# On Farm Milk De-Watering System For Reuse

## Final Report

May 2012

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# Executive Summary

This report provides an overview of a research project into the feasibility of removing 50% of water from cows milk on a dairy farm in Gippsland and identifying beneficial end uses for the water.
A demonstration unit was installed in 2011 and tests were carried out to determine the quality, quantity and options for water reuse.
Results of the data show that it is feasible to economically extract water on a dairy farm and to utilise the extracted water for beneficial use such as milk machinery and yard cleaning, irrigation, pre cooling and potential animal drinking water. Preliminary assessments have identified payback periods for the system to be in the order of one to two years
The report concludes that there exists a real opportunity to further develop the system to optimise the operation and to customise the system to suit the specific needs of the demonstration dairy farm.
An evaluation of three scenarios is provided to help the reader see the financial paybacks depending on their current water use.

Recommendations include:

- Customise system to suit production rates of farm and reduce the physical size of the system
- Operate on raw milk (37 °C) reducing cooling requirements
- Automate system and install fixed piping to further improve quality
- Measure chemical reduction opportunities for CIP of main milking equipment
- Trial feeding water to animals for drinking and measure benefits
- Caryout a Life Cycle Analysis

The report also investigates the identified multi benefits of implementing this system.
These benefits include:

- On farm energy savings
- Transport to manufacturer savings
- Milk machinery cleanliness
  - Optimal chemical use
  - Milk quality
  - Equipment longevity
- Potential milk production improvement from feeding cows cleaner drinking water

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# Background

The dairy industry continues to be one of Australia's major rural industries. Based on a farmgate value of production of $3.9 billion in 2010/11, it ranks third behind the beef and wheat industries. It is estimated that approximately 40,000 people are directly employed on dairy farms and manufacturing plants. Related transport and distribution activities, and research and development projects, represent further employment associated with the industry.

Dairy is also one of Australia's leading rural industries in terms of adding value through further downstream processing. Much of this processing occurs close to farming areas, thereby generating significant economic activity and employment in country regions. Previous ABARES work estimates this regional economic multiplier effect to be in the order of 2.5 from the dairy industry.

Dairying is a well-established industry across temperate and some subtropical areas of Australia. While the bulk of milk production occurs in south-east seaboard states, all states have dairy industries that supply fresh drinking milk to nearby cities and towns. A range of high quality consumer products, including fresh milks, custards, yogurts and a wide variety of specialty cheeses, are produced in most Australian states. Nevertheless, the manufacturing of longer shelf life products, such as cheese and specialised milk powders, is steadily becoming more concentrated in the south-east region of Australia.

Strong growth characterised the dairy industry through the 1990s, but that growth has stalled in the last decade. The industry has experienced a slow recovery from the severe widespread drought of 2002/03, only to experience ongoing dry conditions; with the resulting low water storage levels significantly limiting water allocations in irrigated dairying regions until a couple of seasons ago. The increasing level of market and margin volatility of the industry in recent years has served to undermine confidence in the outlook for many farmers who are seeking reliable returns on which to build a longer term future.[1]

This project concept was originated in the years of 2008/2009 where water shortages on farms was becoming a real issue. So much so, farmers were regularly trucking fresh water onto their farms, especially dairy farms for the purpose of cleaning their milking machines. This resulted in higher costs, but most of all the task of strategically trying to plan this was very frustrating and time consuming for farmers.

While practices such as water recycling from effluent storage ponds to clean yards was beginning to be attractive to farmers, thousands of litres of water was still required on a daily basis to keep the machinery clean. This water was also needing to be relatively clean to minimise chemical use as chemical costs were also rising.

The idea of removing water from milk was not a new practice. This is common in manufacturing plants where final products are made. However, there was no evidence of this practice been carried out on the farm, where reuse of the water extracted could be directly benefited.

So the challenge for this project was to demonstrate that with careful and specific design parameters, downsizing existing technologies of removing water from milk could be made into a size practical and workable for a medium sized dairy.

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1 Australian Dairy Industry In Focus 2011

The main challenge identified as a limiting factor in designing this concept was the cost of providing energy to perform the work in removing the water from the milk.
Others included:

1. ongoing stationary energy costs
2. infrastructure needs - utility connections (electrical, water, hot water and milk)
3. chemical requirements for CIP (Cleaning in Plant)
4. operator intervention requirements.

In other words, the practice of removing water from the milk on the farm needed to provide net benefits to the farmer in comparison to their current practices.

Additionally, a major challenge was to identify the measures for determining the benefits of such a system. While standard cost comparisons was one simple financial method, we also needed to understand the 'benefits' to farmers in providing clean, quantifiable volumes of water for beneficial use.

Thanks to a series of farm audits over previous years in the Bass, Cardinia, West Gippsland and Corangamite regions over 30 dairy farms were investigated and found to have some benefit from implementing such a system.

