final report

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Optimising integrated water reuse and waste heat recovery in rendering plants and abattoirs

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Executive summary

The increasing pressure nationally on water supply resources and the environmental impact of discharging wastewaters has placed a high priority on the need to use non-conventional water sources. Non-potable water streams have been effectively converted to potable supplies using a range of technologies outside the meat industry. Midfield Meat International's rendering subsidiary, Midfield Co-Products, had specific issues with the disposal of wastewater that was threatening its future viability. This plant was seen as an ideal model for investigating the reuse of wastewater to alleviate hydraulic load on the existing pond system.

Midfield Meat International had identified patented Vapour Compression Vacuum Distillation (VCVD) technology utilised by the New Zealand based Distech Company as a potential technology to treat wastewater to a potable standard. The discarded effluent from the Midfield Co-Products facility consists of grossly contaminated non-potable water containing soluble and suspended impurities including fats, proteins, blood, ruminant paunch contents and wash-down debris. The wastewater is currently anaerobically treated and irrigated from the third anaerobic pond. Due to its location adjacent to wetlands and coastal sand dunes there are sustainability issues related to disposing of wastewater in this way.

When developed in April 2004 a successful outcome to this project was seen to set new industry performance benchmarks for water management resulting in new industry standards rewarding industry innovators. One of the objectives of the project was to establish an agreed framework for approval by the appropriate Regulatory Bodies on the use of non-conventional water supplies. During the course of the project between 2004 and 2010 the need to create a framework for acceptance of the use of recycled treated water has been alleviated. The focus of this project was then altered from the development of criteria for acceptance for the use of reused water, to, the practical and economic viability of the Distech waste heat evaporation process as a useful technology for recovering wastewater for reuse in the meat industry.

Studies were conducted on a Distech D50 pilot plant unit and a Distech D1003 commercial production unit. Pilot studies with the Distech D50 found that Cryptosporidium, viruses, E. coli, Enterococci and coliforms spiked into tap water were inactivated in both the product and waste streams. For spiked waste water, E. coli and coliforms were still efficiently inactivated in the waste stream, but some Enterococci were still able to survive. The waste water used would represent the poorest quality that would be used in the D50. The conditions in the D50 were not able to inactivate spores of Clostridium perfringens.

Analysis to date indicates that the distillate water meets the requirements of the Australian Drinking Water Guidelines however it cannot be recommended as suitable as a potable source without further analysis and possibly further treatment, including sterilization. Further assessment should include organoleptic properties including taste and odour. Water sourced from Midfield Co-Products pond #3 is currently able to produce a distillate stream of adequate quality for a range of non-potable uses.

This project was significantly delayed by a number of issues including computer based problems with the Distech equipment. However, the most recent trials have proven the entire treatment plant, including the Distech Vapour Compression Vacuum Distillation (VCVD) equipment can perform reliably on a daily basis.

As this project was targeted at recycling water to eliminate load off the existing effluent ponds and irrigation system, the economics of the process were measured against alternate disposal methods. The alternative to reusing water from the ponds at the Midfield Co-Products rendering plant was to construct a pipeline to provide discharge to the municipal treatment site. The Distech plant failed to be economically competitive on this basis, treating and reusing water at almost 3 times the cost per kilolitre of the alternative option to supply and dispose of water.

In most Australian meat industry scenarios the disposal of wastewater is not likely to be the main concern. Instead the issue is likely to be a shortage of potable water and the need for recycling of wastewater streams on an economically viable basis to produce potable water for use in processing areas. If other, higher quality wastewater streams from meat processing plants are considered, the economics are considerably more favourable. With good quality "clean streams" pre-treatment may be avoided. In this case the cost of operating the Distech unit alone may be feasible and certainly more economically competitive.

Establishment of this technology at other processing plants would require assessment of the economic viability on a case by case basis dependent on the waste stream to be treated.

Contents

1 Background

1.1 Traditional water supplies

Traditionally the meat industry has sourced potable water from municipal supplies, groundwater aquifers through local bores or from nearby rivers for applications. These sources require little or no treatment to allow them to be used as potable water for meat processing. Traditional treatment required has been restricted to sand filtration and chlorination.

The increasing pressure nationally on water supply resources and the environmental impact of discharging wastewaters has placed a high priority on the need to use non-conventional water sources. Non-potable water streams have been effectively converted to potable supplies using a range of technologies outside the meat industry. However all attempts, prior to commencement of this project, to produce acceptable potable water for meat processing from sources other than natural water supplies have been rejected by regulatory authorities. It was identified as essential that criteria for acceptance be established before trials are carried out using the Distech process or any other developing technology.

