KARUAH EFFLUENT REUSE ENTERPRISE – IMPROVING FARMING PRACTICES FOR AGRICULTURAL REUSE

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ABSTRACT

Karuah Effluent Reuse Enterprise (KERE) was established in 2003 as part of the Hunter Sewerage Project. Treated effluent from the Karuah WWTW is stored in a holding dam before irrigation onto fodder crops. The fodder crops are periodically harvested and sold at commercial rates to local farmers. Originally, the operation of the KERE was outsourced to a third party contractor, however since December 2005, Hunter Water Australia (HWA) has been operating the scheme in conjunction with Hunter Water Corporation (HWC).

The changes in operational management of the scheme have resulted in a number of improvements, allowing HWA and HWC to better understand and manage the risks associated with operation of the reuse scheme. The focus of this paper is to review a number of the operational changes such as improving farm operations, improving long term sustainability and reducing operational costs.

KEY WORDS
Agriculture, effluent reuse, sustainability, climatic risks, nutrient balancing.

1.0 INTRODUCTION

The KERE was established in 2003 to prevent effluent from the Karuah WWTW being discharged into the surrounding sensitive environments, including the wetland areas and Karuah River oyster leases. A farm was developed, which requires proactive management to ensure crops are healthy, in order to maximise effluent uptake. There is also a need to manage climatic risks to minimise the likelihood of runoff and dam overflows.

The operation of the KERE was initially outsourced to a third party contractor. However, in December 2005, Hunter Water Australia (HWA) started managing the scheme in conjunction with Hunter Water Corporation (HWC). Daily farming activities are undertaken by an experienced local farmer, who is employed as a third party contractor to HWC but is directed under HWA management.

Balancing crop, effluent and environmental management is a difficult but essential part of ensuring the long term sustainability of the site. For this reason, a number of operational strategies including managing site limitations, climate risks, data and operational communications have been incorporated into the farm operations. This has ensured that the KERE is successfully and also reduces operational costs.

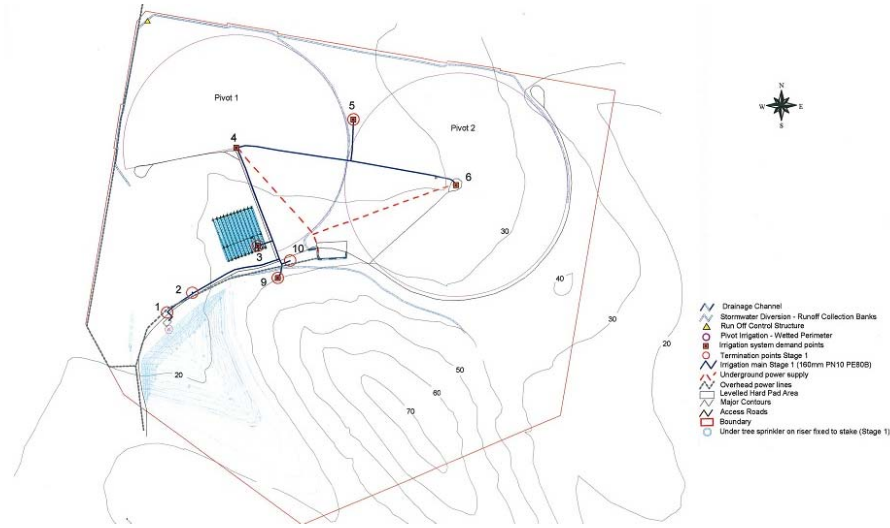
2.0 DISCUSSION

2.1 Overview of the KERE Current Areas

The KERE is located off the Old Pacific Highway at Karuah, on Scotts Road, adjacent to the Karuah WWTW. The total area of the KERE allotment is approximately 100 ha.

Within the farm property there is a 100ML effluent storage dam which was constructed in a gully; two pivot areas (22 ha and 16 ha); and a tree plot area (1.3 ha), which is currently

not being utilised.
The pivot and tree plot areas are relatively flat with less than 10m fall to the north east. The farm layout is shown in Figure 1.



