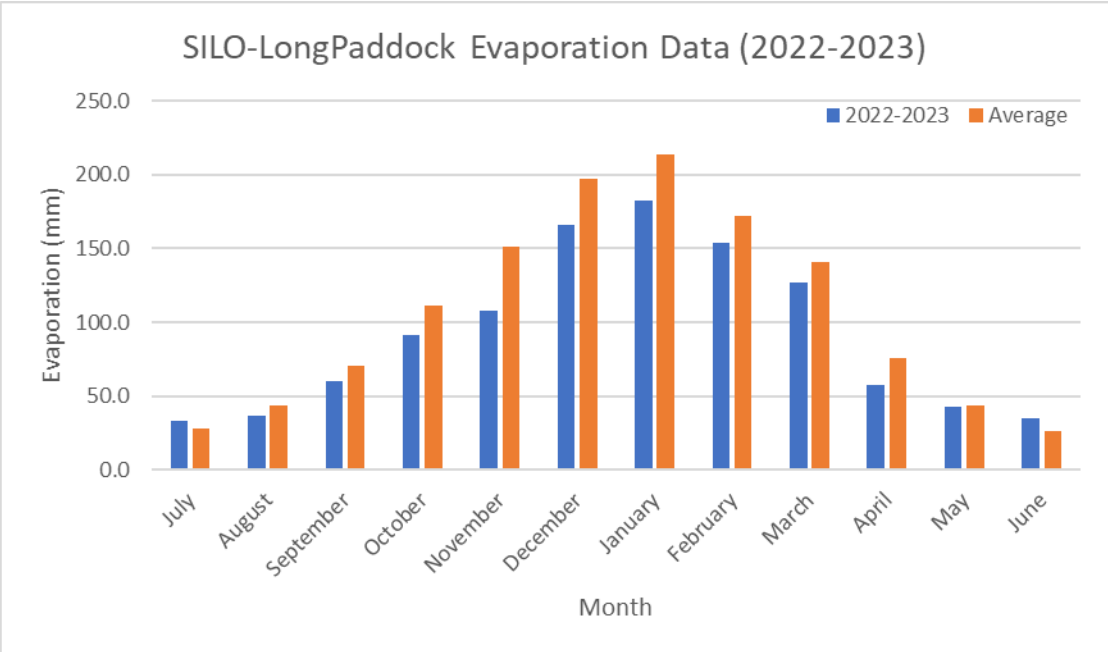


Figure 4: *Monthly evaporation 2022 to 2023 compared to long term average.*

Total rainfall for 2022/23 was 1254.9mm which is higher than the annual average of 909.8mm. Monthly rainfall was above the average except for July, February, May, and June.

Maximum temperatures in 2022/23 were similar to the average while minimum temperatures were variable.

Evaporation in 2022/23 was generally lower than average.

4.0 Groundwater assessment

4.1 Groundwater bores introduction

At Gadara Park, 18 groundwater bores are monitored as specified in the EPA Licence conditions. Depth to piezometric surface and groundwater quality are monitored to ascertain if the mill and irrigation operations have any impact on local groundwater conditions.

Chemical analysis is carried out on a quarterly basis with the following parameters tested:

- Depth and pH (quarterly).
- Electrical conductivity (EC) and nitrate (every 6 months).

Depth to piezometric surface is assessed manually each quarter, with a water level indicator and tape measure. Automated depth monitoring has been installed in two bores as an ongoing improvement to the monitoring program.

The monitoring bores are classified in three main groups used for comparing quality:

- Bores BH1, BH2, BH3, BH4, BH7S, BH7D, BH11S and BH11D are background monitoring bores, and are located upstream of irrigation and mill activities.
- Bores BH8S, BH8D, BH9, BH10, BH15S and BH15D are located downstream and in areas of irrigation and potentially impacting activities.
- Bores BH13, BH14, BH16, and BH17 are located immediately below the winter storage to assess any impacts of the dam on shallow groundwater.

Thirty new groundwater monitoring bores were installed in 2005/06 to gain a better understanding of the groundwater characteristics upstream of, and within the irrigation area. The piezometric surface depth of the new bores in the irrigation and winter storage area is monitored quarterly in conjunction with the existing 18 bores but most of these bores were destroyed in 2022/2023 when the pivots and paddocks were cultivated.

- Bores BH27S, BH27D, BH28S and BH28D are located on either side of the winter storage to assess any impacts of the dam on shallow groundwater.
- Bores BH21S, BH21D, BH22S, BH22D, BH23S, BH23D, BH24S, BH24D, BH25S, BH25D, BH26S and BH26D are located within the irrigation area.
- Bores BH29S, BH29D, BH30S, BH30D, BH31S, BH31D, BH32S, BH32D, BH33S, BH33D, BH34S, BH34D, BH35S and BH35D are located upstream of the irrigation and mill activities and are classified as background bores.

The following map, Figure 5 shows the location of all the monitoring bores. At some sites, shallow (S) and deep (D) bores are located alongside each other. These have been represented as a single monitoring bore site in Figure 5.

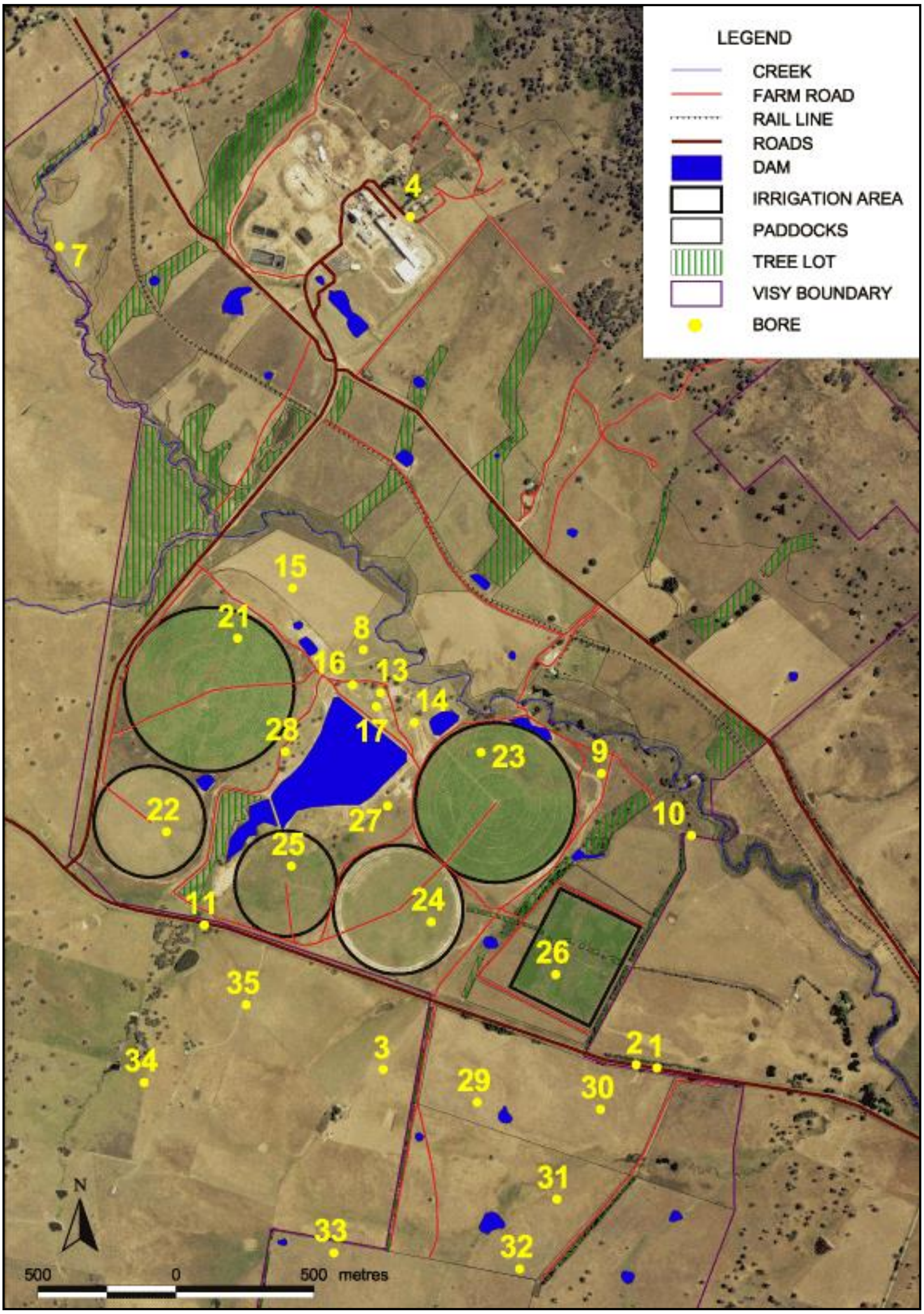


Figure 5: *Bore locations around Gadara Park and the Visy mill.*

4.2 Background bores monitoring

Bores: BH1, BH2, BH3, BH4, BH7S, BH7D, BH11S and BH11D

Bores BH1, BH2, BH3 and BH4 are large diameter bores (75mm to 100mm casing), ranging in depth from 10m to 30m. Bores BH1, BH2 and BH3 are located on the southern boundary of the farm and are higher in elevation compared to the irrigation area. Bore BH4 was located north of the mill site and is higher in elevation than all irrigation and mill activities. It was the deepest bore (30m) and had the highest elevation. In December 2007, Bore BH4 was destroyed during the mill expansion construction process and has not been replaced.

Bores BH7S and BH7D are located on the western margin of the Gadara Park property before the junction of Sandy Creek and Deep Creek. These bores are upstream of all mill and irrigation activities. Bores BH7S and BH7D have respective depths of approximately 7m and 14m.

Bores BH11S and BH11D are located on the Snowy Mountains Highway, at the southern boundary of Gadara Park and upstream of all irrigation and farm activities. These bores have respective depths of approximately 6m and 13m.

4.2.1. Chemical analysis

All results are provided in Attachment A.

pH

All background bores are slightly acidic to slightly alkaline (5.8 – 8.1) with most sitting within the neutral range. Overall, groundwater pH has been variable since monitoring commenced. Since 2013 however, pH is becoming more neutral and stable with a gradual increase noted over time in BH1, BH2 and BH3. When compared to the 2021/22 monitoring period, pH has remained stable.

Electrical Conductivity

EC ranged from 124µS/cm (BH3, July 2022) to 839µS/cm (BH11S, Jul 2022, Jan 2023). EC values have remained relatively stable with a slightly decreasing trend noted since 2001.

Nitrate

Background bores generally exhibited low and stable levels of nitrate. Levels encountered in these bores are classed as low strength for agricultural use, compared against the Australian & New Zealand Guidelines for Fresh & Marine Water Quality (2018) critical values. Nitrate levels were highest at BH2 (4ppm in July 2022) which is typical for this monitoring bore.

4.3 Irrigation bores monitoring

Bores: BH8S, BH8D, BH9, BH10, BH15S and BH15D

BH8S and BH8D are located to the north-east (down-slope) of the western irrigation area slightly above the creek flats. They are 6m and 10m deep respectively.

BH9 is located to the north-east (down-slope) of the eastern irrigation area and Centre Pivot 3. BH9 is 16m deep.

BH10 is located on the eastern edge of the farm, and of all the bores is the furthest downstream of all irrigation activities. BH10 is 14m deep.

BH15S and BH15D are located to the north of Centre Pivot 1 on the creek flats. They are 6m and 17.5m deep respectively.

4.3.1. Chemical analysis

pH

All irrigation bores were typically slightly acidic to neutral across all bores (6.1 – 7.4). The irrigation bores have remained relatively stable since monitoring began.

Electrical Conductivity

EC ranged from 253µS/cm (BH9, July 2022) to 715µS/cm (BH10, July 2022). EC in the irrigation bores has remained relatively stable since monitoring began in 2001. There were no major fluctuations of EC for these bores between July 2022 and January 2023.

Nitrate

Nitrate levels in the irrigation bores are variable ranging from <1mg/L (BH15S July 2022) to 10mg/L (BH9, BH10 & BH15D) which is consistent with the 2021/22 monitoring for these bores. Nitrate levels at BH8S and BH8D have been declining gradually since 2004 but have remained relatively stable for the last two monitoring periods.

4.4 Winter storage bores monitoring

Bores: BH13, BH14, BH16 and BH17

All bores are located to the immediate north of the winter storage dam wall. They are all shallow bores, ranging in depth from 3m to 7.5m. These bores are all shallow in depth compared to the background and irrigation monitoring bores and are measuring shallow aquifers or moisture in colluvial layers only.

4.4.1 Chemical analysis

pH

Winter storage bores were typically neutral to alkaline (6.8 – 8.9) which is typical compared to historical data.

Electrical Conductivity

EC in the winter storage bores ranged from 780µS/cm (BH14, July 2022) to 1630µS/cm (BH16, July 2022). Compared to the 2020/21 & 2021/22 monitoring periods, BH16 has decreased to levels similar to 2017/18, with all other winter bores having remained relatively stable.

Nitrate
Nitrate values were either <1mg/L or 1mg/L. All winter storage bores exhibited low to very low levels of nitrate which is a continuing trend over the last five years.

4.5 Groundwater depth monitoring

Groundwater piezometric depth monitoring takes place on a quarterly basis. All depths are measured from the top of the bore casing which ranges from 200mm to 1000mm above ground level.

Monitoring commenced with the installation of four bores in 1997 and a further 14 bores followed in 2001 to coincide with the commencement of mill operations. In 2006, 30 new groundwater monitoring bores were installed to gain a better understanding of the groundwater characteristics up-gradient of, and within the irrigation area. Historically the background, winter storage and irrigation bores all exhibit similar trends, consistent with peaks and troughs that coincide with recharge from winter and spring rainfall.

Background, irrigation, and winter storage bore groundwater piezometric depths had progressively declined between 2017 and 2020, falling to the levels comparable to the 2008/09 period which experienced the lowest levels historically recorded. Above average monthly rainfall from July 2021 to January 2022, and again from August 2022 to January 2023 led to increases in groundwater depths, indicating that groundwater recharge through rainfall is taking place. Subsequent low rainfall between January 2023 and April 2023 led to all monitoring bores slightly declining in groundwater depth during this period, apart from BH11D, BH13 and BH15D.

A graphical view of groundwater depths from during the 2022/23 monitoring period is provided in Figures 6, 7 and 8.

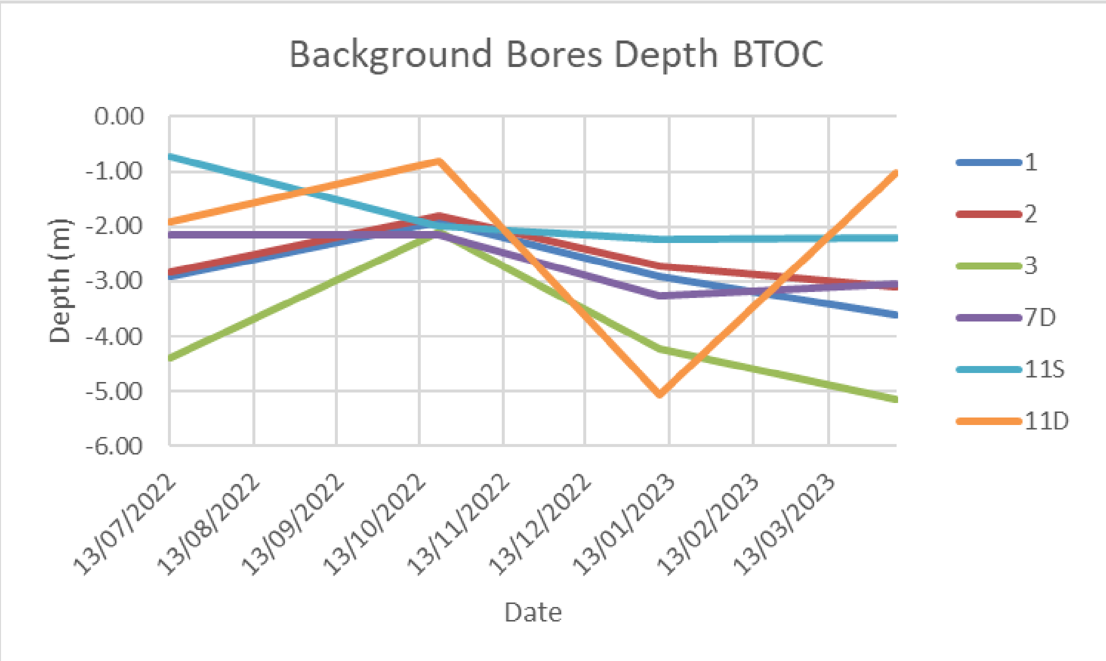


Figure 6: *Depth of background (non-irrigation) bores at Gadara Park in metres below top of casing (BTOC)*

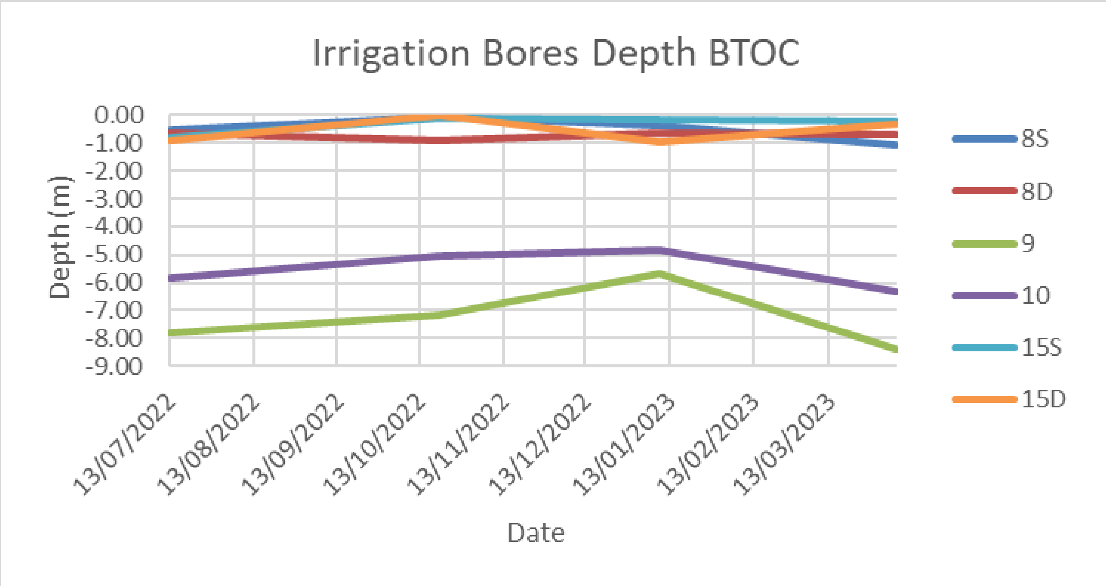


Figure 7: *Depth of irrigation bores at Gadara Park in meters below top of casing (BTOC)*

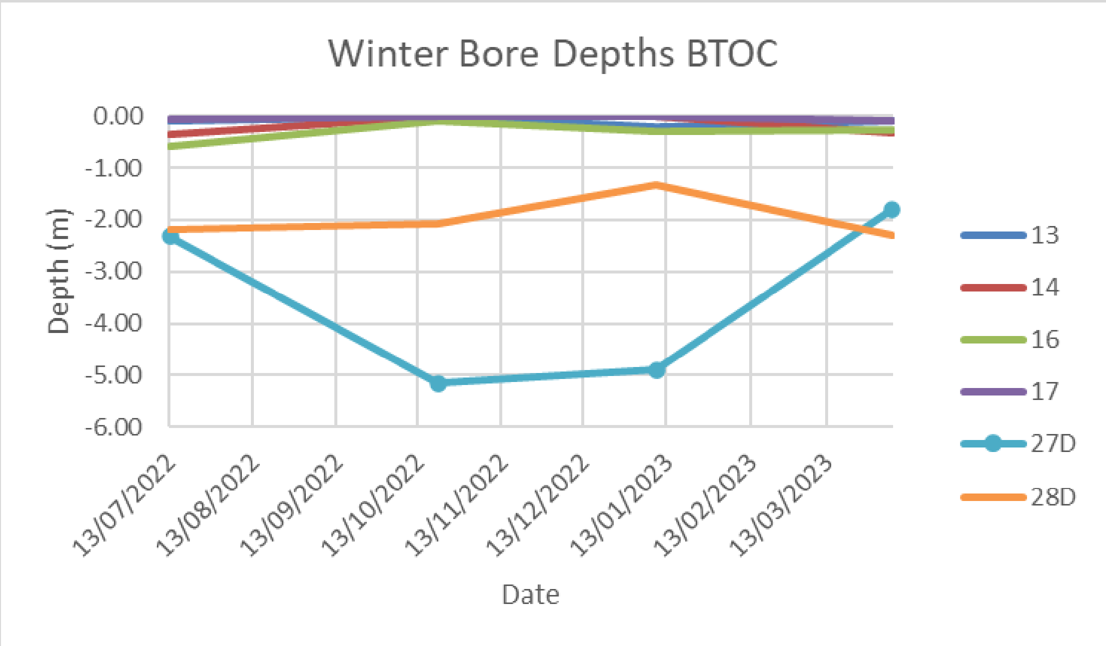


Figure 8: *Depth of winter storage bores at Gadara Park in meters below top of casing (BTOC)***)**

4.6 Groundwater conclusions

The groundwater piezometric levels in 2022/23 mostly increased from the depths monitored in the 2021/22 period, trending generally higher levels at almost all bore sites. Historically, the groundwater piezometric levels are quite dynamic with a peak in October to December following recharge from winter and spring rains. Above average rainfall for the six months following July of the 2022/23 monitoring period saw this trend continue with most bores experiencing peak levels in October 2022. The shallow alluvial aquifers at Gadara Park rely heavily on recharge from rainfall to maintain a constant level. The cyclic trend of groundwater piezometric levels corresponding with rainfall as explained by Coffey is apparent from the historical monitoring data (Coffey, 2003).