Midfield Meat International's rendering subsidiary, Midfield Co-Products, had specific issues with the disposal of wastewater that was threatening its future viability. This plant was seen as an ideal model for investigating the reuse of wastewater to alleviate hydraulic load on the existing pond irrigation system.

1.2 Novel water supplies

Some applications of water use in meat processing can be replaced by non-potable water that has been treated by processes which provide water quality just as good, if not better, than the original potable source. Meat processing plants themselves generate a number of water streams that have the potential to replace some of the traditional supply sources.

Midfield Meat International had identified patented Vapour Compression Vacuum Distillation (VCVD) technology utilised by the New Zealand based Distech company as a potential technology to treat wastewater to a potable standard.

The use of technology such as that of Distech, required the establishment of a framework for the approval of non-conventional water supplies as potable supplies, and the application of this framework for acceptance by regulatory authorities. Once the framework was established, Midfield Co-Products could investigate the use of waste heat evaporation using Distech technology as a means of producing water that could be considered as potable quality.

1.3 Project water supply for novel treatment

The discarded effluent from the Midfield Co-Products site in Swinton Street, Warrnambool consists of grossly contaminated non-potable water containing soluble and suspended impurities including fats, proteins, blood, ruminant paunch contents and wash-down debris. The suspended matter includes both colloidal and non-colloidal suspended solids. This waste is currently discharged to a series of anaerobic treatment ponds prior to irrigation from the third pond, creating a sustainable disposal issue common to wastewater treatment plants at abattoirs and rendering sites.

1.4 Drivers for water supply from a novel treatment source

Midfield Co-Products had wastewater irrigation sustainability issues in disposing of the volume of wastewater generated due to its location adjacent to wetlands and coastal sand dunes. The distillation and reuse of contaminated water currently going to waste would significantly reduce the volumetric load for irrigation. Midfield Co-Products also saw the potential for economic benefit and reduction of the existing non-sustainable practices.

When developed in April 2004, a successful outcome to this project was seen to set new industry performance benchmarks for water management resulting in new industry standards rewarding industry innovators.

While regulators have for many years actively encouraged better wastewater management by raising industry awareness through specific programs for water minimisation and reuse, there was not a workable framework for achieving potability in recycled water for the meat industry. The development and implementation of AQIS Meat Notice 2008/06 “Efficient Use of Water in Export Meat Establishments” has since provided this pathway for acceptance of alternate water sources and the use of recycled water.

During the course of the project between 2004 and 2010 the need to create a framework for acceptance of the use of recycled treated water has been alleviated. This has meant a shift in the project objectives from the development of criteria for acceptance for the use of recycled water, to, the practical and economic viability of the Distech waste heat evaporation process as a useful technology for recovering wastewater for reuse in the meat industry.

2 Project objectives

2.1 Project objectives as contracted in 2004

At the completion of the project, the following objectives would have been achieved:

(a) established an agreed framework for approval by the appropriate Regulatory Bodies on the use of non-conventional water supplies;

(b) proven the acceptability against this framework of water recovered from waste streams by the Distech vacuum distillation process;

(c) demonstrated the economic and environmental benefit by the recovery and reuse of the wastewater from the co-products plant; and

(d) demonstrated cost effective disposal, treatment, or value adding to a concentrated waste stream.

2.2 Project objectives after project variations

After variations to contract in September 2005 and September 2010, the following objectives would have been achieved:

(a) proven the acceptability against this framework of water recovered from waste streams by the Distech vacuum distillation process;

(b) demonstrated the economic and environmental benefit by the recovery and reuse of the wastewater from the co-products plant; and

(c) demonstrated cost effective disposal, treatment, or value adding to a concentrated waste stream.

3 Project Methodology

3.1 Overview

The methodology used involved five main components:

- Establishment of criteria of acceptance,
- Data collection on existing wastewater quantity and quality,
- Pilot plant assessment of the effectiveness of Distech technology as a microbiological control,
- Construction, installation and commissioning of Distech waste heat evaporator and support equipment
- Data collection on Distech performance including:
  - Output stream quality
  - Distech performance
  - Distech economics

Each component comprised of one or more project milestones.