<u>Figure 1:</u> ***KERE farm layout***

2.2 Design Implications

The KERE and Karuah WWTW were designed together as part of the Hunter Sewerage Project. A reuse scheme was an integral part of the project, as it was an environmental requirement that effluent would not be discharged into the sensitive surrounding environment under normal conditions. An irrigated cropping strategy was selected as the preferred reuse scheme. During the design stages, a comprehensive environmental impact study (EIS) was undertaken which reviewed the proposed design and implications of both the construction and operation of the sewage scheme. Environmental models were undertaken as part of the EIS, which determined the allowable dam overflow volumes and effluent quality to minimise environmental impacts. This determined the size of the KERE dam and the treatment process required from Karuah WWTW.

The EIS also reviewed the farm and recommended a number of environmental safeguards to reduce the risk of effluent moving off-site. These included;

- Tree buffer areas around the perimeter of the farm to prevent spray drift.
- The overflow from the dam was fitted with volume monitoring to review the likely impact of the overflow on the environment, based on previous EIS modelling.
- Small bund walls and channel drains were built around the pivots to collect run-off from the pivot areas, which drain to a single collection system. The collection system then allows for water testing before run-off is realised into the environment.

The KERE was built with these environmental safeguards which significantly reduce environmental risks, however, a number of farming practices were not considered in the design, which have caused maintenance complications, including the following:

- There are land pockets which require slashing but are too small for tractor access.
- The bund wall prevent surface water to move off the lower pivot (pivot one), causing marsh conditions in wet weather impacting on crop condition.
- The farmer was not provided with any permanent storage facilities for seed,

chemicals, equipment, record keeping and respite.
- Run-off channels around the pivots were not constructed with correctly sized rocks, causing erosion problems around the pivots.
- The effluent storage dam was constructed in a natural gully area which collects run-off and reduces the reuse scheme capacity.

Since 2005 HWA has undertaken projects to rectify a number of these original problems. The channels have been re-rocked, a storage shed has been constructed and HWA is currently looking at improving pivot drainage. However, the major design issue that has been identified is the current dam position.

The effluent storage dam was constructed in what was a gully area. Gullies maximise water collection during rain events as surrounding surface run-off is naturally divert is into the low lying areas. However for most reuse schemes, including the KERE, the additional surface water is not wanted as the run-off mixes with the effluent, increases the chances of a dam overflow and reduces the capacity of the reuse scheme.

In an attempt to overcome the issues associated with surface run off into the dam, diversion drains around the dam were constructed as part of the original design. The drains were designed to carry a one-in-twenty year storm away from the dam and provide an internal dam catchment area of 5.8 ha.

The internal dam catchment area was used in the EIS modelling to determine dam capacity and overflow frequencies. However, during construction the drain basins were undersized and a number of modifications have since been required. The drains were also placed further out from the original location, increasing the catchment area to approximately 7.2 ha, the additional 1.4 ha now collects more rainfall than was modelled. For example, using climate data from the Bureau of Meteorology (BOM), the median annual rainfall for the KERE is 1168 mm. If it is assumed that 40% of rain water is absorbed into the ground, the 1.4 ha collects approximately 16.4 ML which flows into the dam. To put this into context, Karuah WWTW currently has an average dry weather flow (ADWF) of approximately 0.2 ML/d, therefore the additional run-off, over a median year, accounts for approximately 80 average dry weather days, which has a significant impact on the capacity of the scheme.

The gully design of the dam, while appropriate in the majority of agricultural applications, has had a number of operational repercussions. The most optimal design for the KERE reuse storage dam would be an above ground or ‘turkey nest’ style of dam. This type of dam would have minimised storm water run-off from entering the storage.

The KERE was designed with numerous environmental safeguards, which are important in protecting the surrounding environment, however, a number of practical implications in regard to agricultural activities and effluent storage were not considered in the original design or during construction. Through actively managing the farm, HWA has gained an understanding of these issues and the implications on the operation of the farm and is able to recommend further projects which will improve the long term operation of the scheme.