Background bores exhibit low levels of EC and nitrate.

The irrigation bores exhibit elevated levels of nitrate compared to the background and winter storage bores. The irrigation bores exhibit steady levels of EC typical of alluvial aquifers. The levels of EC in the irrigation bores are slightly higher than in the background bores as a historical comparison. This same comparative trend was noted by Coffey (Coffey, 2003).

Winter storage bores exhibit elevated levels of pH and EC compared to the background and irrigation bores, especially in bores 16 and 17. Levels have remained relatively stable since 2003, with some minor seasonal fluctuations consistent with the background and irrigation monitoring bores.

Overall, the bores have remained relatively stable (with some seasonal fluctuations) in piezometric depth and chemical composition since monitoring commenced, pre-mill construction.

5.0 Surface water assessment

5.1 Surface water monitoring sites

The surface water monitoring sites are outlined in the following map of the Visy mill and Gadara Park farm site, Figure 9. Three of the monitoring sites are upstream (SW1, SW3 and SW4) of all mill and irrigation activities and the other two sites are downstream (SW2 and SW5).

The monitoring results from sites upstream of the mill are compared against downstream results to determine if the mill and irrigation activities are having an effect on water quality.

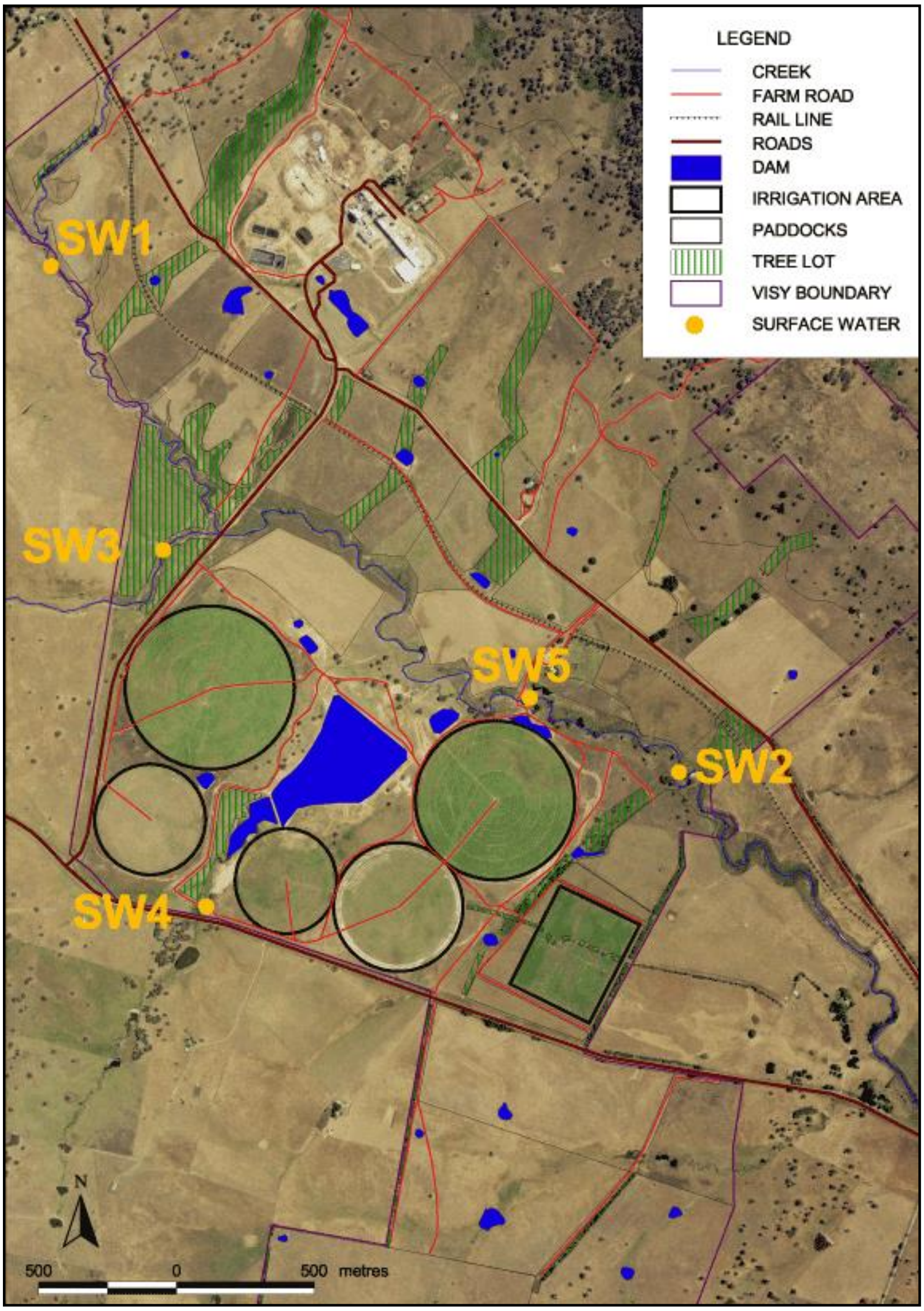


Figure 9: *Surface water monitoring points at Gadara Park*

5.1.1 Surface water site 1 (SW1)

SW1 (surface water monitoring north) is located on the upstream boundary of the Visy mill site. The monitoring site is in an incised creek line (around three metres deep), see Figure 10. Cattle can access the site from the neighbouring farm. There has always been some evidence of cattle around the monitoring site in the form of manure and tracks. The water is mostly running, albeit in limited amounts and water quality has generally been good.

This sampling location monitors water quality offsite and upstream of the mill site (Visy 2003).

Figure 10: *Surface water monitoring point number 1*

5.1.2 Surface water site 2 (SW2)

SW2 (surface water monitoring south) is located downstream of the Visy mill site and is the widest stretch of the creek. There has always been running water at this site and it is on the bend of the creek with a small sandy beach, see Figure 11.

This sampling location monitors water quality downstream as it departs the mill site (Visy 2003).

Figure 11: *Surface water monitoring point number 2*

5.1.3 Surface water site 3 (SW3)

SW3 (surface water monitoring deep creek) is located on Deep Creek upstream of the Visy mill site. The site is a widened pool within an incised creek line, see Figure 12. Water quality has generally been fair to good. There has consistently been particulate matter in the form of algae observed in the water column during sampling. This area is surrounded by a tree lot that is infrequently grazed.

This sampling location monitors water quality in Deep Creek before it joins Sandy Creek (Visy 2003).

Figure 12: *Surface water monitoring point number 3*

5.1.4 Surface water site 4 (SW4)

SW4 (surface water monitoring Snowy Mountains Highway) is located on the Snowy Mountains Highway and is down stream of the Visy mill site and farm. Water analysis usually returns high rates of suspended solids and TDS. The site is at the plateau of an extremely large catchment that has had only intermittent low flows since monitoring commenced in November 2003. With sufficient rainfall, the monitoring site receives high flows of water from the catchment which improves chemical quality.

SW4 is aesthetically the poorest surface water monitoring site because of the usually stagnant and discolored water, see Figure 13. Although this site is considered aesthetically poor, there is an abundance of macro invertebrates and aquatic fauna, indicating reasonable water quality.

This sampling location monitors water quality from upstream of the mill and irrigation areas, (Visy 2003).

Figure 13*:* *Surface water monitoring point number 4*

5.1.5 Surface water site 5 (SW5)

SW5 (surface water monitoring Sandy Creek) is located on the Visy farm at the creek crossing in the center of the farm, see Figure 14. The water quality has generally been fair to good with constant running water.

This sampling location monitors water quality in Sandy Creek as it passes beside the irrigation areas, (Visy 2003).

Figure 14: *Surface water monitoring point number 5*

5.2 Chemical analysis

All results are provided in Attachment B

Total Dissolved Solids

All sites exhibit low levels (<500mg/L) of TDS. The results ranged from 24mg/L (SW3, November 2022) to 362mg/L (SW4, March 2023). There are no significant long-term trends developing other than seasonal peaks in summer and autumn, consistent with lower surface water flows.

Electrical Conductivity

All sites exhibited relatively lower EC readings for all sites in October and November 2022 followed by slightly increased readings over the remaining 2022/23 monitoring period, with values ranging from 80µS/cm (SW1, November 2022) to 582µS/cm (SW4, March 2023).

Biochemical Oxygen Demand

All BOD readings met the (ANZG, 2018) criteria of 15mg/L. All sites were below detectable limits (<2 mg/L) apart from SW3 which had a max BOD reading of 3mg/L and SW4 which had BOD readings ranging from <2mg/L (November 2022 & May 2023) to 12mg/L (March 2023).

pH

The surface water pH for all sites ranged from 6.4 (SW1, May 2023) to 8.4 (SW1 & SW2, January 2023). The recommended pH range for upland streams is between 6.0 and 7.5 (ANZG, 2018). Although the surface water pH is sometimes above the upper guideline value, pH results are consistent between all upstream and downstream monitoring sites suggesting this is inherent to the locale, (ANZG, 2018). Historical data shows similar pH levels since monitoring commenced in 2003.

Faecal coliforms

All surface water monitoring sites exhibit generally low to moderate levels of faecal coliforms with a range between <1fcu/100mL (SW3 & SW4, March 2023) and 3800fcu/100mL (SW3, January 2023). The mean level of faecal coliforms across all sites for the 2022/23 monitoring period was 647fcu/100mL per month, which was lower than the historical mean of 1858fcu/100mL.

Nitrogen and phosphorus

Nitrogen levels for all sites ranged from below detectable levels, <2mg/L (multiple readings) to 5mg/L (SW4, March 2023). Phosphorus ranged from <0.01mh/L (multiple readings) to 0.33mg/L (SW1, November 2023) and was consistent across all sites. The nitrogen and phosphorus levels are consistent with historical data.

Oil and grease

Oil and grease readings ranged from <1mg/L (multiple sites) to 6mg/L (SW3, November 2022). The mean oil & grease level across all sites was 2.3mg/L which is lower than the historical mean of 3.6mg/L. Some higher readings have been recorded at all sites since 2003 when monitoring commenced although all sites have been below the (ANZG, 2018) recommended level of 5mg/L for the 2022/23 monitoring period.

The Hexane Extractable Matter (HEM) APHA 5520 D EPA method was used to test oil and grease. This test detects non-volatile hydrocarbons, chlorophyll, animal fats, vegetable oils, waxes, soaps, greases etc. The HEM method is not designed specifically to detect fuel or fuel oil. The results that are above detectable levels could be due to the detection of any of the above material and are likely to be from a natural source. No known fuel-related, grease-related, or oil-related contaminating activities take place at or upstream of the surface water sites.

6.0 Wastewater assessment

6.1 Wastewater monitoring site

Treated wastewater was sampled from a tap on the decant line (Point 10) that runs from the 2.5ML decant storage dam to the winter storage dam until December 2021, after unusually high readings (8 December 2021) were observed owing to alterations to pipework in the system. Since December 2021, the treated wastewater sample has been taken directly from the 2.5ML decant storage dam at the direction of Visy for a more representative sample of the wastewater that runs to the winter storage dam. In total, six samples were collected in 2022/23.

6.2 Chemical analysis

All results are provided in Attachment C.

BOD

BOD levels ranged from 5mg/L to 13mg/L with a mean of 10mg/L, which is classed as low strength effluent (<40mg/L) for irrigation (DEC 2004) and below the licence limit of 40mg/L.

TDS

TDS ranged from 108mg/L to 222mg/L. All results are classed as a low strength effluent (<600mg/L) for irrigation, (DEC 2004).

SAR

SAR ranged from 3 to 5. The mean SAR of 4.2 is similar to the readings from the previous five monitoring periods.

Nitrogen and phosphorus

The levels of total nitrogen range from below the detection limit of <2mg/L to 6mg/L. All results are below the licence limit of 20 mg/L. The mean of 4.6mg/L is classed as a low strength effluent (<50mg/L) for irrigation, (DEC 2004).

Phosphorus levels range from 0.23mg/L to 1.05mg/L. All results are below the licence limit of 5mg/L. The mean of 0.6mg/L is classed as a low strength effluent (<10mg/L) for irrigation, (DEC 2004).

pH

The pH of the wastewater samples ranged from neutral to alkaline with a range of 7.1 to 7.9. The 7.5 average of the 2022/23 data is inside the suitable range of 6.0 to 8.5 for irrigation, (ANZG, 2018).

Suspended solids

The suspended solids readings ranged from 5mg/L to 40mg/L. Results were below the EPA licence limit of 45mg/L.

Zinc
Low levels of zinc were found in all samples with the highest of these concentrations being 0.055mg/L. The results were under the guidelines for irrigation of 2mg/L, (ANZG, 2018).

Oil and Grease
Oil and grease levels ranged from <1mg/L to 5mg/L. The single reading of 5mg/L (February 2023) was at the EPA licence limit of 5mg/L.

The Hexane Extractable Matter (HEM) APHA 5520 D EPA method was used to test oil and grease. This test detects non-volatile hydrocarbons, chlorophyll, animal fats, vegetable oils, waxes, soaps, greases etc. The HEM method is not designed specifically to detect fuel or fuel oil. The results that are above detectable levels could be due to the detection of any of the above material and is likely to be from a natural source. No known fuel-related, grease-related or oil-related contaminating activities take place at or upstream of the surface water sites.

7.0 Irrigation assessment

A total volume of 894.11 megaliters (ML) of water was land applied during the 2022/23 irrigation season. Of the 894.11ML irrigated, most of the source is treated wastewater, the remaining volume being direct runoff from rainfall into the winter storage dam, runoff pumped from the irrigation run off dams and backwash water from the irrigation filters.

The amount of wastewater irrigated in 2022/23 is 418.11ML higher than the long-term average of 476ML per annum, and the highest irrigation amount since monitoring began in 2002, Table 3. The highest monthly irrigation amounts occurred from November 2022 until February 2023. Irrigation was reduced from 2007 to 2009 owing to the mill conducting water re-use trials in the production cycle and less rainfall runoff into the winter storage dam due to the drought conditions.

Table 3: *Historical irrigation amounts*

Season	Irrigation area (ha)	Volume irrigated	
		Total (ML)	ML/ha
2002-2003	110.86	459	4.14
2003-2004	110.86	568	5.12
2004-2005	110.86	615	5.55
2005-2006	110.86	512	4.62
2006-2007	110.86	258	2.33
2007-2008	110.86	233	2.10
2008-2009	110.86	153	1.38
2009-2010	110.86	74	0.67
2010-2011	110.86	368	3.32
2011-2012	110.86	428	3.86
2012-2013	110.86	762	6.91
2013-2014	110.86	261	2.35
2014-2015	110.86	644	5.81
2015-2016	110.86	617	5.57
2016-2017	110.86	500	4.53
2017-2018	110.86	545	4.92
2018-2019	110.86	372	3.35
2019-2020	110.86	368	3.33
2020-2021	110.86	513	4.63
2021-2022	110.86	852	7.68
2022-2023	110.86	894	8.06

Table 4 presents the breakdown of the volume of water applied to the five Centre Pivot (CP) irrigators (CP1 to CP5) and a soft hose travelling (SHT) irrigator.

Table 4: *Amount of water irrigated to land 2022/23*

Month	CP1	CP2	CP3	CP4	CP5	SHT	Total
July 2022	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
August 2022	0.00	0.00	0.00	0.00	0.00	14.50	**14.50**
September 2022	20.43	8.75	12.38	0.00	0.00	11.82	**53.38**
October 2022	22.14	12.39	0.00	0.00	0.00	0.00	**34.53**
November 2022	33.77	6.56	22.96	19.85	14.46	4.68	**102.29**
December 2022	57.89	22.60	41.78	23.02	21.14	0.00	**166.43**
January 2023	66.12	28.31	60.10	38.87	28.31	0.00	**221.70**
February 2023	51.93	22.23	47.20	30.53	22.23	0.00	**174.12**
March 2023	6.24	7.50	9.99	13.84	6.68	0.00	**44.26**
April 2023	23.84	4.86	10.32	6.67	4.86	0.00	**50.55**
May 2023	9.65	4.13	8.77	5.67	4.13	0.00	**32.36**
June 2022	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Total ML	**292.01**	**117.33**	**213.51**	**138.46**	**101.81**	**31.01**	**894.11**
Area ha	28.27	12.06	25.70	16.60	11.15	17.50	110.3
ML/ha	**10.33**	**9.73**	**8.31**	**8.34**	**9.13**	**1.77**	**8.06**

7.1 Irrigation scheduling

Wastewater application rates aim to match crop types to ensure sustainable and efficient plant water use. The amount of water irrigated in 2022/23 (depending on water availability) is closely matched with anticipated crop water demand. Over the 2022/23 summer irrigation season CP1, CP2, CP3 and CP5 were sown to lucerne & pearl millet, CP4 to pearl millet and SHT to Japanese millet.

When irrigation is taking place, scheduling is reviewed daily considering weather conditions, soil moisture, crop performance and the available irrigation resource. Gadara Park has excellent irrigation monitoring resources including:

- Soil moisture probes installed in each irrigation field with sensors located at 10cm, 30cm and 50cm;
- Evapotranspiration (ET_o) data available from interpolated dataset;
- Accurate irrigation application scheduling through the centre pivots;
- Annual soil analysis; and
- Accurate winter storage capacity data.

The correlation between crop daily water requirements, based on ET_o, and actual water use are demonstrated in Table 5. The ET_o value is from the SILO Data Drill for Lat, Long: -35.30S 148.15E (decimal degrees). This value is interpolated from surrounding Bureau of Meteorology weather stations with adjustments made for elevation. Wind speed is capped at two metres per second, which would exclude the extremely high ET_o days from the data. Potential ET_o is calculated as per FAO Irrigation and Drainage Paper 56. Effective rainfall has been calculated on the assumption that rainfalls of <5mm during the irrigation period are non-significant. In winter, all the rainfall is assumed to be effective (Qassim and Ashcroft, 2001).