3.2 Establishment of criteria of acceptance

A Midfield Meat International led project consortium was established to collaborate with MLA contracted parties such as Dr Mike Johns and representatives from Food Science Australia to form a “Potable Water Reuse” steering committee. This project consortium included the following specialists:

Andrew Westlake – Midfield Meat International Pty Limited (**Midfield**);
Chris Sentance – Food Safety Services (SA) Pty Limited (**FSS**);
Brian Carey –Food Processing Equipment Pty Limited (**FPE**) as agents for Distech;
Eddie Andriessen - Eddie Andriessen Consulting Services;
Warwick Grooby, Paul Monis & Denise Spry - Australian Water Quality Centre

The Midfield consortium was to contribute expertise in:

- project management;
- equipment supply for generation of non-potable, and eventually, approved potable water from effluent;
- regulatory negotiations;
- industry experience with water and effluent supply and management.

The consortium was to identify a variety of water uses at an abattoir site that required water ranging from minimally treated non-potable, through a number of quality steps, to unrestricted use potable water. Quality criteria were to be identified for each and possible sources determined. These quality steps would be the basis of determining usage approvals for non-standard water supplies. Each quality and use would be addressed on a case-by-case basis.

The consortium, with input from other industry specialists, would collate objective data from a range of industrial applications of distilled water generation (Distech technology). Scientific evidence of microbiological safety would be gathered and cases presented for discussion by all relevant regulatory, scientific and industry interest groups. In particular, in-principle approval would be sought from AQIS for the potential use of distilled water within the range of usages identified. Any final approval would be subject to the scientific validation of the water’s safety during this project.

3.3 Data collection of existing wastewater quantity & quality

Data was to be gathered utilising the skills of Masters Students from Deakin University in Victoria under a commercial arrangement with FPE. Data collection involved:

- measurements of various water flows on site;
- sampling & testing of water samples from a range of waste streams
- analysis of these findings to facilitate an informed decision on the most appropriate areas of re-use of the purified water; and
- comparison of current site performance to the industry benchmark data found in the MLA Eco Kit.

3.4 Pilot plant assessment of Distech performance

Concurrently with 3.3 above, FPE was to arrange installation of a pilot plant Distech unit at the AWQC Bolivar Laboratory. AWQC would conduct a detailed assessment of the performance of the pilot plant as follows:

- Phase 1 would be a preliminary assessment using tap water to assess the removal of a panel of microorganisms (*E. coli*, *Klebsiella*, *Enterococci*, enteric virus, *Cryptosporidium*, *Giardia*). This panel was chosen to represent the organisms likely to be present in waste effluent.

- Phase 2 would be a rigorous assessment using tap water to assess the removal of a panel of microorganisms (*E. coli*, *Klebsiella*, *Enterococci*, enteric virus, *Cryptosporidium*, *Giardia*). This phase would involve 3 separate tests of the distillation device and all analyses would be conducted in triplicate by NATA accredited laboratories where appropriate.

- Phase 3 would involve testing the device using 5 effluent water samples (unspiked). The samples would be tested pre and post treatment in accordance with AQIS Notice Meat: 99/15 "Water testing requirements for EU listed meat establishments (including game/farmed game establishments and coldstores)." to determine the microbiological and chemical quality. In addition, testing would be conducted for *Campylobacter*, *Salmonella*, *Cryptosporidium*, *Giardia*, viruses, Helminths and bacteriophage.

3.5 Construction, installation & commissioning of Distech plant

Process plant and equipment would be installed and commissioned at Midfield Co-Products including the following activities:

- laying of slab;
- installation of ancillary equipment/piping;
- installation and commissioning of the patented Vapour Compression Vacuum Distillation (VCVD) Distech equipment;
- training of personnel;

Specific process steps and equipment that were to be installed and commissioned were:

- Duplex multimedia filters;
- Duplex granulated activated carbon filters;
- Auto pH adjustment – acid dosing;
- Flow through decarbonation tower;
- Auto pH adjustment – alkali dosing; and
- Vapour Compression Vacuum Distillation (VCVD) Distech equipment.

Note. The Distech equipment (evaporator, pre-treatment & decarbonator tower) were leased to the project for the originally estimated life of the project. After the trial period the Distech equipment would continue to be leased by Midfield or sold.

3.6 Evaluation & reporting of performance of Distech plant

A detailed analysis of the performance of the plant would be made over a one-year period and will be reported to MLA on a quarterly basis. Activities would include:

a) monitoring of the project performance;
b) analysis and reporting on findings;
c) benchmarking the findings and showing comparison to the industry benchmark data found in the MLA Eco Kit;
d) demonstration of cost effective disposal, treatment, or value adding to the concentrated waste stream (a target of 280kL/week);
e) negotiation with the regulatory body for the acceptance of findings and approval for use of the water produced for potable purposes.