2.3 Understanding and Managing Climatic Risks

The variability of climate is a large risk to any agricultural enterprise. This has been particularly evident with ongoing droughts and localised flooding throughout Australia.

However, while weather is a risk, it can be managed, and establishing flexible practices to respond to the climatic conditions is an essential component of farm management.
The KERE has a secured source of water year round from the Karuah WWTW and for that reason, unlike other agricultural enterprises, drought is not a major risk to the scheme. Flooding and ongoing wet conditions increase run-off into the dam and prevent irrigation onto the pivots, thereby increasing the risk of an overflow, which has environmental implications. For that reason, the greatest climatic risk to the KERE is ongoing wet conditions, which is consistent with the majority of agricultural based reuse schemes. To better manage these climatic risks, it has been important for HWA to become familiar with the tools that the agricultural sector is currently using to form effective climatic management plans.

The Southern Oscillation Index (SOI) is used extensively in the agricultural sector in forecasting rainfall over the east coast of Australia. The SOI is a scale that ranges from approximately +30 to -30 and can be sourced from the BOM. A strong positive change in the SOI generally indicates higher rainfalls over the east coast of Australia.

To determine if the SOI is valid tool for forecasting rainfall over the KERE, annual rainfall and SOI values were graphed over a number of years, as shown in Figure 2. The annual Karuah rainfall and SOI values show relatively consistant trends. From these results, it was concluded that the SOI is a credible rainfall forcasting tool.

HWA has reviewed and gained a solid understanding of the tools available to provide creditable weather forecasts. Using this information, HWA has created climate management plans, which involves reviewing SOI values and adjusting KERE crops accordingly.

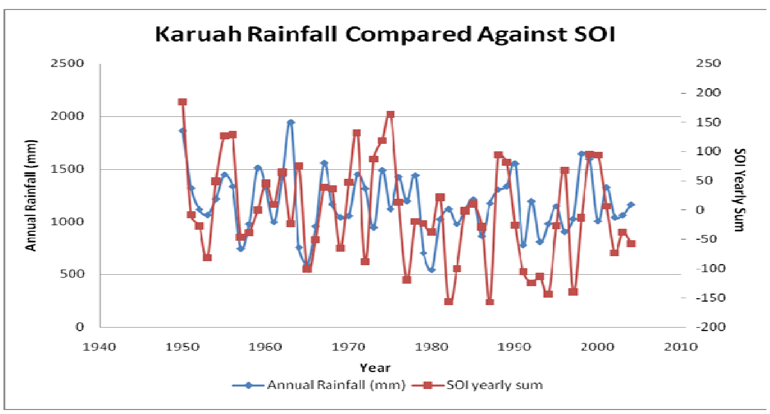


Figure 2: ***Karuah annual rainfall compared to SOI values***

Currently, the main fodder crop for the KERE is a perennial rye clover mix grown on Pivot 2 (22 Ha). A second three-quarters pivot area, Pivot 1 (16 Ha), grows a buffering crop which is dependent on the seasonal forecast. If a season is expected to be drier than normal, cropping would focus on irrigating the perennial crop and allowing the buffering crop to become fallow. This ensures that the more valuable crop survives for the longer term benefit for the farm. In a forecasted wetter than average season, the second pivot area would be planted out and both pivots fertilised and harvested as much as possible to try and promote plant growth , to maximise water uptake. Establishing these types of crop management plans has been important to reduce the risk of wet weather impacting on reuse activities. However, truly managing the impacts of climate is difficult and even with the best of plans, unforseen events will continue to occur and provide challenges in managing the KERE.

2.4 Data Collection and Management

The NSW 'Use of Effluent by Irrigation, Environmental Guideline', (the guidelines) outline that reuse schemes should undertake nutrient balancing to account for the levels of nutrients in the effluent being irrigated, applied fertilisers and harvested volumes. Balancing ensures nutrients are not being over applied, resulting in detrimental impacts on the soil or groundwater. The guidelines also outline the level of disinfection required for different effluent applications to protect public health.