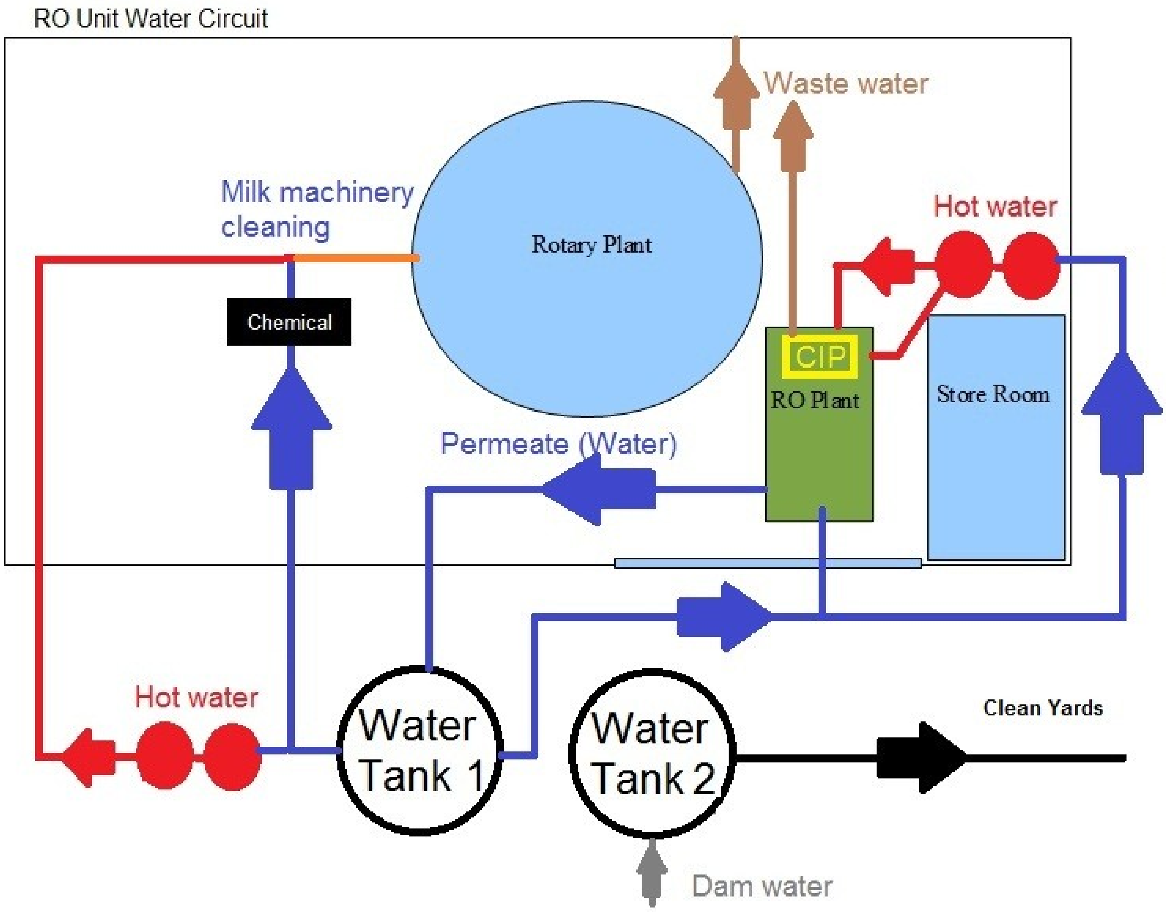
# Introduction

The purpose of this project was to design, manufacture, install and operate a small scale pilot plant on a dairy farm in Gippsland to demonstrate the concept of re-use options for water removed from milk. The beneficial use of the extracted water was the main focus of this project.

The scope of the project was:

1. Select a suitable site for demonstration
2. Design, procure and install the system
3. Commission system
4. Operate and test system
5. Report on findings

The primary objective of the project was to demonstrate beneficial uses for the extracted water from the milk. While transport savings and potential energy savings on farm are of interest, the key deliverable for this project was to show that the water coming out of the milk can be used for beneficial uses on the farm.



# Objectives/Goals

The main objective of the project was to demonstrate on an operational dairy farm within Gippsland a 'system' of extracting upto 50% of water from the raw milk.

The system will be portable, simple in operation, modular (capable of expansion) and reliable.

The system once operational needed to result in an ecological footprint less than or equal to the existing operations.

A major challenge is to deliver multi benefits all of which will have their own individual priorities and influences on the final product being demonstrated.

In summary the key requirements were as follows:

- Removes upto 50% of water from the raw milk
- Milk quality not to be negatively effected
- Pilot plant to be portable
- Plant to be located at a dairy farm in Gippsland
- Preferably the size of the farm to be between 250 – 1000 milking cows
- The system is to be easily operated and user friendly
- The system to have simple and cost effective maintenance requirements
- Demonstrate practical end uses for extracted water
- Optimise energy efficiency
- System to be compliant with local regulatory authorities
- System to comply with all Australian manufacturing statutory requirements and standards
- Demonstrate as practically as possible the multiple benefits arising from such a system
- Establish a website to assist in demonstrating the features of the system.

The key deliverables of the project include:

- A detailed Project Plan
- Development and demonstration of the system
- Detailed reporting of the results of the trial and cost estimates of the initiative.

# Key Steps / Milestones

## *Milestone 1 Planning Stage*

**Milestone Description**

Detailed Project Plan was completed

**Methodology**

Established a Project Steering Committee with representatives including:

Dairy Farmer (John Gordon/Phil Tracy)

Murray Goulburn (Phil Tracy)

DPI (Darold Klindworth)

EPA (Jodie Smith)

South Gippsland Water (Bree Roffey)

Smart Water Fund (Kate Tanner)

**Resources**

SWF;Tetra Pak Pty Ltd; Genesis Now; Steering committee (Dairy farmer, Murray Goulburn, DPI, EPA and water business)

**Timing**

Completed by 31st Aug 2010

**Financial Summary**

| Funding Summary for Milestone 1 | | |
|---|---|---|
| **Source** | **Amount** | |
| | **$** | **In kind** |
| **Smart Water Fund** | $5,000 | |
| **Grantee** | | $5,000 |
| **Other (please name)** | | $2,500 (Genesis Now)<br><br>$1,500 (Combined contribution from steering group) |

**Key Performance Indicators**

Established an agreed project plan by all stakeholders identifying key milestones, activities and responsibilities of participants.