At Gadara Park, water balances are regularly calculated to ensure irrigation supply is matched to crop demands. The water balance for CP3 has been supplied to demonstrate that sustainable irrigation is taking place, with applications on par with crop water demand, Table 5. Irrigation efficiency is commonly 85 to 90%, therefore the amount irrigated will sometimes be slightly more than the plants water requirement. Water losses include drift, evaporation, runoff, and deep drainage. The actual amount of water irrigated is aimed to match the daily crop water requirements, Table 5. The irrigation of CP3 in March 2023 was typical of irrigation scheduling throughout 2022/23 where irrigation occurred on an establishment or production-oriented basis favouring the planted crops used for grazing and/or hay production.

By irrigating smaller amounts more frequently, the risk of surface runoff or through drainage occurring is greatly minimised, therefore reducing potential environmental impacts. Runoff is monitored by a visual inspection of the irrigation areas while through drainage can be assessed by reviewing the real time soil moisture probes and the piezometers installed in the irrigation areas. Runoff and through drainage can occur when irrigation is scheduled in larger amounts of water at a lesser interval. The centre pivot irrigation system at Gadara Park is extremely versatile in the amount of water able to be irrigated by altering the speed of the rotation and droplet size with the use of adjustable nozzles.

Table 5: *Irrigation scheduling and ETo data, March 2023 CP3*

Date	Temp. Min °C	Temp. Max °C	Rain mm	ETo mm	Crop factor	Water requirement mm	Actual irrigation mm
01/03/23	13.8	29.1	0	4.8	1.2	5.8	0
02/03/23	13.4	30.9	0	5.9	1.2	7.1	0
03/03/23	14.0	30.8	0	6.4	1.2	7.7	0
04/03/23	16.1	30.1	0	5.3	1.2	6.4	0
05/03/23	16.4	32.5	0	7.1	1.2	8.5	0
06/03/23	16.6	28.1	5.9	6.8	1.2	8.2	0
07/03/23	9.8	25.7	0	6.2	1.2	7.4	2.8
08/03/23	9.1	20.0	0	5.4	1.2	6.5	12.1
09/03/23	6.7	22.4	0	5.2	1.2	6.2	3.5
10/03/23	4.2	27.3	0	5.3	1.2	6.4	4.0
11/03/23	7.6	28.6	0	5.8	1.2	7.0	12.1
12/03/23	8.7	29.5	0	5.2	1.2	6.2	4.5
13/03/23	13.6	26.8	10.4	4.7	1.2	5.6	0
14/03/23	12.5	28.7	0	4.4	1.2	5.3	0
15/03/23	13.8	30.0	0	6.1	1.2	7.3	0
16/03/23	12.9	30.8	0	7.0	1.2	8.4	0
17/03/23	12.9	29.9	0	6.6	1.2	7.9	0
18/03/23	9.9	33.6	0	7.1	1.2	8.5	0
19/03/23	12.5	38.4	0	7.1	1.2	8.5	0
20/03/23	15.1	27.8	0	6.2	1.2	7.4	0
21/03/23	13.5	21.3	0	2.2	1.2	2.6	0
22/03/23	13.5	21.6	7.0	2.5	1.2	3.0	0
23/03/23	13.7	23.1	0	2.3	1.2	2.8	0
24/03/23	10.7	27.3	11.8	2.9	1.2	3.5	0
25/03/23	13.6	23.1	0	4.4	1.2	5.3	0
26/03/23	14.2	25.2	0	3.1	1.2	3.7	0
27/03/23	16.5	22.4	0	1.9	1.2	2.3	0
28/03/23	15.6	25.6	0	3.2	1.2	3.8	0
29/03/23	14.5	20.0	28.5	3.1	1.2	3.7	0
30/03/23	9.1	18.8	11.1	2.4	1.2	2.9	0
31/03/23	7.0	19.0	0.0	3.1	1.2	3.7	0
TOTALS			**74.7**	**149.7**	**-**	**179.6**	**39.0**

8.0 Irrigated crop assessment

8.1 Crops grown and yields

In June 2023, CP1, CP2, CP3, CP4 and CP5 are all currently sown to Hogan Rye Grass.

8.2. Irrigation cropping program

Details of the crops currently grown at Gadara Park and what is planned to be grown in the following seasons are given in Tables 6 to 10. The amount and type of crop grown is dependent on available water, seasonal conditions and crop rotations.

Presently the cropping program revolves around having a perennial crop of lucerne planted in irrigation areas for a period of around five years then rotated with cereal crops for two to three years for a weed and disease break. Having this cropping rotation in the irrigation areas ensures flexibility of irrigation management and grazing regarding timing and amount of irrigation.

Table 6: *Irrigated summer/autumn cropping for season 2022/23*

Field	Crop	Growing season	Irrigation period
CP1 – 28.3 ha	Lucerne & Pearl Millet	Spring Summer Autumn	Spring Summer Autumn
CP2 – 12.1 ha	Lucerne & Pearl Millet	Spring Summer Autumn	Spring Summer Autumn
CP3 – 25.7ha	Lucerne & Pearl Millet	Spring Summer Autumn	Spring Summer Autumn
CP4 – 16.6ha	Pearl Millet	Spring Summer Autumn	Spring Summer Autumn
CP5 – 10.2ha	Lucerne & Pearl Millet	Spring Summer Autumn	Spring Summer Autumn
SHT – 17.5ha	Japanese Millet	Autumn Winter Spring	Spring Summer Autumn

Table 7: *Irrigated winter/spring cropping for season 2023*

Field	Crop	Growing season	Irrigation period
CP1 – 28.3 ha	Hogan Rye Grass	Autumn Winter Spring	Spring Summer Autumn
CP2 – 12.1 ha	Hogan Rye Grass	Autumn Winter Spring	Spring Summer Autumn
CP3 – 25.7ha	Hogan Rye Grass	Autumn Winter Spring	Spring Summer Autumn
CP4 – 16.6ha	Hogan Rye Grass	Autumn Winter Spring	Spring Summer Autumn
CP5 – 10.2ha	Hogan Rye Grass	Autumn Winter Spring	Spring Summer Autumn
SHT – 17.5ha	Hogan Rye Grass	Autumn Winter Spring	Spring Summer Autumn

Table 8: *Irrigated summer/autumn cropping for season 2023/24*

Field	Crop	Growing season	Irrigation period
CP1 – 28.3 ha	Lucerne & Rye Grass	Spring Summer Autumn	Spring Summer Autumn
CP2 – 12.1 ha	Lucerne & Rye Grass	Spring Summer Autumn	Spring Summer Autumn
CP3 – 25.7ha	Lucerne & Rye Grass	Spring Summer Autumn	Spring Summer Autumn
CP4 – 16.6ha	Lucerne & Rye Grass	Spring Summer Autumn	Spring Summer Autumn
CP5 – 10.2ha	Lucerne & Rye Grass	Spring Summer Autumn	Spring Summer Autumn
SHT – 17.5ha	Hogan Rye Grass	Autumn Winter Spring	Spring Summer Autumn

Table 9: *Irrigated winter cropping for season 2024*

Field	Crop	Growing season	Irrigation period
CP1 – 28.3 ha	Lucerne	Autumn Winter Spring	Spring Summer Autumn
CP2 – 12.1 ha	Lucerne	Autumn Winter Spring	Spring Summer Autumn
CP3 – 25.7ha	Lucerne	Autumn Winter Spring	Spring Summer Autumn
CP4 – 16.6ha	Lucerne	Autumn Winter Spring	Spring Summer Autumn
CP5 – 10.2ha	Lucerne	Autumn Winter Spring	Spring Summer Autumn
SHT – 17.5ha	Ryegrass	Autumn Winter Spring	Spring Summer Autumn

Table 10: *Irrigated summer/autumn cropping for season 2024/25*

Field	Crop	Growing season	Irrigation period
CP1 – 28.3 ha	Lucerne	Spring Summer Autumn	Spring Summer Autumn
CP2 – 12.1 ha	Lucerne	Spring Summer Autumn	Spring Summer Autumn
CP3 – 25.7ha	Lucerne	Spring Summer Autumn	Spring Summer Autumn
CP4 – 16.6ha	Lucerne	Spring Summer Autumn	Spring Summer Autumn
CP5 – 10.2ha	Fallow	Spring Summer Autumn	Spring Summer Autumn
SHT – 17.5ha	Fallow	Autumn Winter Spring	Spring Summer Autumn

9.0 Soil under irrigation assessment

9.1. Soils introduction

The soil monitoring program is conducted in accordance with the Visy EPA Licence 10232. The licence stipulates topsoil monitoring annually and subsoil every three years. This monitoring forms an integral part of crop nutrient budgeting and management. Results are provided in Attachment D.

In addition to the test parameters stipulated in the licence, other nutrients are tested as part of the monitoring program to aid the farm manager in decision making for fertiliser application.

9.2. Soil monitoring sites

There are seven soil monitoring sites at Gadara Park, Figure 15. These seven soil monitoring sites are split into three sample areas:

- West of the winter storage.
- East and south of the winter storage.
- South-east corner.

9.2.1. West of the winter storage

There are three soil monitoring sites in this area. There are two located in CP1 (SMS1, SMS2), and one under CP2 (SMS3) (Visy, 2003).

9.2.2. East and south of the winter storage

There are three soil monitoring sites in this area. There is one soil monitoring site located under CP3, CP4 and CP5 respectively. SMS4 is in CP3, SMS5 is in CP4 and SMS6 is in CP5, (Visy, 2003).

9.2.3. South-east corner

The only soil monitoring site in this region is SMS7 located in the SHT paddock along the eastern boundary of the Gadara Park property, (Visy, 2003).

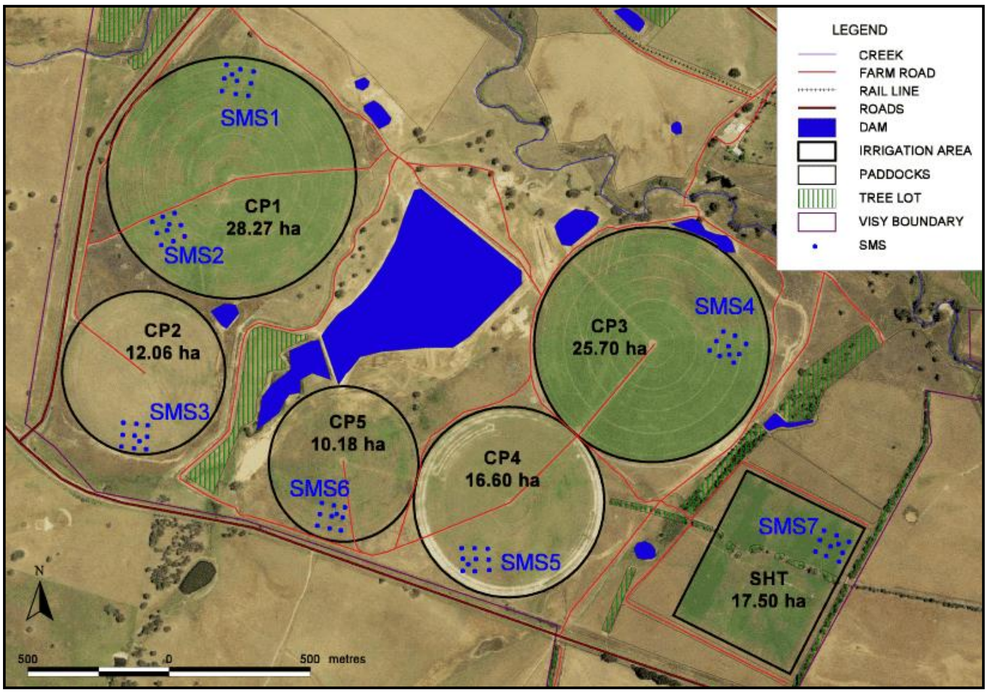


Figure 15: *Centre pivots at Gadara Park showing soil monitoring sites*

9.3 Methodology

Currently there is one soil monitoring site (SMS) per 15.7ha of irrigation area. Recommended soil sampling locations are to be distributed at one per 2 to 20ha, depending on the geological complexity of the site, use of effluent by irrigation (DEC, 2004). The SMSs were established in 2000 and have been navigated to using Global Positioning System (GPS) since 2003.

From a monitoring perspective, the SMSs are an accurate gauge of temporal changes in soil parameters at each location. Friesen and Blair (1984) detail that cluster sampling is the most appropriate procedure for estimating the nutrient status of pastures. This sampling method enables more reasonable estimates to be made of the temporal variations in soil tests.

Both surface and sub-surface samples are taken at each site. Approximately 40 topsoil sub samples are collected for compositing within each SMS. Ten subsoil samples are bulked together for analysis within each SMS.

9.4 Electromagnetic surveying

The DEC recommends that an electromagnetic (EM) survey be used to identify soil sampling sites (DEC, 2004). An EM survey was carried out in 2001 and again in 2003. Ground truthing of the EM survey was carried out with soil cores in 2003 and soil pits have also been investigated in the irrigation areas in 2005.

The EM-38 survey measures the apparent electrical conductivity of the soil profile to a depth of 1.5m, which is the effective root-zone of most irrigated crops.

The main purpose of the EM-38 is to aid in the identification of different soil types that may influence soil analysis and crop performance so that management can be tailored to soil type. The EM-38 survey demonstrated a basic correlation between EM-38 readings and soil types. Low EM-38 readings were measured in the high elevation areas, characterised by a deep well drained soil with a substrate of coarse fragments and decomposed rock. High EM-38 readings were measured in the low-lying areas of the paddocks, characterised by poorly drained alluvium overlying clay subsoils. The EM-38 survey and SMS can be seen in Figure 16.

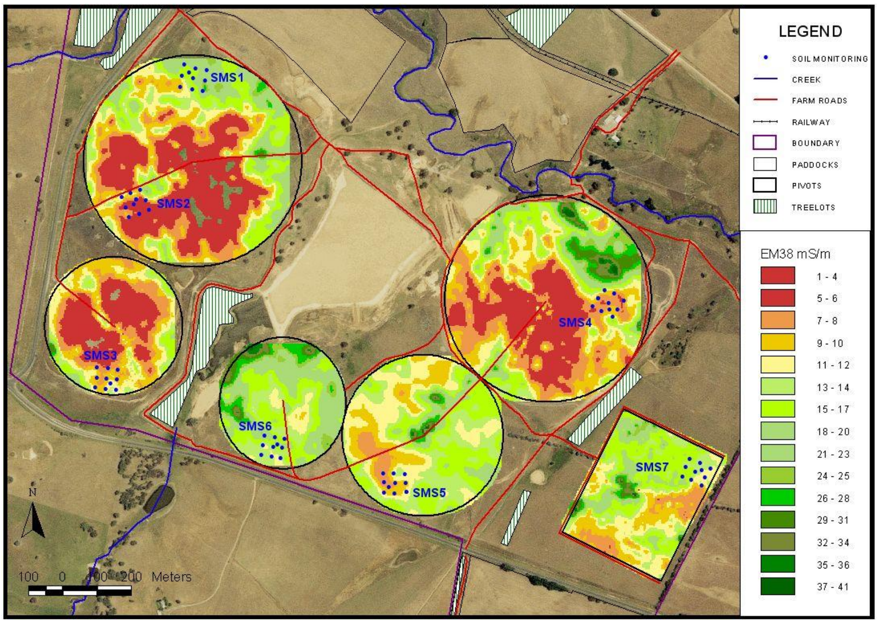


Figure 16: *Location of soil monitoring sites in relation to EM-38 survey*

9.5 Analysis

Topsoil sampling and analysis was undertaken in October 2022 and April 2023. Subsoil sampling and analysis was also undertaken as part of Visy's Environment Protection Licence which stipulates it is carried out every three years. McMahon conducts subsoil testing every year to gain better understanding on the sustainable assimilation of nutrients and provide management recommendations based on the results, Attachment D.

Overall soil health appears to be good with adequate humus levels and an abundance of earthworms in the topsoil. Topsoil organic carbon levels (as an average across the 7 SMS) have risen from 2.0% in 2003 to 2.5% in April 2023 due to the introduction of perennial crops such as lucerne into the cropping program.

Over the last 18 years, macro nutrients have improved to more desirable levels due to a comprehensive fertiliser program and topsoil pH has risen with the application of soil ameliorants.

9.5.1. Monitoring October 2022

Topsoil (0-10cm) analysis was undertaken in October 2022 to coincide with the start of the spring/summer irrigation season. Fertiliser recommendations for the crops were made based on the nutrient budget.

pH
Soil pH is slightly acidic with results ranging from 4.8pH($CaCl_2$) (SMS7) to 7.3pH($CaCl_2$) (SMS5) . Typically, the application of alkaline soil ameliorants has been highly successful with an improvement in topsoil pH to within the desirable range of 5.5 to 7pH($CaCl_2$), (NSW Agriculture, 1998). However, SMS2 and SMS7 were below the desirable range. A neutral soil pH will improve nutrient and water availability for plants.

Cations
Calcium and magnesium ratios are typical for soils of the local area. Potassium % levels range from <1.0 to 7.0 with the higher percentage being SMS7, although this is considered typical for soils of the local area. Sodium levels average 2.1% which is at a suitable level (NSW Agriculture, 1998).

Aggregate stability
Emerson Aggregate Tests were performed by reference to AS1289.3.8.1 and soils were categorised as class number 7 (SMS1, SMS4, SMS5 & SMS7) and class number 8 (SMS2, SMS3 & SMS6). A class 7 soil will not undergo mechanical slaking but will swell when immersed in water while class 8 does not swell under the same conditions.

Organic carbon
Organic carbon levels average 2.71% across all sites. This is desirable and indicative of soils with good structural condition, high structural stability, pH buffering capacity, soil nutrient levels and water holding capacity (NSW Agriculture, 1998). The organic carbon levels are slightly higher compared to the 2021/22 monitoring period.

Salinity
Salinity indicators were very low indicating nil short-term salinity risk. Sodium as a percentage of cations is also low ranging from 0.8% (SMS5) to 4.9% (SMS2). Excessive sodium can cause the soil structure to deteriorate.

Chloride
Chloride levels in October 2022 were low with readings ranging from below the detectable limit of <10ppm (multiple readings) to 21ppm (SMS2), which is slightly lower than the 2021/22 monitoring period.

Nitrogen
Nitrogen and nitrate levels are generally satisfactory for agricultural production and can be improved by the addition of fertiliser if required.

Phosphorus
Phosphorus levels are generally satisfactory for agricultural production and can be improved by the addition of fertiliser if required.

9.5.2. Monitoring April 2023

Topsoil (0-10cm) analysis was undertaken in April 2023 to coincide with the start of the autumn/winter cropping season. Fertiliser recommendations for the crops were made based on analysis of soil fertility.

pH

Soil pH is at a desirable level for all the sampling points except for SMS7 (4.9 pH($CaCl_2$)). Typically, the application of alkaline soil ameliorants has been highly successful with an improvement in topsoil pH to within the desirable range of 5.5 to 7($CaCl_2$), (NSW Agriculture, 1998). A neutral soil pH will improve nutrient and water availability for plants.

Cations

Calcium and magnesium ratios are typical for soils of the local area. Potassium levels range from 1.8% to 6.2% which is above the 1-5% desired range (NSW Agriculture, 1998). Sodium levels are averaging 3.86% across all sites which is at a suitable level (NSW Agriculture, 1998).

Aggregate stability

Emerson Aggregate Tests were performed by reference to AS1289.3.8.1 and soils were categorised as class number 7 (SMS1, SMS3, SMS4, SMS5 & SMS6) and class number 8 (SMS2 & SMS7). A class 7 soil will not undergo mechanical slaking but will swell when immersed in water while class 8 does not swell under the same conditions.

Organic carbon

Organic carbon levels are averaging 2.47%, this is considered to be desirable and is indicative of soils with very good soil structure and high buffering capacity with sufficient organic matter to decrease bulk density and improve water holding capacity (NSW Agriculture, 1998). This is an improvement from the April 2022 results.

Salinity

Salinity indicators were very low indicating nil short-term salinity risk. Sodium as a percentage of cations is also low ranging from 0.4% to 6.2%. Excessive sodium can cause the soil structure to deteriorate.

Chloride

Chloride levels in April were low with readings ranging from below the detectable limit <10ppm (multiple readings) to 14ppm (SMS2). This is lower than the readings for October 2022.