A Final Report covering all process operation data, performance data, conclusions and recommendations to industry was to be prepared by FSS and submitted to MLA.

3.7 Amendments to methodology

As a result of a number of changes and delays to the project, the original project schedule of approximately 21 months was extended to approximately 6 years. As a result, a number of changes to the project methodology occurred, but always with an objective to achieve a useable outcome for Midfield Co-Products, MLA and the Australian Red Meat Industry. These changes and the reasons for them are identified in the Results and Discussion section of this report.

4 Results and discussion

4.1 Establishment of criteria of acceptance

During mid-2004, considerable progress was made with AQIS on an informal basis to consider an alternate approach to the approval of water for potable use based on measurable chemical, physical and microbiological quality rather than on source point. AQIS parties approached included:

Acting General Manager Meat Program, Food Inspection Operations Group
On Plant Veterinary Officer- Midfield Meat Warrnambool
Area Technical Manager Victoria
Area Technical Manager South Australia

A formal discussion paper was prepared and submitted to AQIS for consideration and possible approval. This paper follows the requirements of AQIS MEAT NOTICE 2003/03 and is included as Appendix 7.1 to this report.

In May 2004, following extensive discussions between the P.PIP.0058 Project Team, Meat & Livestock Australia, Food Science Australia and Dr Mike Johns, it was decided that AQIS's consideration of Distech treated water streams for potable use was not appropriate at that time. While this topic continued to be of interest to all meat industry stakeholders, progress with a number of Australian and international projects in that area made the timing of that document less than ideal. The opportunity to further investigate the Distech technology and gather data on its performance would allow for an alternative use for the discussion paper at a future date.

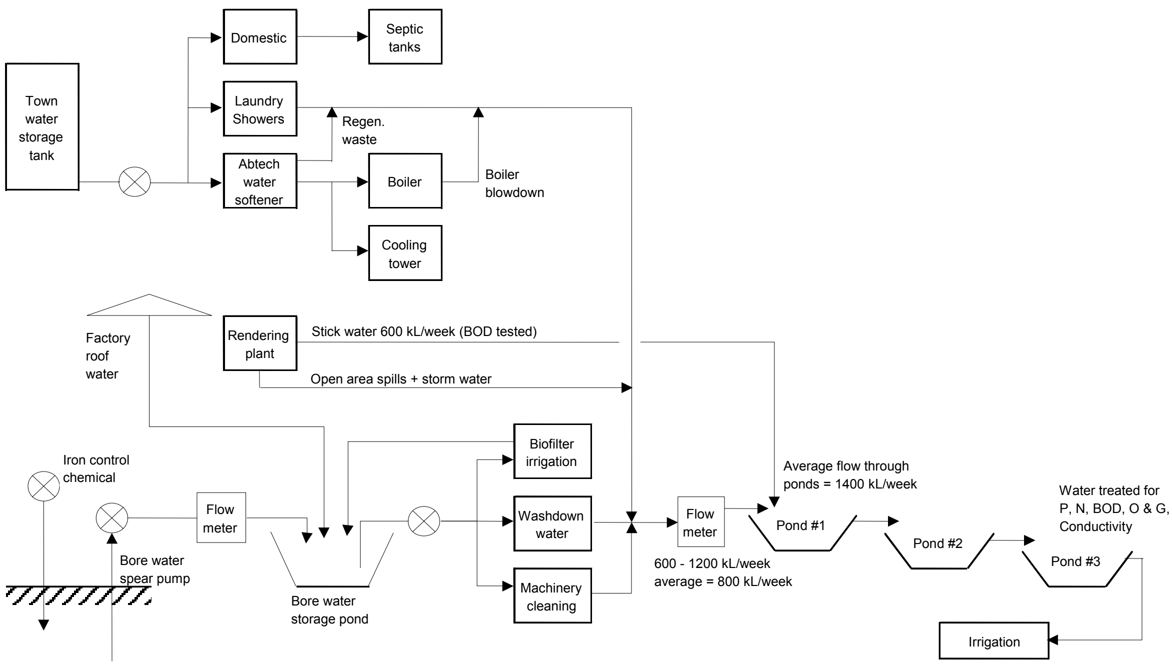
MLA instructed the Project Manager to withdraw the discussion paper from AQIS and to remove all reference to potable use in milestone 1 of this project. Determination of potability of a range of waters from the Distech plant was however to remain a focus of the project.