Project Plan was prepared and submitted to the SWF and was approved.

## *Milestone 2 Feasibility and Design*

**Milestone Description**

Detailed system design was completed, including establishment of operational specifications and requirements, design specifications and manufacturing requirements.

**Methodology**

A System Design Document was developed in accordance with Tetra Pak Pty Ltd standard procedure requirements.

Activities undertaken in this phase included:

- Site inspections
- Equipment procurement surveys
- Stakeholder specification requirements
- Regulatory standards compliance
- Engineering design
- Operational requirements
- Cost estimations
- Feasibility study
- Water reuse options
- Process diagram development
- Design Performance Monitoring System
- Equipment
    - Layout diagrams
    - Lists
    - Specifications
- Energy mass flowcharts
- Operation manuals
- Maintenance manuals
- Time lines
- Project management
- Budget & payment plans

**Resources**

SWF; Tetra Pak Pty Ltd; Genesis Now; Steering committee (Dairy farmer, Murray Goulburn, DPI, EPA and water business)

**Timing**

This was completed by 31/12/2010

## Financial Summary

| Funding Summary for Milestone 2 | | |
|---|---|---|
| **Source** | **Amount** | |
| | **$** | **In kind** |
| **Smart Water Fund** | $20,000 | |
| **Grantee** | $5,000 | $1,000 |
| **Other (please name)** | | $12,500 (Genesis Now)<br><br>$7,500 (Project Officer/farmer)<br><br>$1,500 (combined steering committee group contributions) |

## Key Performance Indicators

Detailed System design Document met:

- Tetra Pak Pty Ltd quality standards
- Regularity requirements
- Australian standards
- Stakeholder requirements

Milestone 2 Report, included details of all design elements and costings and approved by the SWF

## *Milestone 3 Equipment Procurement*

**Milestone Description**
Manufacture system and deliver to site as per detailed system design specification.

**Methodology**
Identify suitable location of manufacture. It was determined that the timeline planned for this project would not meet the requirements to manufacture a system. It was decided to source an already manufactured system.

Product inspections were not needed throughout manufacture as the system was already built.

Quality assurance was signed off before shipment to site.

Performance Monitoring System was integrated into existing system.

**Resources**
Tetra Pak Pty Ltd

**Timing**
Completed by 30th April 2011

**Financial Summary**

| Funding Summary for Milestone 3 | | |
|---|---|---|
| Source | Amount | |
| | $ | In kind |
| Smart Water Fund | $60,000 | |
| Grantee | $4,000 | $20,000.00 |
| Other (please name) | | $2,500(Project Officer/farmer) |

**Key Performance Indicators**
Delivery of system to meet:

- Manufacturer or supply source identified and contract signed
- Construction and completion of system
- Tetra Pak Pty Ltd quality standards signed off
- Detailed System Design Specification
- Stakeholder requirements

Milestone 3 Report included details of all manufacturing elements and costings and was approved by SWF

## *Milestone 4 Installation*

**Milestone Description**

Installation and commissioning of all components of the system was completed, in readiness for farm field trial.

Components include:

- RO unit
- Utility interface
    - Electricity
    - Water
        - Hot Water
        - Cold Water
- Performance Monitoring System
- Water re-use infrastructure
- Operational Instructions/manual/training
- Maintenance schedule and training
- Spare part catalogue, registration and storage

**Methodology**

Commissioning engineers co-ordinated installation technicians to install all components of the system as per the commissioning specification.

**Resources**

Tetra Pak Pty Ltd, Farm Assistant (John Gordon)

**Timing**

Complete by 30 July 2011

**Financial Summary**

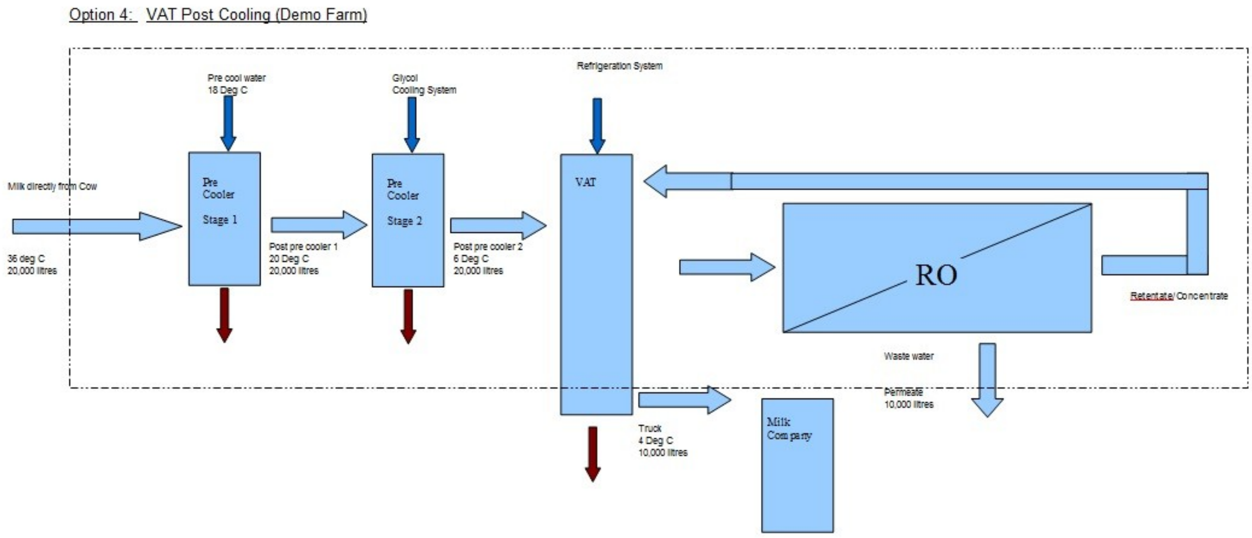
| Funding Summary for Milestone 4 | | |
|---|---|---|
| **Source** | **Amount** | |
| | **$** | **In kind** |
| **Smart Water Fund** | $25,000 | |
| **Grantee** | $3,000 | $10,000.00 |
| **Other (please name)** | | $5,000(Project Officer/farmer) |