Nitrogen

Nitrogen and Nitrate levels are generally satisfactory for agricultural production and can be improved by the addition of fertiliser if required.

Phosphorus

Phosphorus levels are generally satisfactory for agricultural production and can be improved by the addition of fertiliser if required.

10.0 Nutrient balance and forward management plan

The farm nutrient balance forms part of the forward management plan for the wastewater irrigation at Gadara Park, it also satisfies the load-based protocol for the Visy Environment Protection Licence. The nutrient balance and forward management plan are reviewed annually as part of irrigated cropping management. The review ensures maximum nutrient uptake for optimal crop production.

At the commencement of the Visy operations at Gadara Park, the soil nutrient status was poor with below desirable levels for all macronutrients and a very low pH. The macronutrient status and pH at Gadara Park since, has improved due to a strategic fertiliser and amelioration program, and improved cropping management.

Fertiliser is the main source of nutrient supply and application amounts are matched to anticipated crop removal. Nutrients are present in the wastewater but are at insignificant levels to make a marked impact on nutrient availability.

At present, soil testing is carried out bi-annually to coincide with the start of the winter and summer cropping programs. Nutrient budgets are calculated with current soil nutrient status for the crops to be grown, with likely nutrient efficiency and removal. Factors such as anticipated yield, irrigation amounts, rainfall, weed burden, crop variety and seeding rate are taken into account when budgeting actual nutrient removal and supply.

The aim for future nutrient application is to maintain a sustainable macro nutrient bank in the soil that will boost crop production for more efficient water use and crop production.

10.1 Nutrient balance management

The NSW EPA load based licensing protocol details that the following conditions be carried out for licensees to obtain the full fee discount for effluent irrigation.

Condition 1: Have developed a 15 year forward management plan that shows how proposed annual nutrient application rate compares with the annual amounts to be taken up by the biological or physical processes of the crop-soil system. This should be done before the construction of the effluent reuse scheme. Nutrient application rates must be based on the sustainable assimilation of nutrients over a rolling 15 year period.

The nutrient balance outlines the nutrient status from the soil testing carried out in April 2022. Nutrient removal has been calculated from the ranges outlined in Table 11 and efficiency factors have been determined from historical seasonal conditions encountered. The nutrient balance table outlines crop species, seeding rate and an estimated sowing date. The sowing date will change from year to year to suit the cropping programs and seasonal conditions. Perennial crops such as lucerne and ryegrass for example are only sown every five years or so. The table also outlines estimated fertiliser application and nutrient addition from wastewater and biological processes. The areas for which the nutrient balance has been calculated are the centre pivots and soft hose traveller paddock, Figure 15. The 15 year rolling nutrient balance can be seen in Attachment E.

10.2 Nutrient supply

Nutrients are supplied in the form of fertiliser and wastewater. Nitrogen is also supplied by soil biological processes of mineralisation and fixation.

10.2.1 Fertiliser

Fertiliser is the main source of nutrients at Gadara Park. A starter fertiliser (Nitrogen (N) Phosphorus (P) Potassium (K) Sulphur (S) at a ratio of 18.22.0.1) is used at sowing to supply the crops with the season's phosphorus supply and some nitrogen. Crops are usually top dressed with granular urea (NPKS 42.0.0.0) or with liquid nitrogen through the centre pivot or boom spray. Legumes will generally be top dressed with single super (NPKS 0.9.0.11) to supply adequate phosphorus and sulphur. Additional nutrients and trace elements can be added when suitable.

10.2.2 Waste water

A volume of approximately 894 megalitres of wastewater was applied in 2022/23 to approximately 110 hectares of farmland at Gadara Park via existing centre pivots (five of them) and the soft hose traveler irrigator. The irrigation of the wastewater is controlled by Visy's wastewater management plan and the EPA licence conditions. The amounts of nitrogen and phosphorus in the wastewater are very low and are the lowest contributors of nitrogen and phosphorus to the nutrient balance.

10.2.3 Mineralisation

Mineralisation is a process that releases nitrogen from soil organic matter while the temperature and moisture conditions are suitable for the soil microbes to function effectively. As a general rule, mineralisation rarely exceeds 80kg nitrogen per hectare per year. A rate of 40kg nitrogen per hectare per season has been used to approximate mineralisation.

10.2.4 Fixation

Further nitrogen addition is present in the form of fixation from legume crops. The principal annual legume crop grown will be a high density legume consisting of a clover mix. The principal perennial legume crop grown will be lucerne. It is estimated that the high density legume will add approximately 100kg nitrogen per hectare per year (Tisdale et al, 1998). Legumes fix around 20kg nitrogen per tonne dry matter per year - but most of this goes into the organic nitrogen pool. However, the amount of mineral nitrogen available to plants in autumn and early winter will increase in proportion to kilograms per hectare of legume dry matter grown the previous spring. The conversion of atmospheric nitrogen to organic nitrogen is called fixation (Agricultural Bureau of South Australia, 1997).

Experimental estimates of the total annual inputs of fixed nitrogen by grazed lucerne-based pastures range from 80-190kg nitrogen per hectare per year in a Mediterranean-type climate (Peoples et al, 1998).

10.3 Nutrient removal

Nutrient removal will be influenced by the type of crops grown, seasonal weather, sowing rate and general plant health. The following Table 11 has been used as a general guide for nutrient removal ranges, (Reuter and Robinson, 1997).

Table 11: *Nutrient removal ranges for crops grown at Gadara Park*

Crop	Normal nutrient removal range (kg/ha)		
	Nitrogen	Phosphorus	Potassium
Irrigated pasture (cut)	160-400	24-60	120-300
Lucerne hay (cut)	155-465	15-45	125-375
Maize silage	220-550	50-125	200-500
Forage sorghum	220-440	30-60	240-480
Winter cereal hay	200-400	30-60	160-320
Seed barley	38-95	6-15	8-20
Seed wheat	38-95	8-20	10-25
Triticale	29-57	6-12	9-18
Seed oats	15-75	3-15	4-20
Chickpeas	20-80	2-8	2-8
Cowpeas	15-60	2-8	10-40
Faba beans	40-120	4-12	12-36
Lupins	22-90	1-6	4-16

10.3.1 Seasonal influence

Nutrient uptake is heavily influenced by seasonal conditions:

Winter season

The winter growing season at Gadara Park is considered extended because of an early sowing date made possible by irrigation. This gives the winter crops a high nutrient removal rate. Another factor influencing a long growing season is the cool spring climate which aids a long stage of plant development which in turn means a late harvest.

Summer season

The summer growing season at Gadara Park is considered short with a low to medium level of nutrient removal. The rationale for this is the comparatively cooler climate at Gadara Park and cooler temperatures which will influence nutrient removal.

10.4 Depth of nutrient removal

Phosphorus removal has been calculated to 10cm depth. The majority of phosphorus is placed as fertiliser at sowing which is normally to a depth of between 5cm and 7.5cm.

Nitrogen removal has been calculated to a depth of 10cm which is the effective zone of the majority of nitrogen supply and mineralisation at Gadara Park. Mineralisation has been assumed to be 40kg per hectare for the winter cropping period.

The irrigation paddocks at Gadara Park are sampled to a depth of 60cm to assess root zone nitrogen status for the summer crops. Summer crops such as maize will have an effective root zone depth of approximately 60cm and are therefore tested accordingly. The nitrogen fertiliser rate is usually determined by considering the cropping history of the field in conjunction with a soil test for mineral nitrogen (Hocking, Norton and Good, 1999). Growers are advised to use a deep (60cm) soil test for mineral N for calculating N fertiliser requirements. The deep soil test can detect any nitrate-N accumulated at depth. Values for mineral N in soils are typically 30-140kg nitrogen per hectare.

Condition 2: Review the plan every 3 years to ensure that future planned application rates will continue to achieve sustainable assimilation over a rolling 15 year period.

The current management at Gadara Park is to assess the nutrient status at the start of every summer and winter cropping program. From the soil analysis, nutrient budgets are calculated and matched to crop type and efficiency. This will ensure the maximum amount of production from the irrigation area.

Soil testing is undertaken at the start of the summer and winter cropping seasons to determine current nutrient status and budget requirements. Soil testing locations have been GPS located so the same sample sites are visited every time.

The plan will be reviewed formally every 3 years as per EPA recommendations to achieve sustainable nutrient assimilation.

Condition 3: Prepare annual nutrient balances showing nutrient application rates and the results of soil monitoring done as set out in the management plan, and how these outcomes compare with those anticipated in the management plan. Documentation of plan and annual balances must be kept for at least four years.

In October 2022 and April 2023, most soil nutrient levels are at desirable levels for agricultural production. The phosphorus levels have always been very low and targeted application of fertiliser has seen a slow build-up of levels to boost soil fertility and agricultural production.

Nitrogen levels at Gadara Park have been low but are building to more favourable conditions for agriculture after adopting a fertiliser program. Soil nitrogen has been identified as the single biggest crop nutrient limiting factor. Nitrogen can be applied to the crops at Gadara Park in the form of granular urea, and liquid fertiliser which can be center pivot applied or boom spray applied. The introduction of legumes to the cropping rotation will help fix nitrogen in the soil for subsequent crops.

11.0 Whole farm management

11.1 Pasture improvement

As an ongoing pasture improvement program, paddocks are developed and renovated on a rotational basis every 5 to 10 years. Perennial pasture species are introduced to suitable paddocks to maximise production over the summer months. In some paddocks where weed burden is high, annual crops are grown for two to three years to prepare them for a wider range of crop and perennial pasture options.

The pasture improvement includes many management facets that are integral to the successful development program. They include:

- Soil testing and analysis;
- Regular paddock inspections;
- Weed monitoring and control programs;
- Insect monitoring and control programs;
- A pasture variety rotation assessment;
- Seasonal assessment and outlook considerations; and
- Budgetary assessment.

11.2 Tree management

In total, Gadara Park currently has 73 hectares of planted native tree lots in riparian zones and along drainage lines. The tree lots have been established and maintained over the last 16 years as part of a riparian/drainage line stabilisation and habitat improvement program that links the creek flats to the timbered hills.

The areas of tree plantings can be seen in Figure 17.

11.3 Weed management

The Weed Management Plan for Gadara Park was completed and approved as part of the Landscape and Native Vegetation Management Plan in the Operational Environmental Management Plan (OEMP). Two further properties were acquired in 2007 and 2008, “Havilah” and “Woomera” respectively. Weed management has also been undertaken on these properties as discussed for Gadara Park below. A range of weed control methods are employed as part of the land management on land owned by the company including spraying, insect control and “crash grazing” on the centre pivots where the sheep flock or cattle are put on in larger numbers and left for 2 to 3 weeks. This means that the pasture and weeds are grazed, the pasture recovers and continues to grow but the weed growth is checked.

Comments and observations for 2022/23 are as follows:

- Bathurst Burr has been controlled to a point with ongoing inspection and edification of any new germination. This is a summer weed and has required some spraying and chipping for control;
- Bracken Fern - an ongoing reduction program exists, and the fern is mainly occurring in the more inaccessible areas;

- Blackberry – ongoing maintenance program of spraying and treatment of any re-infestations continues;
- Paterson’s curse is subject to ongoing management. Visy began working with the CSIRO and the Department of Primary Industries (DPI) on a biological control program using four types of insect for the control of Paterson’s curse, in 2007 initially within the vegetation corridors, where spraying was unable to be undertaken. The insects however have now spread throughout the property and results have been outstanding. The DPI conducted an Open Day in September 2008 to monitor insect numbers and results and discuss with other landholders the use of these insects, which attracted over 40 people. Overall the insect control has been very successful. Some spraying has been undertaken on thicker areas away from the tree lines.
- Cape Weed - a pasture weed that has been subject to an ongoing spraying program with a good kill rate.
- Saffron Thistle - Spraying programs have been undertaken for this weed in the past. It is a difficult weed to control, occurring on the lower slopes with a late germination period.

The requirements of the Weed Management Plan will continue to be implemented.

11.4 Feral animal management

At Gadara Park there are three main feral animals controlled being: rabbits; foxes; and pigs. Each animal is assessed on a routine basis and baiting, trapping or shooting programs are implemented accordingly. Baiting of foxes using 1080 can be implemented on an individual farm or regional basis which is run by the Livestock Health and Pest Authorities. Rabbits are controlled by shooting, baiting, using 1080 and harbour destruction. Wild pigs are sometimes present at Gadara Park and are controlled by shooting and trapping.

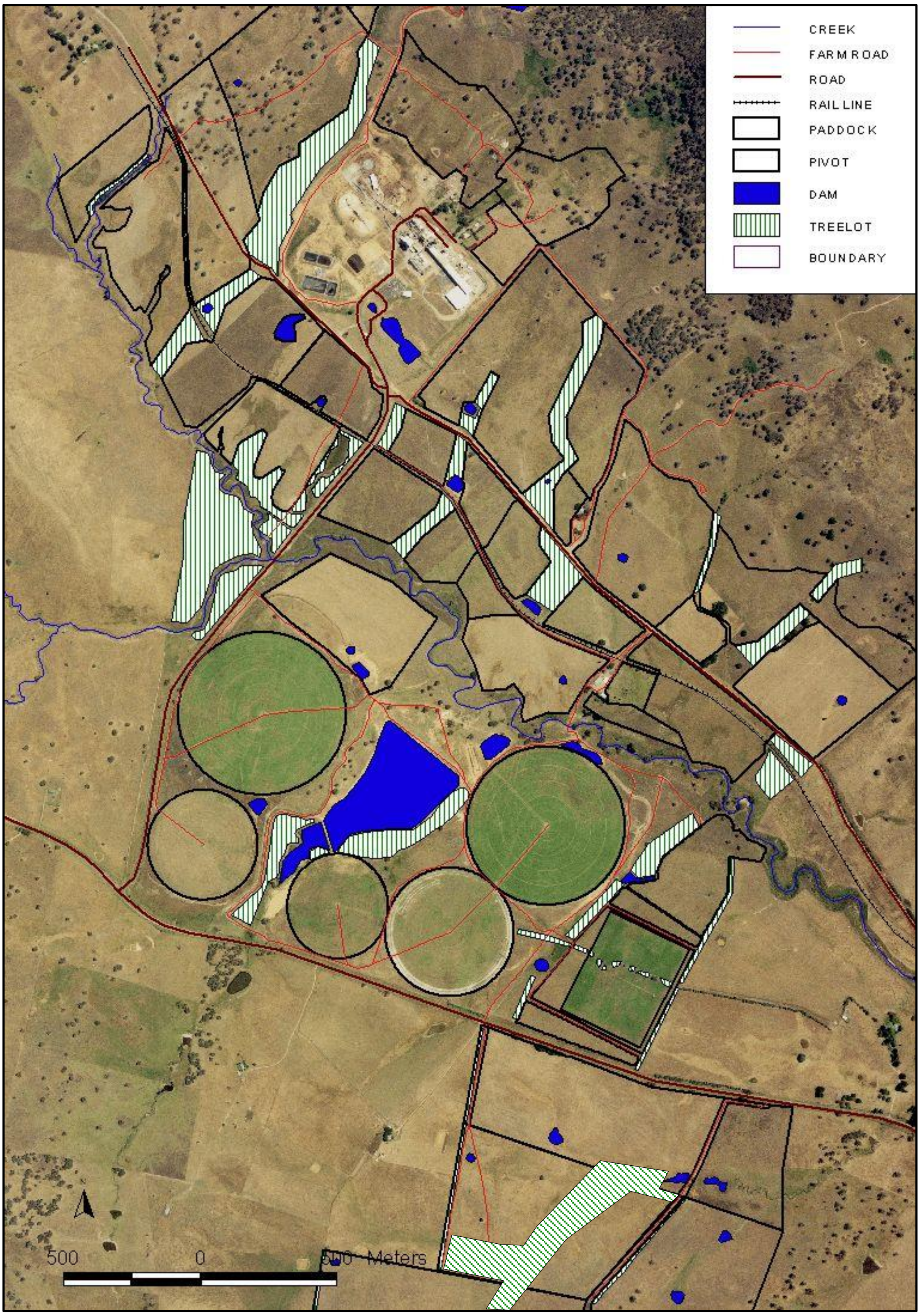


Figure 17: *Tree planting*

12.0 By-products and the soil amendment trial

The Soil Amendment Trial (SAT), for evaluating Visy mill by-products as soil ameliorants was completed in 2006 after the compilation and review of four years of soil testing, hay and silage analysis, animal tissue testing and by-product analysis.

The results show a marked increase in topsoil pH, after being measured as highly acidic pre-trial. Increased agricultural production has been a result of the correction in soil acidity, with improved nutrient availability and a greater variety of crops able to be grown.

Soil heavy metal levels have shown no significant increasing trends since the baseline testing was undertaken in 2001. Hay and silage analysis show heavy metals are not bio-accumulating in the plant tissue. Animal tissue testing indicates there are no food safety concerns, or any other concerns related to the heavy metals of interest.

Up until 30 June 2005, the criteria for the application of by-products was the Environmental Guidelines Use and Disposal of Biosolids Products, (NSW EPA, 1997). As of 1 July 2005, the EPA developed new draft guidelines in the “Land Protection Proposal” under the NSW Residue Waste Regulation. On 1 December 2005, amendments to the Protection of the Environment Operations (Waste) Regulation came into effect. The Regulation prohibited the use of the Visy by-products at Gadara Park, or otherwise, until a specific exemption is granted by the EPA.

After consultation with the EPA, Visy resumed the application of dregs & grits and lime mud in 2010 as the by-products satisfied the parameters as set out in the NSW Fertilisers Act, 1985.

300 tonnes of dregs & grits was land applied to 60 hectares of pasture in 2012 at a rate of 5 tonnes per hectare and 1,520 tonnes was applied to 600 hectares of pasture at a rate of 2.5 tonnes per hectare in January 2013. These applications were approved as one-off exemptions by the NSW EPA.

12.2 Summary of by-products at Visy

Three by-products from the paper making process were used at Gadara Park as soil ameliorants to improve agricultural production. These by-products are green liquor dregs, lime mud and fly ash. A fourth by-product (bottom sand) is inert sand which was previously used to line the roads around the farm, making the roads more readily accessible in wet weather. By-product testing results are provided in Attachment F.

12.2.1 Green liquor dregs

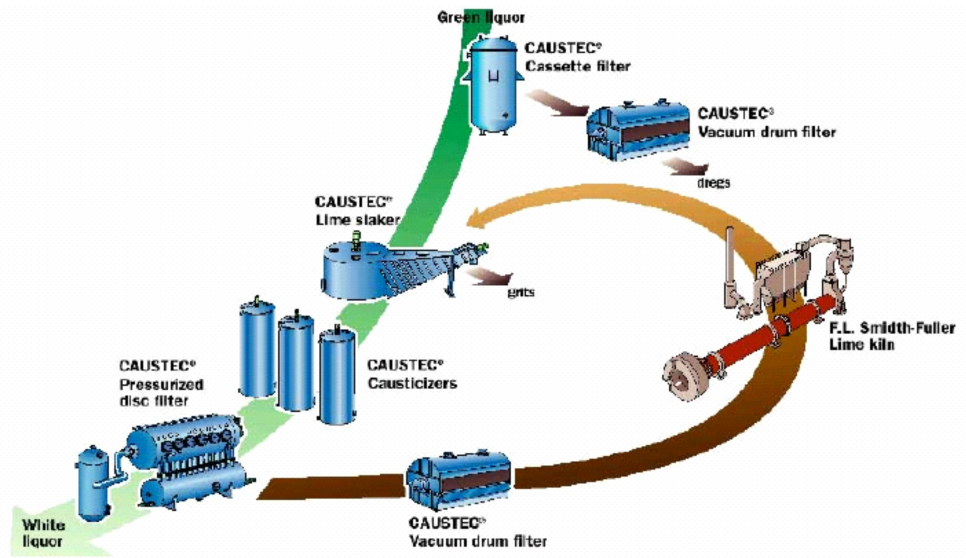
Green liquor dregs (process sediment) are a stabilised alkaline by-product. The source is un-burnt carbon and inorganics (calcium and iron compounds) from the green liquor smelt removed through clarification prior to re-causticising. Insoluble materials within the lime are separated and washed after slaking/causticising. The main components of the dregs and grits are calcium carbonate, unburnt carbon, and some sodium compounds. The benefits of the dregs and grits are the good liming characteristics that raise soil pH and subsequently improve fertility. The drawback of the dregs and grits is the presence of low-level contaminants in chromium, lead, nickel, zinc, and copper.