To achieve the new criteria of milestone 1, i.e. the acceptance by the relevant regulatory authorities for the installation of the Distech plant at the Midfield Co-Products rendering plant and the use of treated waters for non-potable use at the rendering plant, local approval was sought and obtained from the On Plant Veterinary Officer.

4.2 Data collection of existing wastewater quantity & quality

Data on Midfield Co-Products wastewater from pond # 3 was collected as follows:

Flow rates:
Flow sequences and flow rates are given in the Process and Instrumentation Diagram in Figure 1 below.



MIDFIELD MEATS - RENDERING PLANT WATER & WASTEWATER TREATMENT P&ID

Figure 1: Midfield Co-Products P&ID

The flow rates represented in the P&ID were accepted as design flow rates by the Distech project design team because the variance in flow rates that occurred at this site from period to period was small.

Water analysis:
A program of water analysis was undertaken on site to characterise the effluent from pond # 3. This was a critical process in determining the required pre-treatment of effluent for the Distech evaporator.

Parameters of particular interest were; Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (SS), Total Dissolved Solids (TSS), Bicarbonates, Phosphorus (P) and Total Kjeldahl Nitrogen (TKN).

These parameters represented the key indicators of the water quality in pond # 3 and hence would directly influence the effectiveness of the wastewater treatment process.

Since the first 'proof of concept' trial of the Distech D50 on-site at Midfield Co-Products plant in July 2002 (prior to this project), it was determined that the water quality in pond # 3 had slightly deteriorated. Typically doubling of BOD/COD and SS had occurred with the remaining key parameters remaining steady. This situation did not represent a significant problem as the project design team expected the effluent to rapidly improve once the vacuum distillation waste water treatment plant was in operation.

From the varying water analyses carried out, it was decided by the project design team to take the worst case scenario as design criteria for the pre-treatment, as opposed to an average figure of each parameter.

The chosen design parameter values were:

COD	4000 mg/L
BOD	2000 mg/L
SS	1000 mg/L
TDS	5000 mg/L
Bicarbonates	3500 mg/L
P	150 mg/L
TKN	850 mg/L

These values were expected to reduce dramatically when the complete Distech waste water treatment plant was in operation. This is expected from:

- increased retention times in the pond system,
- use of recovered water of a substantially better quality, rather than the bore water currently utilised which has elevated TDS levels.

While it was recognised that pH was critical to the pre-treatment process, there was no monitoring of pH at this stage as pH monitoring and adjustment equipment had been budgeted for in the design of the plant.

4.3 Pilot plant assessment of Distech performance

The pilot plant trials of the Distech D50 vacuum evaporator was conducted in 3 phases:

Phase 1: Preliminary assessment of the D50 to examine the removal of a panel of microorganisms (E. coli, Coliforms, Enterococci, Cryptosporidium, viruses) from spiked tap water.

Phase 2: Rigorous assessment of the D50 to examine the removal of a panel of microorganisms (E. coli, Coliforms, Enterococci, Cryptosporidium, viruses) from spiked tap water.

Phase 3: Assessment of the D50 for the treatment of primary screened abattoir waste water to produce water of sufficient quality to satisfy the requirements of AQIS Notice Meat: 99/15 "Water testing requirements for EU listed meat establishments (including game/farmed game establishments and coldstores)".

These results, prepared by AWQC, are summarised below

Phase 1:

Test organism	Product Stream Log_{10} Removal	Waste Stream Log_{10} Removal
E. coli	>7.8	>7.8
coliforms	>8.0	>8.0
Enterococci	>7.9	>7.9
Cryptosporidium	>5.5	0.3
MS2 phage (virus surrogate)	>5.9	>5.9

The numbers of culturable bacteria or phage (virus surrogate) in the product or waste water were below the detection limit of the assays, indicating good inactivation of these test organisms. The number of *Cryptosporidium* oocysts in the product water was also below the detection limit. Unlike the other assays, the *Cryptosporidium* results represent direct counts of the test organism (oocyst infectivity was not assessed in phase 1). This means that there was good removal of oocysts from the product water.

There was a slight reduction in the number of *Cryptosporidium* oocysts in the waste water when compared with the influent water. Considering the mechanism of operation of the Distech D50, it would be expected that the oocysts should be approximately 2-fold concentrated in the waste stream. Allowing for this concentration effect, it can be concluded that approximately 60% of the oocysts were destroyed during the treatment process.