**Key Performance Indicators**
Commissioning Specification completed and signed off by Tetra Pak Pty Ltd.

Commissioning of the system to meet:

- Installation of system in Farm
- Equipment checks are within standards
- System operation and functioning to meet specifications
- Reuse water system implemented
- System Trial Specification Developed, Documented and Undertaken
- Tetra Pak Pty Ltd quality standards
- Commissioning Specification Works Completed
- Stakeholder requirements

Milestone 4 Report included details of all commissioning elements and costings and approved by the SWF



## *Milestone 5 Trial*

**Milestone Description**

System trial to be conducted in accordance with the System Trial Specification Plan.

Activities undertaken in the trial phase include:

- Liaise with milk company and farmer and establish trial agreement
- Run system with first batch of milk
    - Assess results from Performance Monitoring System
    - Conduct milk quality checks
    - Analyse milk quality results
    - Address any issues and implement changes
    - Document and report any modifications
    - Analyse operation performance
    - Identify improvement measures
    - Implement changes
    - Carry out initial maintenance tasks
    - Perform system checks
- Report on findings of evaluation plan.

**Methodology**

The trial phase will involved several partners that include:

- Commissioning Engineers
- Technicians
- Farmer
- Milk Company (Murray Goulburn)

Trials involved taking cold milk from the Vat and processing it through the system and returning the concentrate to the same Vat. The permeate was pumped to the storage tanks. The results were recorded and analysed. Findings were addressed and modifications were identified to be implemented.

**Resources**

SWF; Tetra Pak Pty Ltd; Farm assistant (John Gordon)

**Timing**

Completed by 30th April 2012

## Financial Summary

| Funding Summary for Milestone 5 | | |
|---|---|---|
| Source | Amount | |
| | $ | In kind |
| Smart Water Fund | $10,000 | |
| Grantee | $2,500 | $10,000 |
| Other (please name) | | $2,500(Project Officer/farmer) |

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**Key Performance Indicators**
System Trial Specification completed and signed off.

Trials of system resulted in:

- Up to 50% of water saved
- Water quality acceptable
- Milk concentration achieved
- Milk quality accepted
- Energy Savings identified
- Transport Savings identified
- Capital costs including configuration options
- Website to be commissioned showing results of the system
- Tetra Pak Pty Ltd quality standards

Final Evaluation Report includes results, findings and recommendations to be prepared by the Grantee and approved by the SWF.

**Stakeholders**
The stakeholders involved are as follows: Smart Water Fund; Tetra Pak Pty Ltd; Farmer

# Findings/Results/Outcomes

The findings for this project was the installation of a reverse osmosis system manufactured by Tetra Pak Dairy & Beverage division. This unit was leased from an operation in New Zealand and retrofitted to suit the needs of this trial.

Below is a picture of the unit installed at the dairy farm in Yanakie.

The system was then connected to two water tanks designed to be the storage tanks for the permeate or water extracted from the milk. It is this water that can then be reused for other uses on the farm. Below is a picture of the tanks.

Milk was then piped from the Vat into the system.

Below is a photo of the two Vat storage tanks for the milk.

The system has a balance tank for storage of the raw milk.

The system has a membrane that fits within an eight inch housing. Three membranes were fitted.

The system is then turned on. The recirculation and feed pumps begin to transport the milk through the membrane. As pressure is built up the water is then extracted as permeate and returned to the storage tanks.

This system was capable of producing 400 ltrs of permeate (reuse water) per hour with a feed flow of between 800 to 3500 ltrs per hour. The energy consumption for this volume was 6.22 kWh for the circulation pump and 6.8 kWh for the feed pump giving a total of 13 kWh.

The milk concentration was tested using a Brix Meter for various samples of milk. The milk samples tested indicated concentration was increased by 50%.

The quality of water extracted from the milk (Permeate) was tested and found to be suitable for cleaning the plant and potential for animal consumption.

The system was then cleaned using approximately 100 ltrs of water. This water was heated up using the installed heat exchanger to 45 ° C. Plant hot water was fed into the heat exchanger at an inlet temperature of 60 °C.

The Clean In Place (CIP) operation required a pre rinse Alkali Clean using Ultrasil 110 operating for 45 min. A 0.5% solution was used. A final rinse of acid wash using Ultrasil 75 for 20 min with a 0.3% solution was applied.

# Risk Management

## *Equipment Procurement*

Early on in the project a potential risk was the feasibility of designing, manufacturing and delivering a custom made system within the time frame of the project. The design was provided to the manufacturers in Sweden, however it was understood that manufacture would take longer than the project milestones. It was decided to source a similar unit and lease it for the purpose of the trial. This unit was located in New Zealand. Shipment was organised and installation and commissioning was carried out within the milestone timeline.