12.2.2 Lime mud

Lime mud is a stabilised alkaline product. It is obtained after decanting the white liquor following re-causticising. The lime mud is not returned to the lime kiln but is purged out of the system. The main compound of the lime mud is calcium carbonate. A greater amount of lime mud is produced, but the mill reuses the lime mud in the paper making process.

The benefit of the lime mud is its similarity to superfine agricultural lime. The lime mud has a neutralising value of around 95% which is classified as the highest grade agricultural lime. The drawback of the lime mud is low level contamination with lead.

The origin of the dregs, grits and lime mud can be identified below in Figure 18.



The Recausticising process

Figure 18: *Figure of the origins of the lime mud and dregs and grits by-products*

13.0 Sludge assessment

13.1. Sludge monitoring site

Twelve samples of sludge were collected in 2022/23 from the Sludge Balancing Tank. Sampling in June 2023 returned unusually high results for multiple parameters. It was also noted that during the sampling event, the sample was visibly darker, had a strong odour and had a substantial amount of particulate matter. All results can be seen in Attachment G. The sludge is transferred from the Sludge Balancing Tank to a trailer-mounted applicator from which the sludge is sprayed onto the paddocks. Approximately 280 kilolitres of sludge were land applied in 2022/23. The sludge applicator can be seen in Figure 19.

Up until 30 June 2005, the criteria for the application of by-products (including sludge) were the NSW EPA Environmental Guidelines Use and Disposal of Biosolids Products. As of 1 July 2005, the EPA developed new draft guidelines in the “Land Protection Proposal” under the NSW Residue Waste Regulation. On 1 December 2005 amendments to the Protection of the Environment Operations (Waste) Regulation came into effect. The Regulation prohibited the use of the Visy by-products (including sludge) at Gadara Park, or otherwise, until liaison and subsequent approval by EPA.

After consultation with EPA, sludge application resumed in May 2008. The application rates and paddock suitability on Gadara Park is determined by following the NSW Environmental Guidelines, Use and Disposal of Biosolids Products (NSW EPA, 1997).

Figure 19: *Sludge being applied to land (Colson 2002)*

13.2 Chemical analysis

BOD

The BOD of the sludge ranged from 6mg/L (July 2022) to 1240mg/L (June 2023). The average BOD result was 123mg/L which is slightly higher than the previous monitoring period's average of 92mg/L but still significantly lower than the 2020/21 monitoring period average of 442mg/L.

TDS

The TDS values of the sludge ranged from 37mg/L (November 2022) to 266mg/L (December 2022). The average TDS result was 177mg/L which is lower than the 2021/22 monitoring period average result of 206mg/L.

EC

The EC values ranged from 298µS/cm (September 2022) to 621µS/cm (February 2023).

Nitrogen and phosphorus

Total nitrogen levels ranged from 9mg/L (April 2023) to 491mg/L (June 2023). Phosphorus levels range from 1.48mg/L (September 2022) to 53.70mg/L (June 2023). Both total nitrogen and phosphorus results are similar to results from the previous five years.

pH

The pH of sludge is slightly acidic to slightly alkaline ranging from 6.8 to 7.9 and is generally in the desirable range for agricultural purposes (ANZG, 2018).

Suspended solids

The suspended solids ranged from 22mg/L (March 2023) to 1050mg/L (August 2022), with one elevated reading of 5320mg/L (June 2023). A visual inspection of the soil where the sludge has been applied indicates free draining topsoil with good porosity, therefore the presence of suspended solids in the sludge appears to have not adversely affected the drainage by blocking soil pores.

Oil and grease

Oil and grease levels ranged from <1mg/L (multiple readings) to 121mg/L (August 2022).

14.0 Recommendations summary

The following improvements to the monitoring program are recommended:

- Most of the thirty additional groundwater monitoring bores that were installed in 2005/06 have been damaged or destroyed in 2022/2023 when the pivots and paddocks were cultivated. An audit of the condition of these bores is recommended and bores that can glean useful information are recommended to be repaired or replaced.
- Soil moisture probes located in the pivots alongside the groundwater monitoring bores were also damaged or destroyed in the 2022/2023 period. An audit of the condition of these probes is recommended and probes that can glean useful information are recommended to be repaired or replaced.
- The naming protocols and sampling locations of the by-products were changed in July 2023, and these are recommended to be outlined in the 2023/2024 AEMR.
- The decant (point 10) sample point is recommended to be signposted for a consistent sampling location.
- The sludge sample location has recently been moved (July 2023) from the SBR to the Sludge Tank discharge line for improved safety. It is recommended this new sampling location be signposted for a consistent sampling location.
- Access to some of the groundwater monitoring locations on the farm is limited owing to gullies and rutted roads and improvement around this is recommended.

15.0 References

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16.0 General glossary

ANZECC	Australia and New Zealand Environment and Conservation Council
BTOC	Below Top of Casing
DEC	NSW Department of Environment and Conservation
DECCW	Department of Environment and Climate Change and Water NSW
DPI	Department of Primary Industries
EPA	Environment Protection Authority (NSW)
ET_c	Crop Evapotranspiration (ET_o multiplied by a Crop Factor)
ET_{pan}	Evaporation measured from a Standard Class A pan (in mm)
K_c	Crop Factor
ET_o	Potential Evapotranspiration calculated using the FAO Penman-Monteith formula (in mm)
NEPC	National Environment Protection Council
SAT	Soil Amendment Trial
TSC	Tumut Shire Council
WWTP	Waste Water Treatment Plant

17.0 Chemical glossary

Alkalinity	The capacity of water to neutralise acid
Al	Aluminium
AS	Aggregate Stability (using Emerson Aggregate Test)
BOD	Biological Oxygen Demand
Ca	Calcium
CEC	Cation Exchange Capacity
Cl	Chloride
EC	Electrical Conductivity
FC	Faecal Coliforms
K	Potassium
Mg	Magnesium
Mn	Manganese
N	Nitrogen
Na	Sodium
OC	Organic Carbon
OCP	Organochlorine Pesticides
P	Phosphorus
PBI	Phosphorus Buffer Index
Na	Sodium
S	Sulphur
SAR	Sodium Adsorption Ratio
SS	Suspended Solids
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
NV	Neutralising Value
ENV	Effective Neutralising Value
As	Arsenic
Cd	Cadmium
Cr	Chromium
Cu	Copper
Hg	Mercury
Ni	Nickel
Pb	Lead
Zn	Zinc
CP	Crude Protein
DM	Dry Matter
DMD	Digestibility
ME	Metabolisable Energy
NDF	Neutral Detergent Fibre
SolCHO	Water Soluble Carbohydrate

18.0 Attachments

Attachment	Details
A. Groundwater 2022-2023	3 pages
B. Surface water 2022-2023	1 page
C. Point 10 2022-2023	1 page
D. SMS October 2022 and April 2023	4 pages
E. Nutrient budget 2022-2023	9 pages
F. By-products 2022-2023	6 pages
G. Sludge 2022-2023	1 page

McMahon EARTH SCIENCE

DOCUMENT ATTACHMENTS

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Attachment A : *Groundwater 2022-2023*

Test Identity	Unit of measure	Critical Range	BH1 July 2022	BH1 Oct 2022	BH1 Jan 2023	BH1 Apr 2023	BH2 July 2022	BH2 Oct 2022	BH2 Jan 2023	BH2 Apr 2023	BH3 July 2022	BH3 Oct 2022	BH3 Jan 2023	BH3 Apr 2023
Conductivity	µS/cm	*350* [1]	375	-	390	-	132	-	151	-	124	-	417	-
Nitrate	ppm	*0.7* [1]	<1	-	0.7	-	4	-	2.7	-	3	-	<1	-
pH	pH units	*6.5-7.5* [1]	5.8	7.1	8.1	5.8	6.1	6.9	8.1	5.8	6.0	6.7	6.5	5.9

Test Identity	Unit of measure	Critical Range	BH7S July 2022	BH7S Oct 2022	BH7S Jan 2023	BH7S Apr 2023	BH7D July 2022	BH7D Oct 2022	BH7D Jan 2023	BH7D Apr 2023	BH11S July 2022	BH11S Oct 2022	BH11S Jan 2023	BH11S Apr 2023
Conductivity	µS/cm	*350* [1]	Dry	Dry	Dry	Dry	283	-	450	-	839	-	690	-
Nitrate	ppm	*0.7* [1]	Dry	Dry	Dry	Dry	<1	-	<1	-	<1	-	<1	-
pH	pH units	*6.5-7.5* [1]	Dry	Dry	Dry	Dry	6.1	6.5	6.5	6.2	7.0	7.2	7.0	6.8

Test Identity	Unit of measure	Critical Range	BH11D July 2022	BH11D Oct 2022	BH11D Jan 2023	BH11D Apr 2023
Conductivity	µS/cm	*350* [1]	800	-	832	-
Nitrate	ppm	*0.7* [1]	<1	-	<1	-
pH	pH units	*6.5-7.5* [1]	6.9	7.0	6.6	6.7

1. ANZG (2018) Australian & New Zealand Guidelines for Fresh & Marine Water Quality.

Bore Reference	Location
BH1	Onsite upstream of irrigated and by-product areas
BH2	Onsite upstream of irrigated and by-product areas
BH3	Deep bore off site to monitor upstream groundwater quality and any mounding as a result of the Winter storage
BH4	Deep bore to monitor groundwater quality upstream of irrigation areas, and downstream of Power Boiler Ash applied area
BH7S	Shallow bore to monitor groundwater quality upstream of irrigation areas and downstream of Power Boiler Ash and Lime Mud applied areas
BH7D	Deep bore to monitor groundwater quality upstream of irrigation areas and downstream of Power Boiler Ash and Lime Mud applied areas
BH11S	Shallow bore to monitor groundwater quality off site and upstream of irrigation and By-product applied areas
BH11D	Deep bore to monitor groundwater quality upstream of irrigated and By-product applied areas

Test Identity	Unit of measure	Critical Range	BH8S July 2022	BH8S Oct 2022	BH8S Jan 2023	BH8S Apr 2023	BH8D July 2022	BH8D Oct 2022	BH8D Jan 2023	BH8D Apr 2023	BH9 July 2022	BH9 Oct 2022	BH9 Jan 2023	BH9 Apr 2023
Conductivity	µS/cm	*350* [1]	511	-	644	-	592	-	556	-	253	-	430	-
Nitrate	ppm	*0.7* [1]	1	-	1.0	-	2	-	1.0	-	10	-	4.0	-
pH	pH units	*6.5-7.5* [1]	6.1	6.6	7.0	6.8	6.4	6.6	6.7	7.0	6.4	6.7	6.8	6.8

Test Identity	Unit of measure	Critical Range	BH10 July 2022	BH10 Oct 2022	BH10 Jan 2023	BH10 Apr 2023	BH15S July 2022	BH15S Oct 2022	BH15S Jan 2023	BH15S Apr 2023	BH15D July 2022	BH15D Oct 2022	BH15D Jan 2023	BH15D Apr 2023
Conductivity	µS/cm	*350* [1]	715	-	694	-	413	-	340	-	340	-	392	-
Nitrate	ppm	*0.7* [1]	10	-	5.6	-	<1	-	2.2	-	10	-	2.6	-
pH	pH units	*6.5-7.5* [1]	7.0	7.3	6.8	6.8	7.4	7.1	7.0	7.1	7.1	7.3	7.2	6.8

1. ANZG (2018) Australian & New Zealand Guidelines for Fresh & Marine Water Quality.

Bore Reference	Location
BH8S	Shallow bore to monitor groundwater quality downstream of irrigated, By-product and Sludge applied areas
BH8D	Deep bore to monitor groundwater quality downstream of irrigated, Lime Mud, Power Boiler Ash and Sludge applied areas
BH9	Deep bore to monitor groundwater quality downstream of the irrigated and By-product applied areas
BH10D	Deep bore to monitor groundwater quality off site and downstream of irrigated and By-product applied areas
BH15S	Shallow bore to monitor groundwater quality downstream of irrigated and By-product applied areas
BH15D	Deep bore to monitor groundwater quality downstream of irrigated and By-product applied areas

Test Identity	Unit of measure	Critical Range	BH13 July 2022	BH13 Oct 2022	BH13 Jan 2023	BH13 Apr 2023	BH14 July 2022	BH14 Oct 2022	BH14 Jan 2023	BH14 Apr 2023	BH16 July 2022	BH16 Oct 2022	BH16 Jan 2023	BH16 Apr 2023
Conductivity	µS/cm	*350* [1]	1080	-	1070	-	780	-	810		1630	-	1510	-
Nitrate	ppm	*0.7* [1]	<1	-	<1	-	<1	-	<1		1	-	<1	-
pH	pH units	*6.5-7.5* [1]	7.3	7.2	6.9	7.0	7.0	7.1	6.8	6.9	7.7	7.7	8.9	7.4

Test Identity	Unit of measure	Critical Range	BH17 July 2022	BH17 Oct 2022	BH17 Jan 2023	BH17 Apr 2023
Conductivity	µS/cm	*350* [1]	1270	-	1270	-
Nitrate	ppm	*0.7* [1]	1	-	<1	-
pH	pH units	*6.5-7.5* [1]	7.6	7.6	8.3	7.5

1. ANZG (2018) Australian & New Zealand Guidelines for Fresh & Marine Water Quality.

Bore Reference	Location
BH13	Shallow bore to monitor seepage from the Winter Storage Dam
BH14	Shallow bore to monitor seepage from the Winter Storage
BH16 and BH17	Shallow bores to monitor seepage from the Winter Storage Dam

Attachment B : *Surface water 2022-2023*

Surface water monitoring

Test Identity	Critical Range	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2
		Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
		20/10/22	**2/11/22**	**5/12/22**	**9/1/23**	**2/2/23**	**2/3/23**	**5/4/23**	**1/5/23**	**20/10/22**	**2/11/22**	**5/12/22**	**9/1/23**	**2/2/23**	**2/2/23**	**5/4/23**	**1/5/23**
pH (pH units)	*6.5-7.5* [1]	7.8	6.8	7.2	8.4	8.1	7.0	6.5	6.4	7.9	6.6	7.3	8.4	8.2	7.0	6.8	6.7
Total dissolved solids (mg/L)	*N/A*	82	87	145	196	210	233	287	234	115	83	183	207	190	266	217	253
BOD (mg/L)	*<15* [1]	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total suspended solids (mg/L)	*<45* [2]	10	286	<2	10	28	8	9	<2	7	98	4	15	20	20	17	47
Zinc (mg/L)	*<0.008* [1]	0.009	0.012	0.002	<0.002	0.002	<0.002	0.004	0.004	0.008	0.011	0.004	<0.002	0.002	<0.002	0.005	0.008
Phosphorus (total) (mg/L)	*<0.02* [1]	0.05	0.33	0.04	0.08	<0.01	0.02	<0.01	0.13	0.04	0.17	0.14	0.09	0.01	<0.01	0.06	0.28
Nitrogen (total) (mg/L)	*<0.25* [1]	<2	<2	<2	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Manganese (mg/L)	*<1.9* [1]	0.069	0.611	0.130	0.126	0.133	0.013	0.073	0.006	0.104	0.222	0.105	0.144	0.141	0.019	0.207	0.020
Conductivity (µS/cm	*<350* [1]	156	80	242	353	378	427	488	410	219	102	304	419	385	451	421	370
Faecal Coliforms (fc	*<150* [1]	45	880	230	320	250	22	32	110	130	2000	170	440	380	4	62	900
Oil & Grease (mg/L	*<5* [2]	4	4	2	<1	<1	<1	<1	<1	1	4	1	<1	<1	<1	1	<1

Test Identity	Critical Range	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4
		Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
		20/10/22	**2/11/22**	**5/12/22**	**9/1/23**	**2/2/23**	**2/3/23**	**5/4/23**	**1/5/23**	**20/10/22**	**2/11/22**	**5/12/22**	**9/1/23**	**2/2/23**	**2/3/23**	**5/4/23**	**1/5/23**
pH (pH units)	*6.5-7.5* [1]	8.1	6.9	7.5	8.3	8.1	7.4	7.0	6.8	8.0	6.9	7.4	8.2	8.1	7.5	7.1	6.9
Total dissolved solids (mg/L)	*N/A*	113	24	202	245	232	286	319	290	105	62	200	288	274	362	315	337
BOD (mg/L)	*<15* [1]	<2	<2	3	<2	<2	<2	<2	3	3	<2	2	4	4	12	5	<2
Total suspended solids (mg/L)	*<45* [2]	7	162	6	41	30	18	37	57	30	17	11	26	26	90	78	14
Zinc (mg/L)	*<0.008* [1]	0.009	0.010	0.006	0.002	<0.002	<0.002	0.019	0.007	0.016	0.022	0.050	0.004	0.006	0.006	0.135	0.009
Phosphorus (total) (mg/L)	*<0.02* [1]	<0.01	0.16	0.07	0.08	<0.01	<0.01	0.07	0.18	0.16	0.15	0.18	0.23	0.11	0.15	0.31	0.15
Nitrogen (total) (mg/L)	*<0.25* [1]	<2	<2	<2	<2	<2	<2	<2	<2	2	2	3	2	3	5	<2	3
Manganese (mg/L)	*<1.9* [1]	0.086	0.255	0.105	0.124	0.133	0.019	0.203	0.023	0.498	0.402	0.132	0.067	0.078	0.032	<0.001	0.018
Conductivity (µS/cm	*<350* [1]	216	99	333	436	413	494	482	417	200	89	328	502	477	582	551	555
Faecal Coliforms (fc	*<150* [1]	685	1280	300	3800	200	<1	14	3000	1470	2890	1000	27	556	<1	2	380
Oil & Grease (mg/L	*<5* [2]	2	6	2	<1	<1	<1	1	2	2	5	1	<1	1	1	<1	2

Test Identity	Critical Range	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5
		Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
		20/10/22	**2/11/22**	**5/12/22**	**9/1/23**	**2/2/23**	**2/3/23**	**5/4/23**	**1/5/23**
pH (pH units)	*6.5-7.5* [1]	8.0	7.0	7.7	8.2	8.1	7.5	7.1	7.0
Total dissolved solids (mg/L)	*N/A*	115	84	180	233	216	259	249	254
BOD (mg/L)	*<15* [1]	<2	<2	<2	<2	<2	<2	<2	<2
Total suspended solids (mg/L)	*<45* [2]	2	120	5	14	21	16	10	25
Zinc (mg/L)	*<0.008* [1]	0.008	0.008	0.002	0.003	0.002	<0.002	0.005	0.008
Phosphorus (total) (mg/L)	*<0.02* [1]	0.06	0.17	0.04	0.18	0.02	<0.01	<0.01	0.13
Nitrogen (total) (mg/L)	*<0.25* [1]	<2	<2	<2	<2	3	3	<2	<2
Manganese (mg/L)	*<1.9* [1]	0.099	0.092	0.096	0.156	0.122	0.057	0.232	0.022
Conductivity (µS/cm	*<350* [1]	219	105	309	418	387	453	436	368
Faecal Coliforms (fc	*<150* [1]	216	1000	220	410	420	8	6	720
Oil & Grease (mg/L	*<5* [2]	2	5	1	<1	1	<1	1	2

1. ANZG (2018) *Australian & New Zealand Guidelines for Fresh & Marine Water Quality* .
2. Visy P & P (2001) *NSW EPA Licence Variation Appendix 20232* .