Phase 2

Test organism	Product Stream Log_{10} Removal	Waste Stream Log_{10} Removal
E. coli 1	>8.0	>8.0
E. coli 2	>7.9	>7.9
E. coli 3	>7.8	>7.8
Coliforms 1	>8.2	>8.2
Coliforms 2	>8.1	>8.1
Coliforms 3	>8.0	>8.0
Enterococci 1	>7.9	>7.9
Enterococci 2	>7.7	>7.7
Enterococci 3	>7.9	>7.9
Cryptosporidium 1	>6	0.1
Cryptosporidium 2	>6	0.2
Cryptosporidium 3	5.9	0.2
Poliovirus	>3.7	>3.7
MS2 phage 1	>5.5	>5.5
MS2 phage 2	>5.5	>5.5

The Phase 2 results were largely in agreement with the Phase 1 data. There were a few notable results. A small number of *Cryptosporidium* oocysts were detected in the product water in round 3 of testing. The product water samples were analysed on a separate day to the waste and influent samples, making it unlikely that the result was due to cross-contamination. This result suggests that some degree of cross-connection between the waste and product streams may have occurred by an unknown mechanism during Distech operation.

Assessment of oocyst infectivity for oocysts in the waste stream demonstrated complete inactivation. These data suggest that the distillation process destroyed at least 50% of oocysts and those remaining are rendered inactive. The number of oocysts in the single positive product water sample was too low to analyse for infectivity. If these oocysts were from the waste water (as opposed to the influent) then they would be inactive.

Phase 3:
Microbiology results

Test organism	Product Stream Log_{10} Removal	Waste Stream Log_{10} Removal
E. coli 1	>9.1	>9.1
E. coli 2	>9.1	>9.1
E. coli 3	>9.1	>9.1
E. coli 4	>9.0	>9.0
E. coli 5	>9.0	>9.0
Coliforms 1	>9.2	>9.2
Coliforms 2	>9.2	>9.2
Coliforms 3	>9.2	>9.2
Coliforms 4	>9.2	>9.2
Coliforms 5	>9.2	>9.2
Enterococci 1	>6.1	3.2
Enterococci 2	>6.1	3.4
Enterococci 3	>6.1	3.1
Enterococci 4	>6.0	3.0
Enterococci 5	>6.0	3.0
SRC* 1	2.7	0
SRC 2	2.5	0
SRC 3	2.5	0
SRC 4	2.5	0
SRC 5	2.5	0
C. perfringens 1	2.6	0
C. perfringens 2	3.5	0
C. perfringens 3	2.9	<2.3
C. perfringens 4	2.3	<2.3
C. perfringens 5	2.5	<2.3

* Sulphite Reducing Clostridia

The Phase 3 results for *E. coli* and coliforms were the same as the previous phases, with complete inactivation of the seeded organisms. In the case of *Enterococci*, there was complete removal of the seed from the product water but not the waste stream. Considering that complete inactivation was achieved in the waste stream using higher numbers of *Enterococci* spiked into tap water, it appears that the matrix has an influence on the survival of some bacteria.

The results for *C. perfringens* were surprising, especially for the product water. *Clostridium* spores are relatively heat resistant and will tolerate 70°C for at least 20 minutes, although the effect of heat in combination with vacuum was unknown. There appeared to be no removal of *Clostridium* from the waste stream, suggesting that the combination of heat and vacuum does not inactivate the spores.

Clostridium spores were detected in the product water, which suggests cross connection between the waste and product streams and supports the earlier Phase 2 findings for *Cryptosporidium*. There were some problems with the accuracy of the *Clostridium* counts due to overgrowth of the plates and the presence of *Clostridia* other than *C. perfringens*, which was the seeded test organism. This affected some of the *C. perfringens* counts in the waste stream and is the reason why some results are <2.3 log_{10} removal when the removal is most likely to be 0.

Visual quality

Visual quality of the pond #3 waste water and the output streams are shown in figure 2.