## *Demonstration Unit*

While the outcome was not a custom built system specific for the demonstration farm, the principal of operation could still be achieved. Auxiliary piping circuits were temporary including flexible piping for the milk supply and return and flexible piping for the water supply and return. This introduced a risk of potential contaminants into the water and milk circuits. Water tests found an increase in Coliforms of which has been attributed to test sampling practices and the temporary piping connections. This issue would be avoided with a custom built system.

## *Clean In Place (CIP)*

Another risk identified was the quality of the water available for cleaning the RO plant. The system requires relatively clean water for cleaning, especially when the membrane is installed. Tests were carried out on the dam water on-site and found to be outside the specification of the system. It was then decided that two water tanks be used for the initial cleaning cycle and extracted water (permeate) from the RO operation would then be the ongoing water for the CIP.

## *Energy required to operate equipment*

The energy consumed by the system was originally identified as a risk. Other plant equipment including grain mills operate on the farm. These considerations were applied to the final design. Trials found the energy consumption to be relatively low and did not cause any concerns. Further energy savings could be made by operating the system on warm milk avoiding the need to cool 50% of the volume.

## *Equipment operational requirements*

The system was to be designed for minimal operator intervention. The more attention required the less effective the system would be. While the demonstration unit wasn't specifically designed for this purpose, the operation ended up relatively simple. Very minimal adjustments were required. Full automation would be possible for this system to avoid the need for operators to attend to the system

## *Transport contractual arrangements*

Transport companies need to approve the final product being supplied. This was a risk identified early on in the project. For the purpose of the trials the volumes were not of concern and did not raise issues from a transport perspective. However, for future systems which are designed for the majority of the farms milk supply, the milk company picking the concentrate up would need to fully understand the product being transported.

# Discussion/Evaluation

The project was successful in extracting water from milk on a dairy farm. The system was capable of producing four hundred litres per hour (400 l/hr) of water. This was pumped to two twenty thousand litre tanks for the purpose of milk machinery and yard cleaning and potential cow drinking water. This water is also suitable for pre cooling of the milk as it leaves the cow. The demonstration farm currently uses chilled water based glycol for the second stage pre cooling. This could be replaced with the permeate leaving the reverse osmosis system prior to storing in the storage tanks. This water is already chilled as the milk entering the reverse osmosis system was coming from the Vat that has milk stored at around 4°C.

The following applications for the extracted permeate water would also be suitable:

- Pasture Irrigation
- Dust Suppression on roads
- Garden/Lawns Irrigation
- Environmental Flows
- Ancillary cleaning for trucks/tractors etc..

The results have shown that upto 50% of the milk volume can be extracted as water. The remaining concentrate can then be transported to the milk factory requiring less transport capacity.

Milk storage capacity on the farm could also be reduced for the same milk production rates. Alternatively, production volumes could increase without requiring storage tank increases or increased pick-up events.

The demonstration farm produces in the order of 20,000 litres of milk per day through a 3 milk a day process. This has resulted in storage concerns for the two Vat's. If 50% of this volume was extracted as water and reused then these milk storage capacity concerns could be addressed.

The extracted water can replace the existing dam water for machinery and yard cleaning, stage 1 pre cooling and is suitable for cow drinking.

The energy consumption per litre of water extracted equated to 32.5 Watts.(32.5 W/ltr)
The system capacity was 400 ltrs of extracted (Permeate) water per hour which consumed 13 kWh of electrical energy. This equates to approximately $6.50 per kilolitre during peak time and $3.25 during off peak time.

Local water charges are approximately $2 per kilolitre if connected to the main water system.
To truck water onto the farm this would cost approximately $10 per kilolitre.
This report assumes water from the dam is free. However, it is understood that water is pumped from a bore or creek nearby to the dam that requires electrical energy to deliver and capital to provide the pumping.

Transport savings for delivering milk to the milk factory would be in the order of $30 per kilolitre.

Opportunities such as increased storage capacity for milk storage has not been estimated. Additionally the milk production benefits of feeding clean water to the cows for drinking has also been excluded.

Chemical use for the Clean in Place process per cycle was approximately $5.27 for the trials or $1.32 per litre of water extracted. However, this cost could be reduced by buying in bulk chemicals and having an account with the supplier.
Calculating chemical use per litre of water extracted for a custom made system would result in chemical use of approximately $0.05 per litre of water extracted.

## Return on Investment

The following table has been prepared to cover the cost of capital over 5 years. Three scenarios have been presented to represent the benefits depending on the current cost of water.

### *Scenario 1: Water Costs of $2 per kilolitre (Typical cost of mains water)*

| Item | per Cycle | per Year | Comments |
|---|---|---|---|
| ***Costs*** | | | |
| Capital | $66.67 | $20,000 | Over 5 years; 300 cycles per year |
| Interest on Capital | $6.67 | $2,000 | Assume 10% pa |
| Chemicals for CIP | $4.22 | $1,264 | Assume 1 CIP per day |
| Electricity | $33.33 | $10,000 | Offpeak rate @ 10c/kWh |
| Operator Costs | $7.50 | $2,250 | Based on 15 min every cycle @ $30/hr |
| Maintenance | $6.67 | $2,000 | Includes Membrane over 5 yrs |
| **Total Costs** | **$125.06** | **$37,517** | |
| | | | |
| ***Savings*** | | | |
| Water Savings | $20.00 | $6,000 | Based on $20 per 10,000 ltrs |
| Transport Savings | $300.00 | $90,000 | Based on 3 cents per litre |
| **Total Savings** | **$320.00** | **$96,000** | |
| | | | |
| Net Benefit | $194.94 | $58,482 | Savings - Costs |
| | | | |
| Option 2 (Operate during Day) | $161.61 | $48,483 | Peak electricity price of 20c/kWh |
| | | | |