Sampling Sites	Location
SW1	Sandy Creek upstream of Winter Storage Dam
SW2	Sandy Creek downstream of Winter Storage Dam
SW3	Deep Creek
SW4	Upstream of Winter Storage Dam
SW5	Downstream of Winter Storage Dam

Attachment C : *Point 10 2022-2023*

Monitoring Point 10 - DECANT

Grab sample

Pollutant	Unit of measure	Critical Range	Wastewater monitoring 2022-23					
			2/08/2022	2/09/2022	2/11/2022	2/02/2023	5/04/2023	1/06/2023
BOD	mg/L	<40 [1]	5	12	13	8	14	6
Nitrogen (total)	mg/L	<20 [1]	4	4	5	4	<2	6
Oil & Grease	mg/L	<5 [1]	2	2	2	5	<1	<1
pH	pH	5.5-9.5 [1]	7.9	7.1	7.8	7.5	7.2	7.2
Phosphorus (total)	mg/L	<5 [1]	0.28	0.57	0.96	0.23	0.35	1.05
Total Suspended Solids	mg/L	<45 [1]	20	28	40	14	11	5
Total Dissolved Solids	mg/L	<1000	108	115	169	222	166	138
Sodium Adsorption Ratio	SAR	<4.5 [2]	4	4	5	5	4	3
Zinc	mg/L	no data	0.022	0.020	0.049	0.055	0.021	0.025

1. Visy P & P (2016) NSW EPA Licence 10232. Chatswood, NSW.

2. DEC (2004) NSW EPA Environmental Guidelines. Use of Effluent by Irrigation. Chatswood, NSW.

Attachment D : *SMS October 2022 and April 2023*

Parameter	Desirable Range	Soil Monitoring Sites (SMS) - 12 October 2022						
		SMS1	SMS2	SMS3	SMS4	SMS5	SMS6	SMS7
		0-10cm	0-10cm	0-10cm	0-10cm	0-10cm	0-10cm	0-10cm
Nitrate Nitrogen (ppm)	>30[3]	3.1	1.9	1.8	1.7	1.7	0.8	1.6
Phosphorus - Colwell (ppm)	>30[3]	65	18	16	8	75	140	47
Phosphorus - (available) Bray (ppm)	>30[3]	10	14	15	14	16	17	<5
P Buffer Index (PBI)	> 30[4]	70	82	54	54	97	110	150
Available K (ppm)	> 225	110	76	68	56	250	160	130
Sulphate Sulphur (KCl40) (ppm)	>10[1]	3	7	3	2	4	6	4
DTPA Zinc (ppm)	1 - 5[6]	4.0	3.0	2.5	1.6	3.9	6.5	2.1
DTPA Copper (ppm)	0.2 - 5[6]	0.8	0.46	0.22	0.33	1.9	0.62	0.33
DTPA Iron (ppm)	*no data*	330	390	210	210	150	150	610
DTPA Manganese (ppm)	1 - 5[6]	16	34	9.6	7	9	18	11
Boron (ppm)	>0.3[2]	0.5	0.5	0.4	0.4	0.6	0.7	0.4
EC (dS/m)	<0.5[1]	0.05	0.06	0.04	0.04	0.12	0.06	0.04
ECe (dS/m)	<2[1]	0.4	0.6	0.4	0.3	1.2	0.6	0.4
Organic C (% C)	2[1]	2.2	3.1	2.3	2	2.7	3.7	3
Chloride (ppm)	< 125[4]	<10	21	19	<10	<10	14	<10
pH (H2O)	6 - 8[1]	6.5	6.4	6.5	6.6	8	6.7	5.8
pH (CaCl2)	5.5 - 7[1]	5.6	5.4	5.6	5.7	7.3	6	4.8
CEC (meq/100gm)	5 - 15[1]	8.1	7.8	7.8	7.6	18.2	13.1	4.9
Exchangeable Aluminium (ppm)	*no data*	0	0	0	0	0	0	0
Exchangeable Potassium (ppm)	*no data*	109.5	74.3	0	54.7	254.2	160.3	129.0
Exchangeable Sodium (ppm)	*no data*	25.3	89.7	39.1	0	34.5	29.9	0
Exchangeable Magnesium (ppm)	*no data*	121.6	133.7	145.9	97.2	109.4	158.2	72.9
Exchangeable Calcium (ppm)	*no data*	1342.7	1242.5	1242.50	1302.6	3406.8	2204.4	761.5
Aluminium (meq/100gm)*	<1[2]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Calcium (meq/100gm)	n/a	6.7	6.2	6.2	6.5	17.0	11.0	3.8
Magnesium (meq/100gm)	n/a	1	1.1	1.2	0.8	0.9	1.3	0.6
Sodium (meq/100gm)	<4.3[2]	0.11	0.39	0.17	0.15	0.15	0.13	0.03
Potassium (meq/100gm)	*no data*	0.28	0.19	0.17	0.14	0.65	0.41	0.33
Ca:Mg Ratio	>2[1]	7.1	5.6	5.2	8.0	20.0	8.5	6.7
K:Mg Ratio	*no data*	-	-	-	-	-	-	-
Aluminium %	<5%[1]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium %	65-80%[1]	82.8	78.7	81.9	87.4	90.9	85.7	80.3
Magnesium %	10-15%[1]	12.4	14.0	15.9	10.8	4.8	10.1	12.7
Sodium %	<5%[1]	1.4	4.9	2.2	<1.0	0.8	1.0	<1.0
Potassium %	1-5%[1]	3.5	2.4	<1.0	1.9	3.5	3.2	7.0
EAT (H2O Class)	*no data*	7	8	8	7	7	8	6
EAT (Low SAR Class)	*no data*	-	-	-	-	-	-	-
EAT (High SAR Class)	*no data*	-	-	-	-	-	-	-
Aluminium total (mg/kg)	*no data*	4440	2620	2780	4010	2990	3480	3990
Arsenic (mg/kg)	<20[7]	-	-	-	-	-	-	-
Cadmium (mg/kg)	<1[7]	-	-	-	-	-	-	-
Chromium (mg/kg)	<100[7]	-	-	-	-	-	-	-
Copper (mg/kg)	<100[7]	-	-	-	-	-	-	-
Lead (mg/kg)	<150[7]	-	-	-	-	-	-	-
Mercury (mg/kg)	<1[7]	-	-	-	-	-	-	-
Nickel (mg/kg)	<60[7]	-	-	-	-	-	-	-
Zinc (mg/kg)	<200[7]	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen (mg/kg)	500-3000[4]	2020	2440	2480	1930	2430	2020	2620
Total Phosphorus (mg/kg)	>30[4]	201	202	199	185	222	241	201

1. NSW Agriculture (1998) Interpreting Soil Results: Rules of Thumb. NSW Agriculture, Wagga Wagga
2. Soils: their properties and management: a soil conservation handbook for NSW. (1991) Ed. Charman & Murphy. Oxford University Press.
3. Gunter S (1997) Understanding Soil Tests. NSW Agriculture Publication, Tamworth.
4. Peverill, Sparrow & Reuter (1999) Soil Analysis: An Interpretation Manual. CSIRO Publishing, Collingwood.
5. Incitec Fertilisers et al. Technical Bulletin.
6. Soil Description Book (1997), Ken Wetherby, Cleve SA
7. NSW EPA (1997) Environmental Guidelines: Use & Disposal of Biosolids Products. NSW EPA Publication, Chatswood.MASCC Agricultural Land

Parameter	Desirable Range	Soil Monitoring Sites (SMS) - 12 October 2022						
		SMS1	SMS2	SMS3	SMS4	SMS5	SMS6	SMS7
		50-60cm	50-60cm	50-60cm	50-60cm	50-60cm	50-60cm	50-60cm
Nitrate Nitrogen (ppm)	>30[3]	1.6	<0.5	0.7	1.6	1.6	0.8	5.4
Phosphorus - Colwell (ppm)	>30[3]	<5	<5	<5	6	7	<5	<5
Phosphorus - (available) Bray (ppm)	>30[3]	<5	<5	<5	<5	<5	<5	<5
P Buffer Index (PBI)	> 30[4]	230	55	160	400	400	370	460
Available K (ppm)	> 225	170	31	42	56	370	100	33
Sulphate Sulphur (KCl40) (ppm)	>10[1]	31	8	13	34	9	56	9
DTPA Zinc (ppm)	1 - 5[6]	0.12	0.15	0.20	0.04	0.19	0.11	0.12
DTPA Copper (ppm)	0.2 - 5[6]	0.26	0.09	0.08	0.12	0.24	0.03	0.06
DTPA Iron (ppm)	*no data*	22	50	30	8	14	3	9
DTPA Manganese (ppm)	1 - 5[6]	2.1	2.6	2.5	2.4	0.7	1.0	0.7
Boron (ppm)	>0.3[2]	0.1	0.1	0.2	0.2	0.9	0.2	0.1
EC (dS/m)	<0.5[1]	0.10	0.04	0.07	0.09	0.07	0.08	0.02
ECe (dS/m)	<2[1]	0.6	0.2	0.4	0.6	0.4	0.5	0.1
Organic C (% C)	2[1]	0.4	0.2	0.4	0.4	0.5	0.2	0.3
Chloride (ppm)	< 125[4]	11	<10	24	<10	<10	14	<10
pH (H2O)	6 - 8[1]	7.0	6.3	6.3	5.9	7.7	5.7	5.2
pH (CaCl2)	5.5 - 7[1]	6.1	4.6	4.9	4.7	6.8	4.7	4.1
CEC (meq/100gm)	5 - 15[1]	10.5	5.0	10.4	7.4	9.6	8.6	6.6
Exchangeable Aluminium (ppm)	*no data*	0.0	36.0	0.0	0.0	9.0	36.0	251.8
Exchangeable Potassium (ppm)	*no data*	168.1	31.3	0.0	0.0	0.0	101.7	31.3
Exchangeable Sodium (ppm)	*no data*	160.9	160.9	252.9	275.9	75.9	158.6	0.0
Exchangeable Magnesium (ppm)	*no data*	340.3	206.6	474.0	279.6	218.8	291.7	303.9
Exchangeable Calcium (ppm)	*no data*	1322.6	440.9	1002.0	661.3	1302.6	982.0	220.4
Aluminium (meq/100gm)	<1[2]	0.1	0.4	0.4	0.4	0.1	0.4	2.8
Calcium (meq/100gm)	n/a	6.6	2.2	5.0	3.3	6.5	4.9	1.1
Magnesium (meq/100gm)	n/a	2.8	1.7	3.9	2.3	1.8	2.4	2.5
Sodium (meq/100gm)	<4.3[2]	0.7	0.7	1.1	1.2	0.3	0.7	0.1
Potassium (meq/100gm)	*no data*	0.4	0.1	0.1	0.1	1.0	0.3	0.1
Ca:Mg Ratio	>2[1]	2.4	1.3	1.3	1.4	3.6	2.0	0.4
K:Mg Ratio	*no data*	-	-	-	-	-	-	-
Aluminium %	<5%[1]	0.9	7.9	3.8	5.4	1.0	4.6	42.6
Calcium %	65-80%[1]	62.7	47.0	50.0	48.5	75.3	59.4	29.9
Magnesium %	10-15%[1]	26.6	36.3	39.0	33.8	20.9	29.1	67.9
Sodium %	<5%[1]	6.6	15.0	11.0	17.6	3.8	8.4	<1.0
Potassium %	1-5%[1]	4.1	1.7	<1.0	<1.0	<1.0	3.2	2.2
EAT (H2O Class)	*no data*	5	5	5	5	5	6	6
EAT (Low SAR Class)	*no data*	-	-	-	-	-	-	-
EAT (High SAR Class)	*no data*	-	-	-	-	-	-	-
Aluminium total (mg/kg)	*no data*	43200	35400	78100	71100	45500	47800	39800
Arsenic (mg/kg)	<20[7]	-	-	-	-	-	-	-
Cadmium (mg/kg)	<1[7]	-	-	-	-	-	-	-
Chromium (mg/kg)	<100[7]	-	-	-	-	-	-	-
Copper (mg/kg)	<100[7]	-	-	-	-	-	-	-
Lead (mg/kg)	<150[7]	-	-	-	-	-	-	-
Mercury (mg/kg)	<1[7]	-	-	-	-	-	-	-
Nickel (mg/kg)	<60[7]	-	-	-	-	-	-	-
Zinc (mg/kg)	<200[7]	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen (mg/kg)	500-3000[4]	390	201	376	400	555	999	766
Total Phosphorus (mg/kg)	>30[4]	55	60	61	66	71	69	71

1. NSW Agriculture (1998) Interpreting Soil Results: Rules of Thumb. NSW Agriculture, Wagga Wagga
2. Soils: their properties and management: a soil conservation handbook for NSW. (1991) Ed. Charman & Murphy. Oxford University Press.
3. Gunter S (1997) Understanding Soil Tests. NSW Agriculture Publication, Tamworth.
4. Peverill, Sparrow & Reuter (1999) Soil Analysis: An Interpretation Manual. CSIRO Publishing, Collingwood.
5. Incitec Fertilisers et al. Technical Bulletin.
6. Soil Description Book (1997), Ken Wetherby, Cleve SA
7. NSW EPA (1997) Environmental Guidelines: Use & Disposal of Biosolids Products. NSW EPA Publication, Chatswood.MASCC Agricultural Land

Parameter	Desirable Range	Soil Monitoring Sites (SMS) - 11 April 2023						
		SMS1	**SMS2**	**SMS3**	**SMS4**	**SMS5**	**SMS6**	**SMS7**
		0-10cm	0-10cm	0-10cm	0-10cm	0-10cm	0-10cm	0-10cm
Nitrate Nitrogen (ppm)	>30[3]	13.0	22.0	9.1	20.0	4.9	9.8	16.0
Phosphorus - Colwell (ppm)	>30[3]	23	22	17	38	80	62	75
Phosphorus - (available) Bray (ppm)	>30[3]	11	14	15	14	21	20	21
P Buffer Index (PBI)	> 30[4]	62	46	56	45	73	82	100
Available K (ppm)	> 225	63	110	38	89	99	220	120
Sulphate Sulphur (KCl40) (ppm)	>10[1]	5	7	6	5	6	5	2
DTPA Zinc (ppm)	1 - 5[6]	2.2	2.5	1.5	1.6	2.0	5.8	2.3
DTPA Copper (ppm)	0.2 - 5[6]	0.99	0.25	0.41	0.36	0.50	0.46	0.33
DTPA Iron (ppm)	*no data*	170	130	190	150	190	150	340
DTPA Manganese (ppm)	1 - 5[6]	12.0	13.0	5.4	5.3	7.7	8.5	6.6
Boron (ppm)	>0.3[2]	0.4	0.4	0.3	0.4	0.5	0.6	0.4
EC (dS/m)	<0.5[1]	0.06	0.08	0.06	0.06	0.07	0.08	0.05
ECe (dS/m)	<2[1]	0.5	0.6	0.5	0.5	0.7	0.6	0.4
Organic C (% C)	2[1]	1.9	2.5	1.6	2.0	2.9	3.3	3.1
Chloride (ppm)	< 125[4]	<10	14	13	<10	11	<10	<10
pH (H2O)	6 - 8[1]	6.7	6.7	6.8	6.7	7.1	7.1	5.9
pH (CaCl2)	5.5 - 7[1]	5.8	5.9	5.7	5.8	6.2	6.2	4.9
CEC (meq/100gm)	5 - 15[1]	6.1	7.5	5.7	6.7	9.8	12.0	4.9
Exchangeable Aluminium (ppm)	*no data*	0	0	0	0	0	0	0
Exchangeable Potassium (ppm)	*no data*	62.6	109.5	39.1	89.9	97.8	219.0	117.3
Exchangeable Sodium (ppm)	*no data*	73.6	80.5	80.5	69.0	57.5	92.0	4.6
Exchangeable Magnesium (ppm)	*no data*	109.4	133.7	85.1	133.7	85.1	182.3	73.0
Exchangeable Calcium (ppm)	*no data*	941.9	1142.3	901.8	1002.0	1723.4	1903.8	781.6
Aluminium (meq/100gm)*	<1[2]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Calcium (meq/100gm)	n/a	4.7	5.7	4.5	5	8.6	9.5	3.9
Magnesium (meq/100gm)	n/a	0.9	1.1	0.7	1.1	0.7	1.5	0.6
Sodium (meq/100gm)	<4.3[2]	0.3	0.4	0.35	0.3	0.25	0.4	<0.02
Potassium (meq/100gm)	*no data*	0.2	0.3	0.1	0.2	0.3	0.6	0.3
Ca:Mg Ratio	>2[1]	5.0	5.2	6.4	4.5	12.0	6.3	6.8
K:Mg Ratio	*no data*	-	-	-	-	-	-	-
Aluminium %	<5%[1]	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4
Calcium %	65-80%[1]	77.3	76.7	79.6	75.4	87.8	79.4	80.9
Magnesium %	10-15%[1]	14.8	14.8	12.4	16.6	7.1	12.5	12.4
Sodium %	<5%[1]	5.3	4.7	6.2	4.5	2.6	3.3	0.4
Potassium %	1-5%[1]	2.6	3.8	1.8	3.5	2.6	4.7	6.2
EAT (H2O Class)	*no data*	7	8	7	7	7	7	8
EAT (Low SAR Class)	*no data*	-	-	-	-	-	-	-
EAT (High SAR Class)	*no data*	-	-	-	-	-	-	-
Aluminium total (mg/kg)	*no data*	4580	2280	3180	3990	3240	3910	4020
Arsenic (mg/kg)	<20[7]	-	-	-	-	-	-	-
Cadmium (mg/kg)	<1[7]	-	-	-	-	-	-	-
Chromium (mg/kg)	<100[7]	-	-	-	-	-	-	-
Copper (mg/kg)	<100[7]	-	-	-	-	-	-	-
Lead (mg/kg)	<150[7]	-	-	-	-	-	-	-
Mercury (mg/kg)	<1[7]	-	-	-	-	-	-	-
Nickel (mg/kg)	<60[7]	-	-	-	-	-	-	-
Zinc (mg/kg)	<200[7]	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen (mg/kg)	500-3000[4]	1780	1810	1890	2010	2280	3120	3660
Total Phosphorus (mg/kg)	>30[4]	188	190	177	181	199	202	188

1. NSW Agriculture (1998) Interpreting Soil Results: Rules of Thumb. NSW Agriculture, Wagga Wagga
2. Soils: their properties and management: a soil conservation handbook for NSW. (1991) Ed. Charman & Murphy. Oxford University Press.
3. Gunter S (1997) Understanding Soil Tests. NSW Agriculture Publication, Tamworth.
4. Peverill, Sparrow & Reuter (1999) Soil Analysis: An Interpretation Manual. CSIRO Publishing, Collingwood.
5. Incitec Fertilisers et al. Technical Bulletin.
6. Soil Description Book (1997), Ken Wetherby, Cleve SA
7. NSW EPA (1997) Environmental Guidelines: Use & Disposal of Biosolids Products. NSW EPA Publication, Chatswood.MASCC Agricultural Land