To meet the guidelines recommendations the following farm data is being collected:
- Daily irrigation volumes.
- Effluent quality including nutrient and faecal coliform levels.
- Groundwater and soil sampling, to provide assurance that farming activities are not having impacts on the surrounding environment.
- Farming activities including fertiliser, herbicide applications and harvesting volumes.

The KERE is also a commercial property with agistment and bale sales being returned to HWC, which helps to offset a portion of the scheme's operational costs. The sale records need to be captured and recorded as part of the scheme management.

Due to the environmental and guideline requirements a reuse scheme requires a high level of monitoring that is generally well above that of traditional farming. Furthermore, managing this data to produce summary reports of farming operations can be a challenge for most reuse schemes.

After taking over the management of the KERE in late 2005, HWA reviewed the information being captured and a number of spreadsheets were established to capture farming activities. After a year of managing the farm, it was evident that the amount of information was becoming difficult to control. Independent to farm operations, HWA was creating spreadsheets for HWC treatment plants to collect operational information, improve performance and to undertake better data interrogation. The development of the Karuah WWTW spreadsheet provided a unique opportunity to integrate farm data collection.

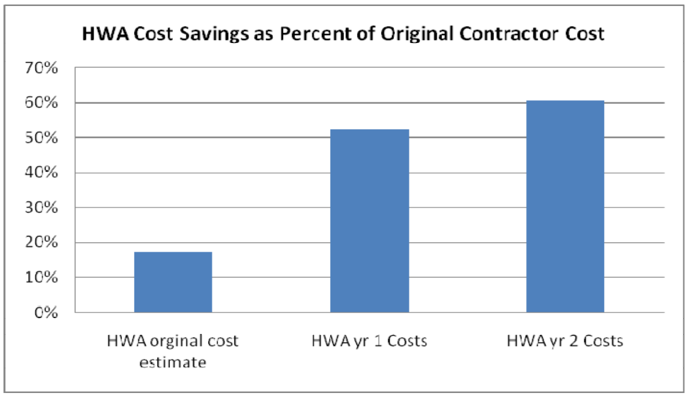
Over the last five months, farming information has been included into the Karuah WWTW spreadsheet. This information has included irrigation volumes, effluent nutrient and faecal coliform levels, sales and adjistment records, fertiliser and herbicide applications, harvesting amounts, groundwater and soil monitoring results. Additional tools have been created which generate monthly summaries of farm activities and work is being undertaken to automate nutrient and hydraulic balancing. This work has substantially reduced the time and effort required to review information, as well as centralising and improving record integrity.

Work on the spreadsheets is planned to continue, to develop further tools to ensure monitoring is not only undertaken to meet the guidelines requirements, but also provides valuable information to ensure the farm is being sustainable managed over the long term.

2.5 Managing Operational Costs

After taking over farm operations in late 2005, HWA has been actively involved in establishing sound relations and communication with the farmer.
Through these improved relationships HWA has been able to effectively target weed management, fertilising and harvesting. HWA has also been able to undertake a biosolids trial to reduce fertiliser costs and improve soil conditions.

The time invested in gaining a good understanding of the farm, has resulted in a dramatic decrease in operational costs. HWA reviewed the fees of the original contractor and estimated that the annual operational costs could be reduced by 17%. After the first year of operation HWA had in fact reduced cost by approximately 52% and by the second year costs were further reduced by another 8%. The cost savings per year as a percent of the original contractor's costs are shown in Figure 3.



<u>Figure 3:</u> ***Karuah operational cost savings***

An increased understanding of the farm, onsite presence and effective communications with the farmer has reduced operational costs and provided HWC with a better understanding of the farm, including its operational risks.

3.0 CONCUSIONS

The changes in operational management by HWA have resulted in a number of improvements to the scheme, including a greater understanding of site limitations, climate risks and data management. HWA has also increased communications and onsite presence, which has further improved farm management and lowered operational costs.

Managing the KERE scheme will be an ongoing challenge. However, as HWA gains more experience with the enterprise, all efforts will be made to make positive changes to continually improve operations and therefore the long term sustainability of the scheme.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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