### *Scenario 2: Water Costs of $100 per kilolitre (Typical cost of trucking in water)*

| Item | per Cycle | per Year | Comments |
|---|---|---|---|
| ***Costs*** | | | |
| Capital | $66.67 | $20,000 | Over 5 years; 300 cycles per year |
| Interest on Capital | $6.67 | $2,000 | Assume 10% pa |
| Chemicals for CIP | $4.22 | $1,264 | Assume 1 CIP per day |
| Electricity | $33.33 | $10,000 | Offpeak rate @ 10c/kWh |
| Operator Costs | $7.50 | $2,250 | Based on 15 min every cycle @ $30/hr |
| Maintenance | $6.67 | $2,000 | Includes Membrane over 5 yrs |
| **Total Costs** | **$125.06** | **$37,517** | |
| | | | |
| ***Savings*** | | | |
| Water Savings | $100.00 | $30,000 | Based on $100 per 10,000 ltrs |
| Transport Savings | $300.00 | $90,000 | Based on 3 cents per litre |
| **Total Savings** | **$400.00** | **$120,000** | |
| | | | |
| Net Benefit | $274.94 | $82,482 | Savings - Costs |
| | | | |
| Option 2 (Operate during Day) | $241.61 | $72,483 | Peak electricity price of 20c/kWh |
| | | | |

## *Scenario 3: Water Costs of $0 per kilolitre (Dam Water)*

| Item | per Cycle | per Year | Comments |
|---|---|---|---|
| ***Costs*** | | | |
| Capital | $66.67 | $20,000 | Over 5 years; 300 cycles per year |
| Interest on Capital | $6.67 | $2,000 | Assume 10% pa |
| Chemicals for CIP | $4.22 | $1,264 | Assume 1 CIP per day |
| Electricity | $33.33 | $10,000 | Offpeak rate @ 10c/kWh |
| Operator Costs | $7.50 | $2,250 | Based on 15 min every cycle @ $30/hr |
| Maintenance | $6.67 | $2,000 | Includes Membrane over 5 yrs |
| **Total Costs** | **$125.06** | **$37,517** | |
| | | | |
| ***Savings*** | | | |
| Water Savings | $0.00 | $0 | Based on $0 per 10,000 ltrs (Dam water) |
| Transport Savings | $300.00 | $90,000 | Based on 3 cents per litre |
| **Total Savings** | **$300.00** | **$90,000** | |
| | | | |
| Net Benefit | $174.94 | $52,482 | Savings - Costs |
| | | | |
| Option 2 (Operate during Day) | $141.61 | $42,483 | Peak electricity price of 20c/kWh |
| | | | |

## Conclusion

This project has been successful by achieving the following:

- Removes upto 50% of water from the raw milk
- Milk quality was not negatively effected
- Pilot plant is portable and relocatable
- Plant was located at a dairy farm in Gippsland (Yanakie)
- The size of the farm was between 250 – 1000 milking cows
- The system is easily operated and user friendly
- The system has simple and cost effective maintenance requirements
- System demonstrated practical end uses for extracted water
- Identified further energy efficiency opportunities
- System is compliant with local regulatory authorities
- System complies with all Australian manufacturing statutory requirements and standards
- System has multiple benefits
- Results available to established a website to assist in demonstrating the features of the system.
- Bench top estimate for a 10,000 litre a day system will save $48,483 per year with a simple payback of 2 years.

## Recommendations

The implementation of this project has provided a much better understanding of the issues associated with water quality and water availability in a typical dairy farm.
The key objectives of the project have been met and provides firm evidence that a system of this nature is a real opportunity for dairy farmers.
The multi benefits by operating a system such as this provides a variety of options for farmers to consider. Whether it is the supply of reliable, clean water or the savings in transport costs directly, this project has provided the initial research to build a case to further progress the technology.

Some of the recommendation for further consideration include:

1. Consider using permeate water for stage 2 pre cooling
2. Operate system on milk directly from cows (37°C)
3. Design and manufacture a custom built system for the demonstration farm
4. Provide fully automated controls and monitoring systems
5. Explore feeding permeate water to cows

1. Consider using permeate water for stage 2 pre cooling

The trials for this project was configured to use cold milk from the VAT and remove the water then return the cold concentrate to the Vat ready for pick-up. This results in permeate water to be at around 4°C. This temperature is not required for cleaning the machinery or for feeding to the cows. Therefore there is scope to reduce energy for the dairy shed even further by using the cold permeate water in the second stage pre cooler. Stage 1 pre cooling is dam water which is at approximately 16°C. Stage 2 pre cooling is normally a chilled water glycol mix at around 4 to 6°C. This water glycol mix is chilled via a refrigeration system accounting for upto 25% of the energy consumption in the dairy shed.

2. Operate system on milk directly from cows

It is understood that filtration of cold milk requires more energy to extract the water than warm milk. Reduced energy consumption from the system would be achieved. Additionally, cooling energy would be reduced as half the volume of milk would only need to be chilled.

3. Design and manufacture a custom built system for the demonstration farm

It is highly recommended to design a custom made system suitable for the Yanakie dairy farm. The farm currently produces in the order of 20,000 litres of milk per day. The water supply is from a dam and is of poor quality. A system could be designed to remove 10,000 litres of water per day to perform machinery cleaning and animal drinking water. Chemical savings could also be possible if clean permeate water is used for machinery cleaning. The life of the milking equipment could also be increased with using the clean permeate water.

