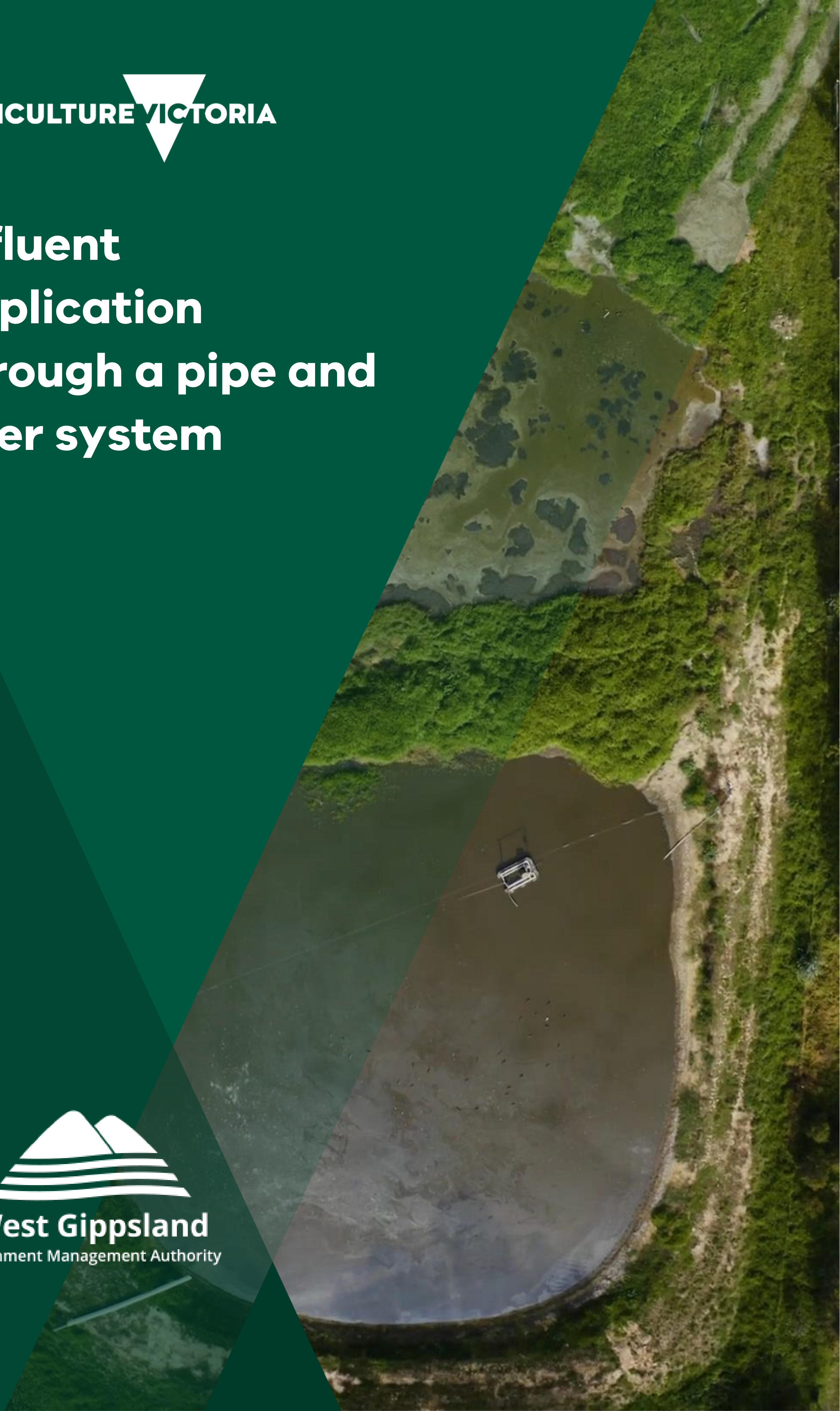
AGRICULTURE VICTORIA

Effluent application through a pipe and riser system



West Gippsland
Catchment Management Authority

Effluent injection into pipe and riser systems combined with soil testing has enhanced nutrient management, avoiding environmental impacts.