Figure 2: Comparison of waste water influent, treated waste water and the product water

Chemistry results

Parameter	EU target	Average for Waste water (seed)	Average for Product water	Log_{10} Reduction
Aluminium	200 μg/l	942	210	0.7
Ammonia	0.5 mg/l	88.2	40.4	0.3
Colour	15 TCU	985	7	2.1
Conductivity	- uS/cm	22445	192.6	2.1
pH	6.5 - 8.5	6.75	9.48	-
Nitrite	0.5 mg/l	0.05	<0.005	>1.0
TDS	- mg/l	1200	106	1.1
Boron	1 mg/l	0.788	≤0.04	>1.3
Chloride	250 mg/l	327	10.2	1.5
Cyanide	50 μg/l	<50	<50	-l
Fluoride	1.5 mg/l	0.83	<0.10	>0.9
Lead	10 μg/l	5.3	<0.5	>1.0
Lithium (spike)	- μg/l	1104	6.4	2.2
Manganese	50 μg/l	100.5	0.7	2.2
Nickel	20 μg/l	9.45	1.68	0.8
Pesticides	0.01 μg/l	<0.01	<0.01	-
Total Pesticides	0.05 μg/l	<0.05	<0.05	-
Sulphate	250 mg/l	23.7-173	148.2	0.07
BOD	- mg/l	745	10.6	1.8
Grease	- mg/l	215	3.5	1.8
Zinc	- μg/l	1371	9.4	2.2

Chemical analyses were conducted on the seeded waste water prior to treatment and the resulting product water stream following waste water treatment through the D50. The product water was within the EU requirements for the parameters tested, with the exception of Aluminium, Ammonia and pH (highlighted in red). The high pH is unusual for distilled water (which is usually acidic) and is probably due to the high levels of ammonia.

The concentration of most metals and biological oxygen demand (BOD) decreased by approximately 2 log_{10}. The BOD levels may be suspect due to difficulty encountered with the analysis of the abattoir waste water.

In these instances, the concentrations in the product water were consistent with a small cross-connection between the product and waste streams and the carryover was similar to that observed for *Clostridium*. Assuming that Zinc, Manganese, Lithium and *Clostridium* were completely removed from the product water, it can be estimated that the waste water contaminated the product water at an approximate ratio of 1:300 waste stream: product stream based on the metal results and an approximate ratio of 1:600 waste stream: product stream based on the *Clostridium* results.

Given these ratios, it would be expected that the culturable *Enterococci* present in the waste stream would be diluted below detection level, which is consistent with the observed results. In the case of chemicals with a removal of less than 2 log_{10} (Aluminium, Ammonium, Nickel and Sulphate in particular), it would appear that there has been some carryover of that chemical into the product water, in addition to any contribution from the waste stream as a result of the cross connection.

The reasons why some of these chemicals are not removed is not clear. It is not likely to be due to molecular weight given that Lithium was removed and is of a lower molecular weight than Sulphate.

4.4 Construction, installation & commissioning of Distech plant

The following equipment was installed at Midfield Co-Products rendering plant and successfully commissioned on water as operational:

- Baleen primary filtration system;
- Integra chemical dosing equipment;
- Auto pH adjustment – acid dosing;
- Decarbonator process;
- Auto pH adjustment – alkali dosing; and
- Distech vacuum evaporator (Model D1000 – unit # D1003)

Key items of equipment are shown in figures 3 & 4.

Figure 3: Baleen filter installation

Figure 4: Distech D-1003 installation

All items, except the Distech unit, had been on-site since mid to late 2005 and were progressively commissioned as they were installed. The Distech unit was delayed in construction in New Zealand due to some additional design and development requirements for this unique item of equipment. In particular delays were caused by:

- Specialised parts supply delays. In particular a serious delay occurred in construction of the evaporation plates by a US company. The plates are a specialty item constructed from a specialised grade stainless steel on order basis only. They experienced lead times of 12-16 weeks for this item, which is generally 6-8 weeks lead-time.
- The D1000 installed at Midfield Co-Products is only the second of this capacity unit constructed.
- Design changes were made to improve on the first D1000 built.
- The Distech operation moved from Auckland to Hamilton during construction of the D1000
- Distech engineers requested longer testing times to ensure performance

The Distech unit was pre-commissioned in Hamilton New Zealand and was fully operational when shipped in late 2005. Commissioning trials have shown that the actual performance is 25% higher than expected.

Design throughput - 4,000 litres/hour
Actual throughput - 5,000 litres/hour

Following pre-commissioning in NZ, the unit was shipped to Warrnambool and installed on site with other process equipment already successfully commissioned on water.

The Distech D1003 was finally in full operation processing Warrnambool town water on Tuesday 7th March 2006. For the purpose of commissioning a closed loop was set up for the system where the distillate and the concentrate from the D1003 were directed back into the Distech feed tank. The D1003 ran at design parameters consistently for 3 hours. In this time the FPE & Distech commissioning team were able to confirm all elements of the D1003 were functional. All PLC functions were operational and very simple to use.