4. Provide fully automated controls and monitoring systems

It is recommended that the custom made system should have fully automated control systems and CIP.

5. Explore feeding permeate water to cows

As mentioned earlier the quality of water extracted from the milk is suitable for feeding to cows for drinking. This trial never carried out any trials to identify any potential milk production improvements.

## Acknowledgements

Tetra Pak- Courtney McSpadden; (Processing Sales Manager Australia)

Farmer – Phil Tracy (Owner)

Farm Assistant – John Gordon (Technical Assistant)

Smart Water Fund – Kate Tanner

GenesisNow – Geoff Andrews

South East Climate Change Change Alliance – Greg Hunt

Western Port Catchment Landcare Network – Peter Ronalds

Bass Coast Landcare Network – Moragh Mackay

West Gippsland Catchment Management Authority – Peter Newgreen

# Appendices

## *Test Results*

Dam Water Analysis

PTY. LTD. **ANALYTICAL LABORATORIES**

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Fax: (03) 9701 5712

**REPORT ON SAMPLE OF WATER**

**FILE NO :** 110881667 **DATE ISSUED :** 16/08/2011

GLENN MACMILLAN
PO BOX 254
BEACONSFIELD, VIC 3807

**CLIENT ID :** MAC116
**PHONE :** 0428 427 004

**REFERENCE :**

**REFERENCE ID :**
**PHONE :**
**DATE RECEIVED :** 11/08/2011

**SAMPLE ID :** WATER

**ANALYSIS REQUIRED :** Turbidity, Fe, Mn, $SiO_2$
Total Hardness, Total Undissolved, Residue OC/OP,
Total Count (37°C): <20/ml, Total Count (21°C): < 200/ml
Total Coliform Bacteria

| ITEMS | ABBREVIATION | UNIT | RESULTS | |
|---|---|---|---|---|
| TURBIDITY | | NTU | **23.5** | |
| TOTAL IRON | Fe | ppm | **1.4** | |
| TOTAL MANGANESE | Mn | ppm | **0.05** | |
| TOTAL SILICA | SiO2 | ppm | **12.3** | |
| TOTAL HARDNESS AS CaCO3 | | ppm | **71.2** | |
| TOTAL UNDISSOLVED SOLID | | ppm | **55** | |
| TOTAL PLATE COUNT 21oC | | cfu/ml | **10800** | |
| TOTAL PLATE COUNT 37oC | | cfu/ml | **4000** | |
| TOTAL COLIFORMS | | mpm | **9** | per 100ml |

Permeate Water

ANALYTICAL LABORATORIES PTY. LTD.

ABN 26 005 031 569

Tel: (03) 9701 6007
Fax: (03) 9701 5712

**REPORT ON SAMPLE OF WATER**



**FILE NO :** 120486456 **DATE ISSUED :** 23/04/2012

GLENN MACMILLAN
PO BOX 254
BEACONSFIELD, VIC 3807

**CLIENT ID :** MAC116
**PHONE :** 0428 427 004

**DATE RECEIVED :** 13/04/2012

**SAMPLE ID :** WATER OUT

**ANALYSIS REQUIRED :**
Total Hardness, Total Undissolved, OC/OP Screen,
Total Count (37°C): <20/ml, Total Count (21°C): < 200/ml
Total Coliform Bacteria, COD, OC

| ITEMS | ABBREVIATION | UNIT | RESULTS | UNIT |
|---|---|---|---|---|
| TURBIDITY | | NTU | **1.18** | |
| TOTAL IRON | Fe | ppm | **0.04** | |
| TOTAL MANGANESE | Mn | ppm | **0.00060** | |
| TOTAL SILICA | $SiO_2$ | ppm | **0.06** | |
| TOTAL HARDNESS as $CaCO_3$ | | ppm | **0.31** | |
| TOTAL UNDISSOLVED SOLIDS | | ppm | **3.79** | |
| TOTAL PLATE COUNT 21°C | | cfu | **4,000** | per ml |
| TOTAL PLATE COUNT 37°C | | cfu | **44,000** | per ml |
| TOTAL COLIFORMS | | MPM | **>1100** | per 100 ml |
| CHEMICAL OXYGEN DEMAND | COD | ppm | **16** | |
| ORGANIC CARBON | OC | | **Nil** | |

ANALYTICAL LABORATORIES
PTY. LTD.
ABN 26 005 031 569

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**REPORT ON SAMPLE OF WATER**