INTRODUCTION

The Macalister Irrigation District (MID) is a dairy and horticulture dominated irrigation district located in central Gippsland. The MID is located within the Lake Wellington catchment and outfalls into the Ramsar listed Gippsland Lakes.

The Victorian Government's Sustainable Irrigation Program (SIP) is implemented in the MID by Agriculture Victoria in partnership with the West Gippsland Catchment Management Authority. These organisations have been working collaboratively to minimise the offsite and environmental impacts of irrigation for over 24 years.

The SIP program has focused on minimising the environmental impacts of irrigation by retaining nutrients on farm and increasing irrigation water use efficiency. A vast amount of on-farm investment by farmers, as well as a sustained effort by the partner agencies, has seen a significant reduction in irrigation drainage water and nutrients leaving the district.

Despite the environmental gains made, there is still significant social pressure on dairy farmers in the MID to minimise their environmental impact. There is a particular focus on effluent storages and their potential to overflow in high rainfall events, contributing a point source of nutrient into waterways that ultimately impacts upon the Gippsland Lakes. Keeping effluent storages as low as possible and providing sufficient disposal area so that effluent is applied to soil at low rates is crucial to reducing the impact of nutrient losses and potential impacts on the Gippsland Lakes.

With this outcome in mind, a demonstration project was set up at Steve and Jess Knight's farm in Llowalong in 2023-24, to evaluate the efficacy of using pipe and riser surface irrigation to disperse effluent across a dairy farm. Steve and Jess's farm backs onto the Avon River, and is on an active flood plain. This makes regular and effective effluent disposal a priority to avoid nutrient losses in high rainfall events.

Farm development and effluent disposal

The Knights' farm consists of a small existing dairy farm, and a dryland beef block that they have converted to an irrigated dairy farm. The dairy portion of the farm was undeveloped, with old infrastructure. Traditionally, effluent on this farm was disposed through an open channel and restricted to one small paddock close to the dairy.

Steve and Jess identified early on in their farm development that the effluent system would require a major upgrade.

To this end, they developed a two pond effluent storage system, and completely stopped putting effluent on the paddock close to the dairy that had been the historical disposal area.

Figure 1, Steve and Jess' two pond effluent system, linked to their pipe and riser infrastructure.

While Steve and Jess were upgrading the effluent system, they were also busy improving the irrigation systems on the farm. They have installed centre pivots and pipe and riser surface irrigation in a staged development process.

'When we got here, irrigation was a lot of hard work… very antiquated systems.'
– Jess Knight

The pipe and riser system is very effective at distributing effluent, requiring no filtration. This allows for greater flexibility in spreading valuable nutrients contained in effluent across a much larger area of the property. Utilising a larger area to distribute effluent avoids high nutrient loads accumulating in paddocks and ensures that nutrient application is at levels that the plants can use, not in excess.

This project aims to demonstrate that effluent is a valuable resource that can assist in maintaining soil nutrient levels without the use of artificial fertiliser. The project will provide data to irrigators on changes in nutrient levels in paddocks that receive effluent through pipe and riser surface irrigation. It also aims to show that effluent can be dispersed efficiently through pipe and riser irrigation at low rates to match plant nutrient needs, without artificial fertiliser application or nutrient loss off farm.

'I find it works very well… we pretty much take that watering, inject it with the effluent as a nitrogen application…

As we get the cows out of the paddock, there will be water coming on, and then we give it that maximum infiltration/rest time to let that nutrient do its thing between grazing.'
– Stephen Knight

METHOD

Soil testing

There are 5 focus areas on the farm that have been soil tested for the 12 months of the project. These focus areas are outlined in Figure 3 below, with the following treatment conditions:

1. Two years of effluent application
2. One year of effluent application
3. Zero years of effluent application (started in 2024 season)
4. Control area – no effluent application
5. Area with a long history of effluent application

Figure 2, Focus areas that have been subject to soil testing over the 12 months of the demonstration project.

The five focus areas were soil tested as follows: to a depth of 0-10cm at the start of the project, midway, and end of the project. Soil testing to depths of 10-30cm and 30-60cm also took place at the start and end of the project.