Parameter	Desirable Range	Soil Monitoring Sites (SMS) - 11 April 2023						
		SMS1	SMS2	SMS3	SMS4	SMS5	SMS6	SMS7
		50-60cm	50-60cm	50-60cm	50-60cm	50-60cm	50-60cm	50-60cm
Nitrate Nitrogen (ppm)	>30[3]	<0.5	1.1	<0.5	2.4	<0.5	<0.5	4.7
Phosphorus - Colwell (ppm)	>30[3]	<5	<5	<5	<5	6	24	<5
Phosphorus - (available) Bray (ppm)	>30[3]	<5	<5	<5	<5	<5	<5	<5
P Buffer Index (PBI)	> 30[4]	320	67	76	110	31	170	310
Available K (ppm)	> 225	57	48	15	35	6	360	24
Sulphate Sulphur (KCl40) (ppm)	>10[1]	55	20	15	7	3	15	22
DTPA Zinc (ppm)	1 - 5[6]	0.60	2.40	1.80	0.15	0.14	2.00	0.11
DTPA Copper (ppm)	0.2 - 5[6]	0.15	0.21	0.19	0.31	0.09	0.37	0.08
DTPA Iron (ppm)	*no data*	9	37	32	17	22	52	10
DTPA Manganese (ppm)	1 - 5[6]	0.7	4.1	4.0	0.8	1.4	2.2	1.8
Boron (ppm)	>0.3[2]	0.3	1.9	1.2	0.2	0.1	0.6	0.3
EC (dS/m)	<0.5[1]	0.14	0.06	0.06	0.04	0.03	0.08	0.03
ECe (dS/m)	<2[1]	0.9	0.4	0.4	0.2	0.3	0.5	0.2
Organic C (% C)	2[1]	0.3	0.2	0.3	0.3	<0.2	0.3	0.4
Chloride (ppm)	< 125[4]	56	11	14	<10	<10	<10	<10
pH (H2O)	6 - 8[1]	6.0	6.3	6.6	7.3	7.0	6.0	5.7
pH (CaCl2)	5.5 - 7[1]	4.9	4.5	5.1	6.1	6.1	4.5	4.6
CEC (meq/100gm)	5 - 15[1]	9.1	5.3	5.0	6.2	1.8	9.7	7.3
Exchangeable Aluminium (ppm)	*no data*	0.0	54.0	0.0	0.0	9.0	107.9	80.9
Exchangeable Potassium (ppm)	*no data*	58.7	46.9	0.0	0.0	0.0	359.7	23.5
Exchangeable Sodium (ppm)	*no data*	344.9	163.2	165.5	87.4	25.3	216.1	0.0
Exchangeable Magnesium (ppm)	*no data*	619.9	267.4	194.5	133.7	12.2	376.8	316.0
Exchangeable Calcium (ppm)	*no data*	400.8	360.7	460.9	921.8	320.6	701.4	741.5
Aluminium (meq/100gm)	<1[2]	0.3	0.6	0.3	<0.1	<0.1	1.2	0.9
Calcium (meq/100gm)	n/a	2.0	1.8	2.3	4.6	1.6	3.5	3.7
Magnesium (meq/100gm)	n/a	5.1	2.2	1.6	1.1	0.1	3.1	2.6
Sodium (meq/100gm)	<4.3[2]	1.50	0.71	0.72	0.38	0.11	0.94	0.09
Potassium (meq/100gm)	*no data*	0.2	0.1	0.0	0.1	0.0	0.9	0.1
Ca:Mg Ratio	>2[1]	0.4	0.8	1.4	4.2	19.0	1.1	1.4
K:Mg Ratio	*no data*	-	-	-	-	-	-	-
Aluminium %	<5%[1]	3.3	11.0	6.0	1.6	5.2	12.4	12.2
Calcium %	65-80%[1]	22.9	37.3	49.4	74.6	87.4	41.4	57.4
Magnesium %	10-15%[1]	58.3	45.5	34.3	17.8	5.5	36.6	40.3
Sodium %	<5%[1]	17.1	14.7	15.5	6.2	6.0	11.1	1.4
Potassium %	1-5%[1]	1.7	2.5	0.9	1.5	1.1	10.9	0.9
EAT (H2O Class)	*no data*	6	3	5	5	3	5	6
EAT (Low SAR Class)	*no data*	-	-	-	-	-	-	-
EAT (High SAR Class)	*no data*	-	-	-	-	-	-	-
Aluminium total (mg/kg)	*no data*	41800	35500	81400	69900	31800	38800	35500
Arsenic (mg/kg)	<20[7]	-	-	-	-	-	-	-
Cadmium (mg/kg)	<1[7]	-	-	-	-	-	-	-
Chromium (mg/kg)	<100[7]	-	-	-	-	-	-	-
Copper (mg/kg)	<100[7]	-	-	-	-	-	-	-
Lead (mg/kg)	<150[7]	-	-	-	-	-	-	-
Mercury (mg/kg)	<1[7]	-	-	-	-	-	-	-
Nickel (mg/kg)	<60[7]	-	-	-	-	-	-	-
Zinc (mg/kg)	<200[7]	-	-	-	-	-	-	-
Total Kjeldahl Nitrogen (mg/kg)	500-3000[4]	499	299	595	587	555	888	747
Total Phosphorus (mg/kg)	>30[4]	72	69	89	85	86	95	80

1. NSW Agriculture (1998) Interpreting Soil Results: Rules of Thumb. NSW Agriculture, Wagga Wagga
2. Soils: their properties and management: a soil conservation handbook for NSW. (1991) Ed. Charman & Murphy. Oxford University Press.
3. Gunter S (1997) Understanding Soil Tests. NSW Agriculture Publication, Tamworth.
4. Peverill, Sparrow & Reuter (1999) Soil Analysis: An Interpretation Manual. CSIRO Publishing, Collingwood.
5. Incitec Fertilisers et al. Technical Bulletin.
6. Soil Description Book (1997), Ken Wetherby, Cleve SA
7. NSW EPA (1997) Environmental Guidelines: Use & Disposal of Biosolids Products. NSW EPA Publication, Chatswood.MASCC Agricultural Land

Attachment E : *Nutrient budget 2022-2023*

WINTER 2022	CROP (VARIETY)	DATE SOWN	SOIL P STATUS (kg/ha)	SOIL N STATUS (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE, OATS & RYEGRASS	n/a	46.8	4.4	26.4	84.4	1	45	45	100	29.2	33.8
CP2	LUCERNE, OATS & RYEGRASS	n/a	28.6	3.0	26.4	84.4	1	45	45	100	11.0	32.4
CP3	LUCERNE, OATS & RYEGRASS	n/a	9.1	18.2	26.4	84.4	1	45	45	100	0.0	47.6
CP4	RYEGRASS	n/a	49.4	36.4	26.4	63.6	1	45	42	93	34.8	52.0
CP5	LUCERNE, OATS & RYEGRASS	n/a	128.7	35.1	13.2	42.4	1	45	45	100	97.9	22.5
SHT	OATS, RYE & CANOLA	n/a	70.2	104.0	26.4	21	1	45	45	100	52.6	70.0

SUMMER 2022/23	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE & MILLET	n/a	29.2	33.8	52.8	190	3	45	50	250	35.0	18.8
CP2	LUCERNE & MILLET	n/a	11.0	32.4	52.8	190	3	45	50	250	16.8	17.4
CP3	LUCERNE & MILLET	n/a	0.0	47.6	52.8	190	3	45	50	250	5.8	32.6
CP4	MILLET	n/a	34.8	52.0	26.4	190	1	45	50	250	12.2	37.0
CP5	LUCERNE & MILLET	n/a	97.9	22.5	13.2	190	3	45	50	250	64.1	7.5
SHT	MILLET	n/a	52.6	70.0	26.4	190	1	45	50	250	30.0	55.0

WINTER 2023	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	35	18.8	26.4	63.6	1	45	42	93	20.4	34.4
CP2	RYEGRASS	tba	16.8	17.4	26.4	63.6	1	45	42	93	2.2	33.0
CP3	RYEGRASS	tba	5.8	32.6	39.6	63.6	1	45	42	93	4.4	48.2
CP4	RYEGRASS	tba	12.2	37	39.6	63.6	1	45	42	93	10.8	52.6
CP5	RYEGRASS	tba	64.1	7.5	26.4	63.6	1	45	42	93	49.5	23.1
SHT	RYEGRASS	tba	30	55	26.4	63.6	1	45	42	93	15.4	70.6

SUMMER 2023/24	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE & RYEGRASS	tba	20.4	34.4	26.4	135	3	45	32	200	17.8	14.4
CP2	LUCERNE & RYEGRASS	tba	2.2	33	39.6	135	3	45	32	200	12.8	13.0
CP3	LUCERNE & RYEGRASS	tba	4.4	48.2	26.4	135	3	45	32	200	1.8	28.2
CP4	LUCERNE & RYEGRASS	tba	10.8	52.6	26.4	135	3	45	32	200	8.2	32.6
CP5	LUCERNE & RYEGRASS	tba	49.5	23.1	26.4	135	3	45	32	200	46.9	3.1
SHT	RYEGRASS	tba	15.4	70.6	44	45	1	45	45	93	15.4	67.6

WINTER 2024	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	17.8	14.4	22	23	3	193	25	200	17.8	30.4
CP2	LUCERNE	tba	12.8	13	22	23	3	193	25	200	12.8	29.0
CP3	LUCERNE	tba	1.8	28.2	22	23	3	193	25	200	1.8	44.2
CP4	LUCERNE	tba	8.2	32.6	22	23	3	193	25	200	8.2	48.6
CP5	LUCERNE	tba	46.9	3.1	22	23	3	193	25	200	46.9	19.1
SHT	RYEGRASS	tba	15.4	67.6	48.4	45	1	45	45	100	19.8	57.6

SUMMER 2024/25	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	17.8	30.4	26.4	0	3	193	25	200	22.2	23.4
CP2	LUCERNE	tba	12.8	29	26.4	0	3	193	25	200	17.2	22.0
CP3	LUCERNE	tba	1.8	44.2	26.4	0	3	193	25	200	6.2	37.2
CP4	LUCERNE	tba	8.2	48.6	26.4	0	3	193	25	200	12.6	41.6
CP5	FALLOW	tba	46.9	19.1	0	0	0	0	0	0	46.9	19.1
SHT	FALLOW	tba	19.8	57.6	0	0	0	0	0	0	19.8	57.6

WINTER 2025	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	22.2	23.4	22	0	3	193	25	200	22.2	16.4
CP2	LUCERNE	tba	17.2	22	22	0	3	193	25	200	17.2	15.0
CP3	RYEGRASS	tba	6.2	37.2	26.4	44	1	45	21	93	12.6	33.2
CP4	RYEGRASS	tba	12.6	41.6	26.4	44	1	45	21	93	19.0	37.6
CP5	RYEGRASS	tba	46.9	19.1	26.4	18.6	1	90	21	93	53.3	34.7
SHT	RYEGRASS	tba	19.8	57.6	26.4	44	1	45	21	93	26.2	53.6

SUMMER 2025/26	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	22.2	16.4	26.4	0	3	193	25	200	26.6	9.4
CP2	LUCERNE	tba	17.2	15	26.4	0	3	193	25	200	21.6	8.0
CP3	RYEGRASS	tba	12.6	33.2	22	11	3	53	21	47	16.6	50.2
CP4	RYEGRASS	tba	19	37.6	22	11	3	53	21	47	23.0	54.6
CP5	RYEGRASS	tba	53.3	34.7	22	11	3	53	21	47	57.3	51.7
SHT	RYEGRASS	tba	26.2	53.6	22	23	3	53	21	47	30.2	82.6

WINTER 2026	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	26.6	9.4	22	23	3	193	25	200	26.6	25.4
CP2	LUCERNE	tba	21.6	8	22	23	3	193	25	200	21.6	24.0
CP3	RYEGRASS	tba	16.6	50.2	26.4	23	1	45	21	93	23.0	25.2
CP4	RYEGRASS	tba	23	54.6	26.4	23	1	45	21	93	29.4	29.6
CP5	RYEGRASS	tba	57.3	51.7	26.4	23	1	45	21	93	63.7	26.7
SHT	RYEGRASS	tba	30.2	82.6	26.4	18.6	1	45	21	93	36.6	53.2

SUMMER 2026/27	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	26.6	25.4	26.4	0	3	193	25	200	31.0	18.4
CP2	LUCERNE	tba	21.6	24	26.4	0	3	193	25	200	26.0	17.0
CP3	RYEGRASS	tba	23	25.2	0	23	3	53	21	47	5.0	54.2
CP4	RYEGRASS	tba	29.4	29.6	0	23	3	53	21	47	11.4	58.6
CP5	RYEGRASS	tba	63.7	26.7	0	23	3	53	21	47	45.7	55.7
SHT	RYEGRASS	tba	36.6	53.2	22	23	3	53	21	47	40.6	82.2

WINTER 2027	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	31	18.4	22	0	3	193	25	200	31.0	11.4
CP2	LUCERNE	tba	26	17	22	0	3	193	25	200	26.0	10.0
CP3	WHEAT	tba	5	54.2	48.4	18	1	45	45	100	9.4	17.2
CP4	WHEAT	tba	11.4	58.6	26.4	39	1	45	45	100	0.0	42.6
CP5	RYEGRASS	tba	45.7	55.7	26.4	18	1	45	21	93	52.1	25.7
SHT	RYEGRASS	tba	40.6	82.2	26.4	39	1	45	21	93	47.0	73.2

SUMMER 2027/28	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	31	11.4	26.4	0	3	193	25	200	35.4	4.4
CP2	LUCERNE	tba	26	10	26.4	0	3	193	25	200	30.4	3.0
CP3	FALLOW	tba	9.4	17.2	0	0	0	0	0	0	9.4	17.2
CP4	FALLOW	tba	0	42.6	0	0	0	0	0	0	0.0	42.6
CP5	RYEGRASS	tba	52.1	25.7	22	23	3	53	21	47	56.1	54.7
SHT	RYEGRASS	tba	47	73.2	22	23	3	53	21	47	51.0	102.2

WINTER 2028	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	35.4	4.4	22	0	3	193	25	200	35.4	0.0
CP2	LUCERNE	tba	30.4	3	22	23	3	193	25	200	30.4	19.0
CP3	WHEAT	tba	9.4	17.2	39.6	63.6	1	45	45	100	5.0	25.8
CP4	WHEAT	tba	0	42.6	52.8	63.6	1	45	45	100	8.8	51.2
CP5	RYEGRASS	tba	56.1	54.7	22	18.6	1	45	21	93	58.1	25.3
SHT	RYEGRASS	tba	51	102.2	22	18.6	1	45	21	93	53.0	72.8

SUMMER 2028/29	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	35.4	0	0	23	3	53	21	47	17.4	29.0
CP2	RYEGRASS	tba	30.4	19	0	23	3	53	21	47	12.4	48.0
CP3	LUCERNE	tba	5	25.8	37.4	0	3	193	25	200	20.4	18.8
CP4	LUCERNE	tba	8.8	51.2	37.4	0	3	193	25	200	24.2	44.2
CP5	RYEGRASS	tba	58.1	25.3	0	23	1	53	21	47	38.1	54.3
SHT	RYEGRASS	tba	53	72.8	0	23	3	53	21	47	35.0	101.8

WINTER 2029	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	17.4	29	26.4	23	1	45	21	93	23.8	4.0
CP2	RYEGRASS	tba	12.4	48	26.4	23	1	45	21	93	18.8	23.0
CP3	LUCERNE	tba	20.4	18.8	22	0	3	193	25	200	20.4	11.8
CP4	LUCERNE	tba	24.2	44.2	22	0	3	193	25	200	24.2	37.2
CP5	RYEGRASS	tba	38.1	54.3	26.4	23	1	45	21	93	44.5	29.3
SHT	RYEGRASS	tba	35	101.8	26.4	23	1	45	21	93	41.4	76.8

SUMMER 2029/30	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	23.8	4	22	0	3	53	21	47	27.8	10.0
CP2	RYEGRASS	tba	18.8	23	22	0	3	53	21	47	22.8	29.0
CP3	LUCERNE	tba	20.4	11.8	22	0	3	193	25	200	20.4	4.8
CP4	LUCERNE	tba	24.2	37.2	22	23	3	193	25	200	24.2	53.2
CP5	RYEGRASS	tba	44.5	29.3	22	0	3	53	21	47	48.5	35.3
SHT	RYEGRASS	tba	41.4	76.8	22	0	3	53	21	47	45.4	82.8

WINTER 2030	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	WHEAT	tba	27.8	10	39.6	46	1	45	45	100	23.4	1.0
CP2	WHEAT	tba	22.8	29	39.6	46	1	45	45	100	18.4	20.0
CP3	LUCERNE	tba	20.4	4.8	22	46	3	193	25	200	20.4	43.8
CP4	LUCERNE	tba	24.2	53.2	22	0	3	193	25	200	24.2	46.2
CP5	WHEAT	tba	48.5	35.3	26.4	55	1	45	45	100	30.9	35.3
SHT	RYEGRASS	tba	45.4	82.8	26.4	23	1	45	21	93	51.8	57.8

SUMMER 2030/31	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	FALLOW	tba	23.4	1	0	0	0	0	0	0	23.4	1.0
CP2	FALLOW	tba	18.4	20	0	0	0	0	0	0	18.4	20.0
CP3	LUCERNE	tba	20.4	43.8	22	0	3	193	25	200	20.4	36.8
CP4	LUCERNE	tba	24.2	46.2	22	0	3	193	25	200	24.2	39.2
CP5	MAIZE	tba	30.9	35.3	44	162	3	53	50	250	27.9	0.3
SHT	RYEGRASS	tba	51.8	57.8	0	0	3	53	21	47	33.8	63.8

WINTER 2031	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	WHEAT	tba	23.4	1	39.6	69	1	45	45	100	19.0	15.0
CP2	WHEAT	tba	18.4	20	39.6	46	1	45	45	100	14.0	11.0
CP3	LUCERNE	tba	20.4	36.8	22	0	3	193	25	200	20.4	29.8
CP4	LUCERNE	tba	24.2	39.2	22	0	3	193	25	200	24.2	32.2
CP5	WHEAT	tba	27.9	0.3	39.6	55	1	45	45	100	23.5	0.3
SHT	RYEGRASS	tba	33.8	63.8	26.4	46	1	45	21	93	40.2	61.8

SUMMER 2031/32	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	19	15	26.4	21	3	193	25	200	23.4	29.0
CP2	LUCERNE	tba	14	11	26.4	21	3	193	25	200	18.4	25.0
CP3	LUCERNE	tba	20.4	29.8	22	21	3	193	25	200	20.4	43.8
CP4	LUCERNE	tba	24.2	32.2	22	21	3	193	25	200	24.2	46.2
CP5	FALLOW	tba	23.5	0.3	0	0	0	0	0	0	23.5	0.3
SHT	FALLOW	tba	40.2	61.8	0	0	0	0	0	0	40.2	61.8

WINTER 2032	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	23.4	29	22	0	3	193	25	200	23.4	22.0
CP2	LUCERNE	tba	18.4	25	22	0	3	193	25	200	18.4	18.0
CP3	RYEGRASS	tba	20.4	43.8	26.4	44	1	45	21	93	26.8	39.8
CP4	RYEGRASS	tba	24.2	46.2	26.4	44	1	45	21	93	30.6	42.2
CP5	RYEGRASS	tba	23.5	0.3	26.4	63.6	1	45	21	93	29.9	15.9
SHT	RYEGRASS	tba	40.2	61.8	26.4	63.6	1	45	21	93	46.6	77.4

SUMMER 2032/33	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	23.4	22	26.4	0	3	193	25	200	27.8	15.0
CP2	LUCERNE	tba	18.4	18	26.4	0	3	193	25	200	22.8	11.0
CP3	RYEGRASS	tba	26.8	39.8	11	23	3	53	21	47	19.8	68.8
CP4	RYEGRASS	tba	30.6	42.2	11	23	3	53	21	47	23.6	71.2
CP5	RYEGRASS	tba	29.9	15.9	22	23	3	53	21	47	33.9	44.9
SHT	RYEGRASS	tba	46.6	77.4	11	23	3	53	21	47	39.6	106.4

WINTER 2033	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	27.8	15	22	0	3	193	25	200	27.8	8.0
CP2	LUCERNE	tba	22.8	11	22	18.6	3	193	25	200	22.8	22.6
CP3	RYEGRASS	tba	19.8	68.8	26.4	18.6	1	45	21	93	26.2	39.4
CP4	RYEGRASS	tba	23.6	71.2	26.4	18.6	1	45	21	93	30.0	41.8
CP5	RYEGRASS	tba	33.9	44.9	26.4	42.6	1	45	21	93	40.3	39.5
SHT	RYEGRASS	tba	39.6	106.4	26.4	18.6	1	45	21	93	46.0	77.0

SUMMER 2033/34	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	27.8	8	22	22	3	193	25	200	27.8	23.0
CP2	LUCERNE	tba	22.8	22.6	22	0	3	193	25	200	22.8	15.6
CP3	RYEGRASS	tba	26.2	39.4	0	0	3	53	21	47	8.2	45.4
CP4	RYEGRASS	tba	30	41.8	22	0	3	53	21	47	34.0	47.8
CP5	RYEGRASS	tba	40.3	39.5	22	0	3	53	21	47	44.3	45.5
SHT	RYEGRASS	tba	46	77	22	0	3	53	21	47	50.0	83.0