Page 1 of 2

**FILE NO :** 120486455

**DATE ISSUED :** 23/04/2012

GLENN MACMILLAN
PO BOX 254
BEACONSFIELD, VIC 3807

**CLIENT ID :** MAC116
**PHONE :** 0428 427 004

**DATE RECEIVED :** 13/04/2012

**SAMPLE ID :** WATER IN

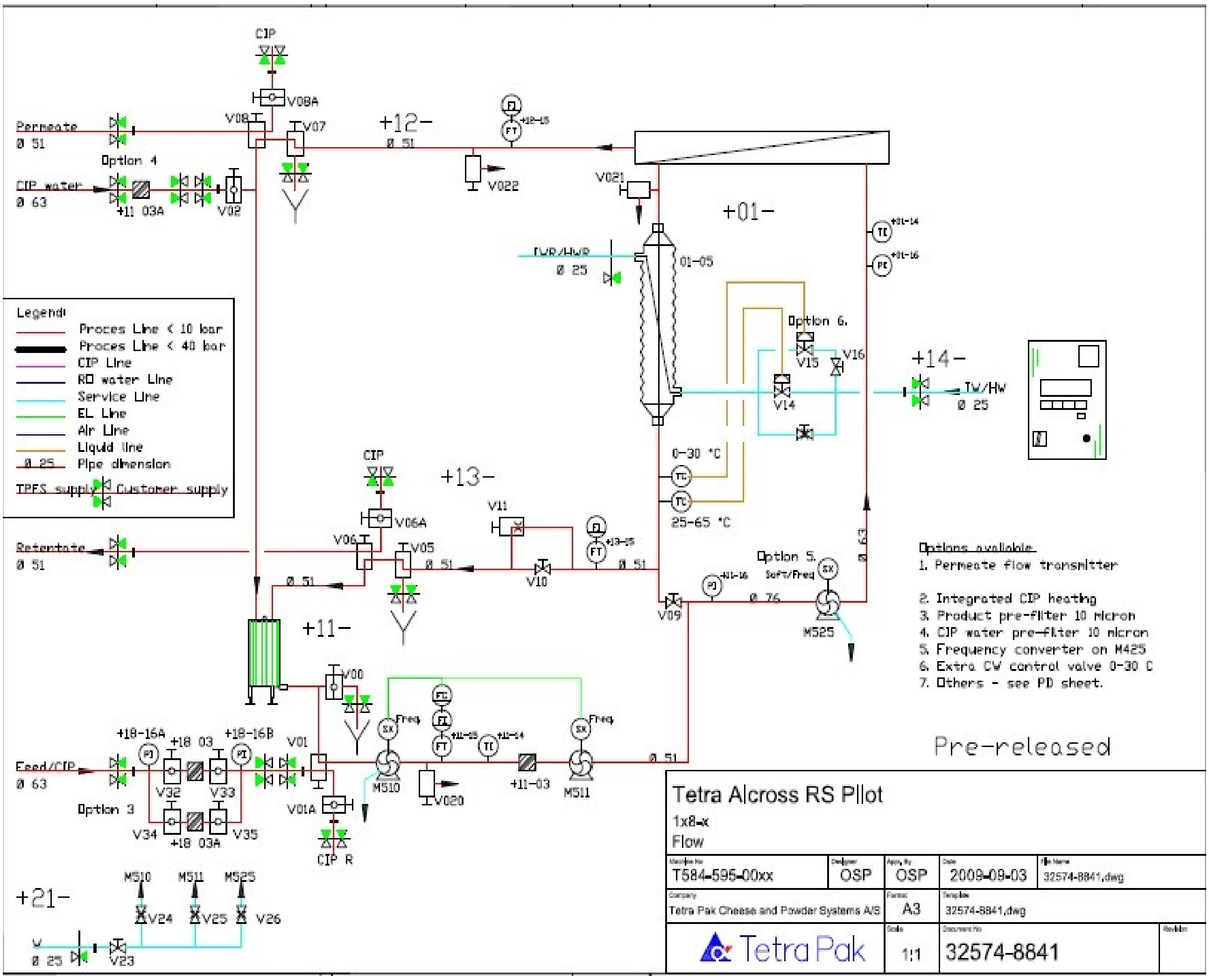
**ANALYSIS REQUIRED :** Turbidity, Fe, Mn, $SiO_2$
Total Hardness, Total Undissolved, OC/OP Screen,
Total Count (37°C): <20/ml, Total Count (21°C): < 200/ml
Total Coliform Bacteria, COD, OC

| ITEMS | ABBREVIATION | UNIT | RESULTS | UNIT |
|---|---|---|---|---|
| TURBIDITY | | NTU | **1.58** | |
| TOTAL IRON | Fe | ppm | **0.17** | |
| TOTAL MANGANESE | Mn | ppm | **0.01** | |
| TOTAL SILICA | SiO2 | ppm | **8.64** | |
| TOTAL HARDNESS as CaCO3 | | ppm | **33.4** | |
| TOTAL UNDISSOLVED SOLIDS | | ppm | **4.23** | |
| TOTAL PLATE COUNT 21°C | | cfu | **20,000** | per ml |
| TOTAL PLATE COUNT 37°C | | cfu | **18,000** | per ml |
| TOTAL COLIFORMS | | MPM | **<3** | per 100 ml |
| CHEMICAL OXYGEN DEMAND | COD | ppm | **10** | |
| ORGANIC CARBON | OC | | **Nil** | |

NTU = Nephelometric Turbidity Units
ppm = parts per million
cfu = colony forming units
MPM = Most Probable Number

< = Less than
Nil = Not Detected

## *System PID*


Permeate
Ø 51
CIP water
Ø 63
Legend:
Proces Line < 10 bar
Proces Line < 40 bar
CIP Line
RO water Line
Service Line
EL Line
Air Line
Liquid line
Pipe dimension
TPFS supply
Customer supply
Retentate
Ø 51
Feed/CIP
Ø 63
Option 3
Option 4
Option 5.
Option 6.
+01-
+11-
+12-
+13-
+14-
+21-
TW/HW
Ø 25
0-30 °C
25-65 °C
Options available
1. Permeate flow transmitter
2. Integrated CIP heating
3. Product pre-filter 10 micron
4. CIP water pre-filter 10 micron
5. Frequency converter on M425
6. Extra CW control valve 0-30 C
7. Others - see PD sheet.
Pre-released
Tetra Alcross RS Pilot
1x8-x
Flow
T584-595-00xx
OSP
OSP
2009-09-03
Tetra Pak Cheese and Powder Systems A/S
A3
1:1
32574-8841
Tetra Pak