Plant tissue testing

Plant tissue tests were taken at the start, midway and end of the project.

Effluent testing

The effluent pond was sampled at the start and end of the project.

RESULTS

Soil tests

Soil testing was undertaken in May 2023, December 2023, and June 2024. For the duration of the project, Steve and Jess applied no nutrient, besides effluent where indicated, to any areas, apart from focus area 2 which received an additional chicken manure application at $10m^3$ post laser grading in autumn 2021.

Focus areas 3 and 4 were the only areas that were within optimum levels for major nutrients. The soil tests across the rest of the areas showed that nutrient levels were mostly in excess of plant needs, in particular phosphorus and potassium (figures 3 and 4, respectively).

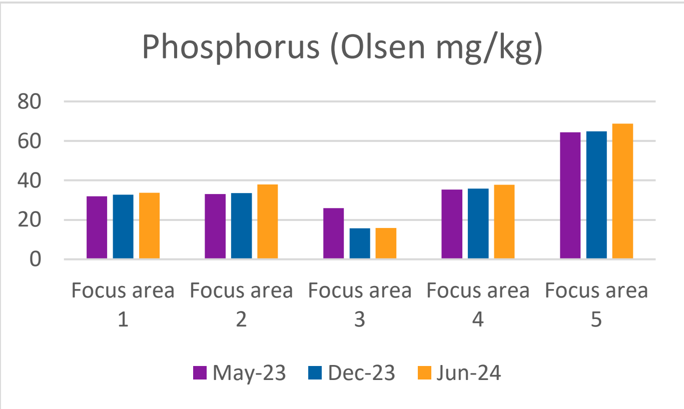


Figure 3, Concentrations of phosphorus in soils across the focus areas

The pH of the soil was also quite high where effluent had been applied, with a measurement between 5.9 and 6.9 pH. The exception was area 4 which had not had effluent applied, soil testing identified that it needs lime application to raise the pH and provide calcium.

Focus area 5 where effluent had been historically applied was particularly high in all nutrients, reading at 1091 mg/kg available potassium (figure 4), and 64.4 mg/kg Olsen Phosphorus (figure 3). Magnesium, calcium, and zinc were also all double the optimum levels in focus area 5.

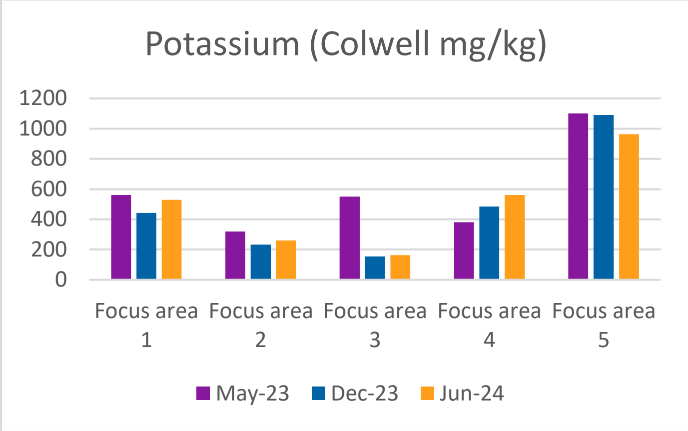


Figure 4, Concentrations of potassium in soils across the focus areas

Recommendations from a local agronomist were that nothing but effluent needed to be applied to the areas in the trial, and even then, only for the nitrogen content (figures 5 and 6). The exception to this was focus area 5, which must have nothing applied to it and needs to be mined of nutrients for several years yet due to the extremely high levels of nutrient already present.