WINTER 2034	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	27.8	23	22	0	3	193	25	200	27.8	16.0
CP2	LUCERNE	tba	22.8	15.6	22	0	3	193	25	200	22.8	8.6
CP3	WHEAT	tba	8.2	45.4	39.6	44	1	45	45	100	3.8	34.4
CP4	WHEAT	tba	34	47.8	26.4	44	1	45	45	100	16.4	36.8
CP5	RYEGRASS	tba	44.3	45.5	26.4	23	1	45	21	93	50.7	20.5
SHT	RYEGRASS	tba	50	83	26.4	23	1	45	21	93	56.4	58.0

SUMMER 2034/35	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	27.8	16	22	22	3	193	25	200	27.8	31.0
CP2	LUCERNE	tba	22.8	8.6	22	22	3	193	25	200	22.8	23.6
CP3	FALLOW	tba	3.8	34.4	22	22	3	53	21	47	7.8	62.4
CP4	FALLOW	tba	16.4	36.8	22	23	0	0	0	0	38.4	59.8
CP5	RYEGRASS	tba	50.7	20.5	22	23	3	53	21	47	54.7	49.5
SHT	RYEGRASS	tba	56.4	58	22	23	3	53	21	47	60.4	87.0

WINTER 2035	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	LUCERNE	tba	27.8	31	22	0	3	193	25	200	27.8	24.0
CP2	LUCERNE	tba	22.8	23.6	22	0	3	193	25	200	22.8	16.6
CP3	WHEAT	tba	7.8	62.4	52.8	46	1	45	45	100	16.6	53.4
CP4	WHEAT	tba	38.4	59.8	26.4	46	1	45	45	100	20.8	50.8
CP5	RYEGRASS	tba	54.7	49.5	26.4	18.6	1	45	21	93	61.1	20.1
SHT	RYEGRASS	tba	60.4	87	26.4	18.6	1	45	21	93	66.8	57.6

SUMMER 2035/36	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	27.8	24	22	23	3	53	21	47	31.8	53.0
CP2	RYEGRASS	tba	22.8	16.6	22	23	3	53	21	47	26.8	45.6
CP3	LUCERNE	tba	16.6	53.4	37.4	0	3	193	25	200	32.0	46.4
CP4	LUCERNE	tba	20.8	50.8	37.4	23	3	193	25	200	36.2	66.8
CP5	RYEGRASS	tba	61.1	20.1	0	23	1	53	21	47	41.1	49.1
SHT	RYEGRASS	tba	66.8	57.6	0	23	3	53	21	47	48.8	86.6

WINTER 2036	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	31.8	53	22	0	3	193	25	200	31.8	46.0
CP2	RYEGRASS	tba	26.8	45.6	22	0	3	193	25	200	26.8	38.6
CP3	LUCERNE	tba	32	46.4	44	63.6	1	45	45	100	32.0	55.0
CP4	LUCERNE	tba	36.2	66.8	44	63.6	1	45	45	100	36.2	75.4
CP5	RYEGRASS	tba	41.1	49.1	26.4	18.6	1	45	21	93	47.5	19.7
SHT	RYEGRASS	tba	48.8	86.6	26.4	18.6	1	45	21	93	55.2	57.2

SUMMER 2036/37	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	31.8	46	0	12.5	22	53	21	47	32.8	64.5
CP2	RYEGRASS	tba	26.8	38.6	0	12.5	22	53	21	47	27.8	57.1
CP3	LUCERNE	tba	32	55	37.4	0	3	193	25	200	47.4	48.0
CP4	LUCERNE	tba	36.2	75.4	37.4	0	3	193	25	200	51.6	68.4
CP5	RYEGRASS	tba	47.5	19.7	0	23	22	53	21	47	48.5	48.7
SHT	RYEGRASS	tba	55.2	57.2	0	23	3	53	21	47	37.2	86.2

WINTER 2037	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	27.8	57.1	22	0	3	193	25	200	27.8	50.1
CP2	RYEGRASS	tba	47.4	48	22	0	3	193	25	200	47.4	41.0
CP3	LUCERNE	tba	51.6	68.4	44	63.6	1	45	45	100	51.6	77.0
CP4	LUCERNE	tba	48.5	48.7	44	63.6	1	45	45	100	48.5	57.3
CP5	RYEGRASS	tba	37.2	86.2	26.4	44	1	45	21	93	43.6	82.2
SHT	RYEGRASS	tba	37.2	86.2	26.4	55	1	45	21	93	43.6	93.2

SUMMER 2037/38	CROP (VARIETY)	DATE SOWN	SOIL P AT SOWING (kg/ha)	SOIL N AT SOWING (kg/ha)	P FERTLISER (kg/ha)	N FERTILISER (kg/ha)	P ADDITIONAL (kg/ha)	N ADDITIONAL (kg/ha)	P REMOVAL (kg/ha)	N REMOVAL (kg/ha)	P AFTER CROP (kg/ha)	N AFTER CROP (kg/ha)
CP1	RYEGRASS	tba	27.8	50.1	0	23	22	53	21	47	28.8	79.1
CP2	RYEGRASS	tba	47.4	41	0	23	22	53	21	47	48.4	70.0
CP3	LUCERNE	tba	51.6	77	37.4	0	3	193	25	200	67.0	70.0
CP4	LUCERNE	tba	48.5	57.3	37.4	0	3	193	25	200	63.9	50.3
CP5	RYEGRASS	tba	43.6	82.2	0	0	22	53	21	47	44.6	88.2
SHT	RYEGRASS	tba	43.6	93.2	26.4	0	3	53	21	47	52.0	99.2

Attachment F : *By-products 2022-2023*

Pollutant	Unit of measure	Bell Press by-products monitoring 2022-23												
		5/07/2022	2/08/2022	2/09/2022	5/10/2022	2/11/2022	5/12/2022	10/01/2023	2/02/2023	2/03/2023	5/04/2023	1/05/2023	1/06/2023	Mean
Arsenic	ppm	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5
Cadmium	ppm	< 0.2	< 0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.4	< 0.2	0.8	0.6	0.3
Chromium	ppm	9.2	6.6	31.0	19.9	28.1	27.4	20.1	22.8	15.2	20.9	14.1	12.0	18.9
Copper	ppm	51.0	59.0	120.0	109.0	111.0	108.0	122.0	112.0	132.0	128.0	88.0	103.0	103.6
Lead	ppm	38	40	78	50	67	44	55	51	43	45	60	27	50
Mercury	ppm	< 0.05	< 0.05	0.10	0.14	0.34	0.20	0.16	0.19	0.06	0.25	0.16	0.14	0.15
Nickel	ppm	10	4	18	15	17	15	16	16	11	15	8	14	13
Zinc	ppm	122.0	110.0	190.0	135.0	144.0	136.0	141.0	138.0	188.0	145.0	260.0	145.0	154.5
Sodium	ppm	1550	1250	1100	1140	1240	1100	1220	1230	1380	1250	1380	1380	1268
Moisture	%	50.1	51.3	11.3	49.2	79.3	170.0	112.0	111.0	529.0	110.0	104.0	102.0	123.3
Boron	ppm	58	38	18	28	27	25	15	20	31	21	17.0	37	28
Conductivity	dS/m	1.920	1.540	0.764	0.874	0.888	0.822	1.240	1.290	1.420	1.300	1.480	1.420	1.247
Molybdenum	ppm	1	< 1	< 5	< 1	< 1	< 1	< 1	< 1	7	< 1	4	2	2
pH	pH	7.0	9.3	8.8	9.1	9.0	9.1	9.2	9.3	9.0	9.1	8.6	10.3	9.0
Selenium	ppm	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2	< 2	< 2	< 2	2
Total Organic Carbon	ppm	279000	255000	145000	192000	188000	185000	191000	187000	190000	188000	199000	199000	200909

Pollutant	Unit of measure	Bottom Sand by-products monitoring 2022-23												
		5/07/2022	2/08/2022	2/09/2022	5/10/2022	2/11/2022	5/12/2022	10/01/2023	2/02/2023	2/02/2023	5/04/2023	1/05/2023	1/06/2023	Mean
Arsenic	ppm	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5
Cadmium	ppm	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2
Chromium	ppm	5.1	4.8	15.0	10.4	11.8	10.8	12.2	11.8	17.1	13.3	6.4	5.8	10.4
Copper	ppm	3.6	4.7	7.0	4.3	5.5	4.9	5.1	5.1	6.3	5.5	3.5	4.4	5.0
Lead	ppm	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1
Mercury	ppm	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05	0.05
Nickel	ppm	4	5	10	5	8	10	6	8	7	5	4	4	6
Zinc	ppm	28.5	15.5	71.0	48.1	44.8	48.1	55.1	49.8	57.8	51.1	25.7	25.0	43.4
Sodium	ppm	92	188	470	670	601	555	666	581	490	555	173	176	435
Moisture	%	< 0.1	< 0.1	0.1	< 0.1	< 0.1	0.3	< 0.1	< 0.1	< 0.1	1.7	< 0.1	0.1	0.3
Boron	ppm	35	25	19	19	22	21	15	16	28	20	7.8	15	20
Conductivity	dS/m	0.386	0.317	0.767	0.548	0.606	0.589	0.548	0.470	0.650	0.550	0.185	0.444	0.505
Molybdenum	ppm	< 1	< 1	< 5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1	1	1
pH	pH	11.8	11.6	10.9	11.1	11.0	11.0	11.7	11.9	10.9	11.5	10.4	11.0	11.2
Selenium	ppm	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2

Pollutant	Unit of measure	Fly ash by-products monitoring 2022-23												
		5/07/2022	2/08/2022	2/09/2022	5/10/2022	2/11/2022	5/12/2022	10/01/2023	2/02/2023	2/03/2023	5/04/2023	1/05/2023	1/06/2023	Mean
Arsenic	ppm	6	< 5	9	8	7	11	9	10	7	10	8	6	8
Cadmium	ppm	< 0.2	< 0.2	1.7	< 0.2	1.0	0.9	0.8	0.9	1.4	1.0	2.5	2.2	1.1
Chromium	ppm	32.8	22.1	40.0	48.0	44.1	41.2	47.7	42.2	46.4	43.3	57.3	25.3	40.9
Copper	ppm	48.1	31.5	35.0	33.5	34.8	36.8	33.6	34.8	40.5	39.9	59.1	35.9	38.6
Lead	ppm	8	12	24	6	15	11	10	11	8	10	13	8	11
Mercury	ppm	0.11	0.12	0.23	0.20	0.15	0.25	0.26	0.21	0.19	0.11	0.19	0.15	0.18
Nickel	ppm	23	25	27	26	23	19	22	20	27	22	36	20	24
Zinc	ppm	301.0	333.0	300.0	315.0	322.0	299.0	311.0	302.0	325.0	319.0	485.0	332.0	329
Sodium	ppm	1550	1330	1900	1120	1560	1550	1880	1660	1380	1710	1890	1220	1563
Moisture	%	39.4	38.5	1.2	10.2	59.9	2.5	1.7	22.8	61.7	37.0	76.3	52.9	33.7
Boron	ppm	202	200	170	147	199	188	151	166	133	140	222	182	175
Conductivity	dS/m	6.500	14.800	10.800	8.080	9.990	9.880	9.420	2.800	13.500	11.000	17.900	12.100	10.564
Molybdenum	ppm	2	1	< 5	< 1	< 1	< 1	< 1	< 1	2	< 1	3	2	2
pH	pH	12.5	11.7	12.0	10.1	11.1	10.9	10.9	12.9	10.3	10.9	10.3	10.5	11.2
Selenium	ppm	< 2	< 2	3	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2.1
Total Organic Carbon	ppm	55500	54800	52400	47200	51400	50800	48800	51100	50500	49900	44100	48800	50442

Pollutant	Unit of measure	Green Liquor Dregs by-products monitoring 2022-23												
		5/07/2022	2/08/2022	2/09/2022	5/10/2022	2/11/2022	5/12/2022	10/01/2023	2/02/2023	2/03/2023	5/04/2023	1/05/2023	1/06/2023	Mean
Arsenic	ppm	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5
Cadmium	ppm	< 0.2	< 0.2	2.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	2.7	< 0.2	3.1	2.6	1.0
Chromium	ppm	30.3	31.1	77.0	41.4	42.8	44.8	55.8	49.9	66.5	59.9	96.2	60.9	54.7
Copper	ppm	44.8	51.0	110.0	72.2	74.8	77.7	89.1	80.1	149.0	99.1	230.0	208.0	107.2
Lead	ppm	391	288	220	211	299	275	301	299	163	281	230	195	263
Mercury	ppm	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
Nickel	ppm	15	15	48	30	35	31	39	35	55	38	76	56	39
Zinc	ppm	389.0	302.0	550.0	444.0	489.0	501.0	481.0	499.0	#####	505.0	796.0	849.0	552.1
Sodium	ppm	9880	9810	12000	15800	14400	15500	16600	16100	9800	12200	15400	31200	14891
Moisture	%	39.5	39.8	13.3	46.8	38.1	73.6	81.5	30.6	118.0	76.9	35.6	166.0	63.3
Boron	ppm	20	15	22	31	29	26	30	29	18	22	17	26	24
Conductivity	dS/m	2.840	2.660	2.990	33.400	31.900	31.100	3.580	15.600	4.780	4.610	5.660	5.010	12.011
Molybdenum	ppm	3	< 1	< 5	< 1	< 1	< 1	< 1	< 1	2	< 1	5	5	2
pH	pH	9.7	10.9	10.0	12.0	11.9	11.5	10.5	14.1	9.4	10.9	9.5	9.8	10.9
Selenium	ppm	< 2	< 2	< 2	3	< 2	< 2	< 2	< 2	4	< 2	< 2	< 2	2

Pollutant	Unit of measure	Lime mud by-products monitoring 2022-23												
		5/07/2022	2/08/2022	2/09/2022	5/10/2022	2/11/2022	5/12/2022	10/01/2023	2/02/2023	2/03/2023	5/04/2023	1/05/2023	1/06/2023	Mean
Arsenic	ppm	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5
Cadmium	ppm	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.7	< 0.2	0.9	0.6	0.3
Chromium	ppm	4.8	2.4	8.0	5.3	4.9	4.2	4.5	4.6	7.0	5.5	7.8	7.8	5.6
Copper	ppm	2.5	4.4	< 0.2	0.4	4.9	4.1	4.5	4.6	1.1	3.9	1.0	0.7	2.7
Lead	ppm	444	400	230	364	301	288	299	291	281	279	353	383	326
Mercury	ppm	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Nickel	ppm	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2	< 1	2	2	1
Zinc	ppm	1.1	2.2	11.0	5.0	5.6	4.8	5.5	5.1	8.3	5.9	1.7	3.8	5.0
Sodium	ppm	9910	9990	8300	4480	7890	7710	5550	6990	8370	7770	9650	9110	7977
Moisture	%	11.8	13.5	1.4	1.9	9.5	12.4	7.1	26.2	18.0	18.7	21.7	23.8	13.8
Boron	ppm	22	20	17	9	29	25	18	20	24	20	17.1	10	19
Conductivity	dS/m	4.210	0.511	0.667	2.000	0.981	0.999	1.860	2.100	3.139	2.320	1.110	2.200	1.8
Molybdenum	ppm	< 1	< 1	< 5	< 1	< 1	< 1	< 1	< 1	2	< 1	3	1	2
pH	pH	12.7	11.3	11.5	11.5	11.5	11.0	11.6	12.5	10.8	11.5	10.4	10.6	11.4
Selenium	ppm	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2.0

Pollutant	Unit of measure	Paper Machine Rejects by-products monitoring 2022-23												
		5/07/2022	2/08/2022	2/09/2022	5/10/2022	2/11/2022	5/12/2022	10/01/2023	2/02/2023	2/03/2023	5/04/2023	1/05/2023	1/06/2023	Mean
Arsenic	ppm	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5
Cadmium	ppm	< 0.2	< 0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2	0.7	0.6	0.3
Chromium	ppm	9.9	5.0	25.0	20.6	21.8	22.5	19.8	20.8	15.8	18.8	17.3	10.0	17.3
Copper	ppm	58	55	90.0	86.6	88.2	90.2	88.1	88.9	86.9	84.9	77.8	98	82.7
Lead	ppm	32	41	31	26	32	30	23	26	37	29	45	28	32
Mercury	ppm	0.06	0.06	0.07	0.07	0.28	0.14	0.18	0.14	0.09	0.22	0.15	0.15	0.13
Nickel	ppm	11	4	15	10	12	11	12	10	9	10	10	8	10
Zinc	ppm	111.0	99.8	170.0	121.0	155.0	145.0	128.0	133.0	198.0	155.0	207.0	155.0	148.2
Sodium	ppm	1810	1050	1200	1260	1110	1080	1110	1090	1160	1120	1260	1440	1224
Moisture	%	45.9	50.7	9.9	71.2	111.0	136.0	108.0	83.9	171.0	104.0	101.0	99.2	91.0
Boron	ppm	61	33	19	23	20	21	15	20	19	18	18	16	24
Conductivity	dS/m	2	1.280	0.813	1.260	0.999	0.947	1.330	1.210	1.119	1.220	1.250	1.200	1.2
Molybdenum	ppm	< 1	< 1	< 5	< 1	< 1	< 1	< 1	< 1	3	< 1	4	2	2
pH	pH	7.4	9.7	9.5	9.4	9.5	9.1	9.8	10.0	9.6	9.7	8.8	10.3	9.4
Selenium	ppm	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2
Total Organic Carbon	ppm	277000	234000	150000	223000	248000	199000	232000	198000	189000	195000	195000	198000	211500

Attachment G : *Sludge 2022-2023*

Monitoring Point - Sludge
Sampled from SBR

Pollutant	Critical Range	Unit of measure	Sludge monitoring 2022-23											
			5/07/2022	2/08/2022	2/09/2022	5/10/2022	2/11/2022	5/12/2022	10/01/2023	2/02/2023	2/03/2023	5/04/2023	1/05/2023	1/06/2023
Manganese	0.2 [1]	mg/L	0.221	0.222	0.100	0.128	0.455	0.425	0.294	0.333	0.284	0.300	1.120	3.480
Total suspended solids	<45 [2]	mg/L	33	1050	40	52	26	973	84	202	22	36	22	5320
BOD	<15 [1]	mg/L	6	23	10	14	11	59	13	34	13	13	44	1240
Sodium Adsorption Ratio	<4.5 [1]	SAR	3	2	2	2	4	3	3	3	3	3	3	2
Nitrogen (total)	<20 [2]	mg/L	17	12	11	14	12	66	36	38	26	9	41	491
Phosphorus (total)	<0.05 [1]	mg/L	3.32	11.40	1.48	1.99	6.35	9.91	10.30	6.79	6.23	2.25	12.00	53.70
Total dissolved solids	<225 [1]	mg/L	143	98	191	188	37	266	220	222	212	152	232	166
pH	6.0-8.5 [1]	pH	7.1	6.8	6.9	7.7	7.1	7.9	7.1	7.3	7.0	7.1	6.8	7.2
Conductivity	<350 [1]	uS/cm	377	300	298	315	432	443	616	621	518	372	620	505
Chloride	175	mg/L	15.7	31.8	8.9	20.1	40.0	20.4	23.4	54.8	33.1	21.1	32.2	31.9
Oil & Grease	<5 [2]	mg/L	1	121	<1	5	2	29	6	6	4	<1	<1	52
Sodium - dissolved	115	mg/L	55.2	44.2	31.0	31.5	51.7	42.3	41.1	42.8	42.9	41.7	45.0	30.7

1. ANZG (2018) Australian & New Zealand Guidelines for Fresh & Marine Water Quality.

2. Visy P & P (2016) NSW EPA Licence 10232. Chatswood, NSW.

3. Grade A & C Land Application Limits are from NSW EPA, (1997) Environmental Guidelines: Use & Disposal of Biosolids Products.