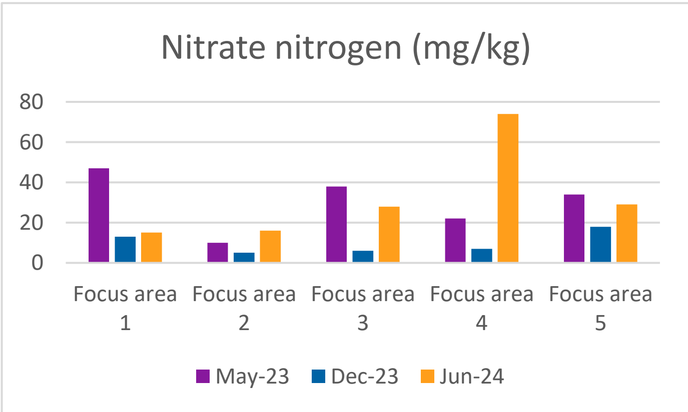


Figure 5, Concentrations of nitrate nitrogen across the focus areas

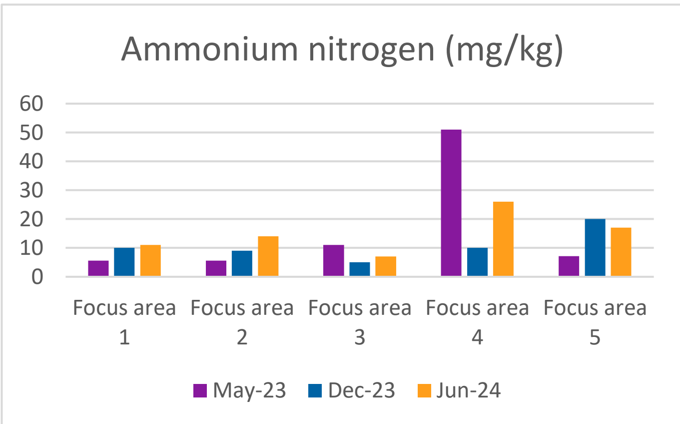


Figure 6, Concentrations of ammonium nitrogen across the focus areas

Most of the areas needed gypsum to improve soil structure due to historic sodicity, with the added benefit of making calcium more bioavailable in the soil by decreasing the levels of potassium and magnesium. Some gypsum has been applied in areas 2 and 3 recently and there was a significant difference in the health of the pasture compared to the other focus areas.

These results show that Steve and Jess need to actively mine the nutrients in their soil, particularly in focus area 5 which had effluent applied for a long time. Regular soil testing will allow them to concentrate effluent on the areas that need nutrient, and avoid the areas that need to be mined.

'It's allowing us to compare these different areas and see the effect that we're having by applying the effluent.' – Jess Knight

Plant tissue tests

Plant tissue testing was undertaken in May 2023, December 2023, and June 2024, except for the ammonium nitrogen assessment, which was unable to be conducted in December 2023 (Figure 7). Most nutrients were relatively stable across the tests and within optimum ranges for plant growth.

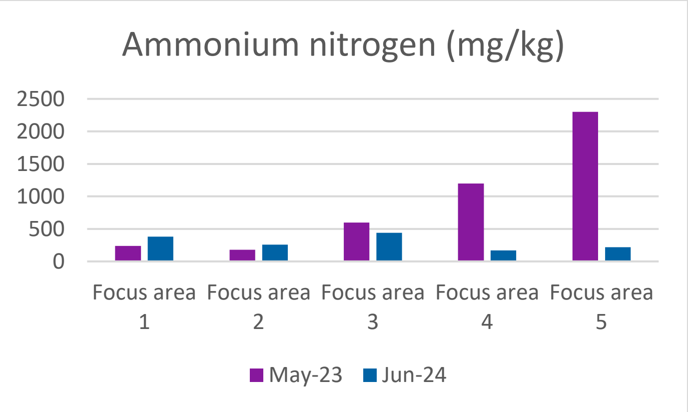


Figure 7, Concentrations of ammonium nitrogen in plant tissues across the focus areas

Interestingly, the extremely high volumes of nutrient showing in the soil tests did not seem to be reflected in the tissue tests. This suggests that a large amount of the nutrients present, such as nitrate nitrogen (figure 8) are not plant available, most likely because of the excess of major nutrients including phosphorus and potassium.

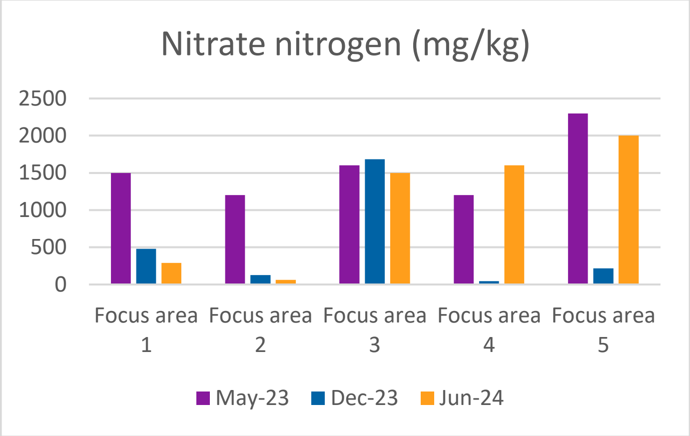


Figure 8, Concentrations of nitrate nitrogen in plant tissues across the focus areas

Boron was the only nutrient that tested lower than optimum in all areas and may need to be strategically applied to increase the levels in the soil and the plants. Iron was particularly high in the plants (figure 9), which may be related to waterlogging caused by recent flooding events experienced in late 2023 and early 2024.

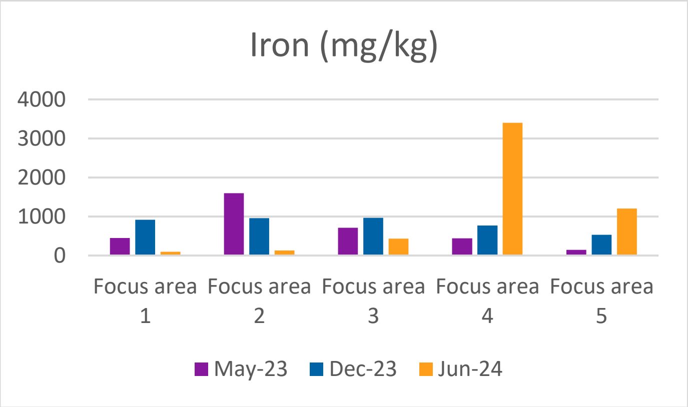


Figure 9, Concentrations of iron in plant tissues across the focus areas

Effluent tests

The effluent testing at the start and end of the project showed minimal change in nutrient levels, with most nutrient at optimu levels. The pH was in the neutral range, which is an advantage for irrigating Steve and Jess's soils with effluent (figure 10) as they are slightly acidic (pH between 4.7 (never had effluent) and 6.9 (the historic effluent paddock)).

Figure 10, A pipe and riser outlet irrigating effluent water onto focus area 3, which had never had effluent applied to it.

Values to be aware of and to regularly soil test to track were high sodium in both samples, and slightly high iron, sulphur, and manganese in the end of project sample.

OUTCOME AND CONCLUSIONS

The outcome of this project is that Steve and Jess will continue to only apply effluent to the areas that need it across the farm, as a nitrogen application after grazing.

Most areas, particularly area 5, will need to be mined of most macro nutrients for quite some time. This practice should result in more nutrient becoming plant available as levels of macronutrients decrease to non limiting levels in the soil.

Steve and Jess will also continue to apply gypsum and lime in areas that need it, to improve soil structure and to make nutrient more plant available.

The clear benefit of pipe and riser effluent irrigation is that Steve and Jess can selectively target paddocks that need nutrient and direct the effluent away from areas that need to be mined for nutrient to bring the soil into balance.

The benefits of these practices are that nutrient is only applied where it is needed, such as focus area 3 (figure 11), and both effluent and artificial fertiliser will not be at risk of being washed away as runoff into the creeks and the Avon River, or lost below the root zone.

Figure 11, Aerial view of the pipe and riser irrigating the lush pasture in focus area 3 with injected effluent.

'When the effluent water does get to the end of the bay, there is a re-use dam there where all of the water is captured and then can be directed back onto the farm so none of those nutrients are going into the local waterways.' – Jess Knight

This project shows that regular soil testing is crucial to make the most of any fertiliser application, whether that be effluent or artificial fertiliser.

Without these soil test results, Steve and Jess may have continued to apply fertiliser and effluent to areas that don't need it. Soil testing on Steve and Jess's farm is protecting the environment, maximising productivity and stock health, and saving money in fertiliser at the same time.