The Distech technician also demonstrated the functions available to optimise the process, for example, changing the portion of feed flow through the concentrate and distillate heat exchangers. This balance is very important in energy recovery and maximising distillation rate.

The Deakin Masters student working on this project, who had provided the data for previous milestones, had now left the project to take up employment elsewhere. Deakin University had provided another student who was becoming familiar with previous work and the equipment. This student was on a 12-month study project ensuring that the project would be covered through the balance of its scheduled life.

A loss of control of the existing wastewater ponds over the last few months prior to plant commissioning had unfortunately resulted in some significant changes to the pond performance and the water quality from pond #3 that was to feed the Distech plant. The Deakin student quantified these changes and attempted to adjust pre-treatment conditions to ensure that the feed water to the Distech unit met design specifications.

From July 2006 through to December 2006, the Deakin University Masters student was on-site full time monitoring and documenting the following:

- Chemical use of the plant
- Energy use of the plant
- Functionality of the daily operation of the plant
- Water quality
- Required maintenance
- Plant by-products management
- Pond performance (any changes due to plant)

4.5 Evaluation & reporting of performance of Distech plant

Midfield Meat International employed a full time project engineering graduate (Matt Boyce) under the MLA Graduate Program to work on the Distech, and other, environmental projects. Matt's role in the project was to resolve the experienced issues and manage the project to completion, eliminating the need for the sue of Deakin University students which had not been entirely successful. Matt now takes over the role as lead contact for Midfield for this project from Andrew Westlake.

Progress in evaluation of the system was slow due to the number of key reasons. Firstly the quality of the water from pond #3 had deteriorated to a point where it could not be effectively and economically pre-treated and no longer met the Distech D1003 feedwater design specifications. Secondly a number of failures occurred in the Distech PLC control systems. These issues were addressed as followed:

Pond #3 cleaning

To improve the quality of source water for the Distech process, pond #3 was dredged to clean out accumulated solids and return the pond to its previous condition on which the Distech design parameters were based. Several months delay occurred during dredging and during a period of re-stabilisation of pond performance.

Baleen

Equipment design issues:

The transfer pump for the Baleen filtrate to the de-carbonator tank was over sized and hence capitates, as it could not draw enough effluent fast enough.

Solids residue remained on top of the effluent post Baleen. It was estimated that the Baleen was removing 99% of solids, however it was clear that a very basic secondary filtration step should take place, prior to the de-carbonation process, to remove any carry over solids before pH adjustment.

Response action:

The transfer pump was replaced with a smaller pump.

The screen was changed on the Baleen filter from 125 micron to 38 micron to increase screening efficiency. Flow rate was not affected by the screen change, as flocs formed were very healthy and hence filterable.

A secondary filtration step was installed to provide further protection to the Distech unit from poor feed quality. A multimedia filter was installed post Baleen to carry out this role.

The Baleen sump pump was changed to VSD control to provide constant pressure and flow to filter.

The Baleen and Decarb system only requires operator input to check chemical levels as well as floc quality over the Baleen on occasion. Placement of a Turbidity probe post Baleen has been considered as a fail safe for chemical dosing issues.

Chemical dosing system

Equipment design issues:

Prior to pond cleaning chemical consumption was very high due to the pond effluent being high in fat and proteins. It was clear that the pond effluent had very high organic loadings, which require increased chemical dosing rates to achieve desired solids reduction.

In addition, the pond effluent was very inconsistent and could vary greatly from day to day, or depending on what level the pond was at when pumped to the Baleen feed tank. This situation required manual adjustment of chemical dosing rates otherwise floc formation was affected resulting in poor solids removal.

Response action:

The cleaning of pond #3 reduced nutrient loading in the Distech pre-treatment source water and improved the consistency of this source water.

The polymer dose pump was replaced with a much larger unit to be able to increase the polymer dose rate. The polymer make-up system was fine-tuned to improve its accuracy.

Two variable speed drive (VSD) units were introduced into the system to allow quick and easy adjustment of the polymer dosing rate and the polymer make-up system.

Chemical dosing points were changed back to the original points and coagulation and flocculation improved to an excellent quality with the revised dosing points.

De-carbonator

Equipment design issues & response action:

The 4 valves for chemical dosing pipes that draw the chemical were installed to eliminate air entering the pipe.

The transfer pump for delivering effluent, post de-carbonation process, to the Distech feed tank was too small and also lost prime. This pump was swapped with the Baleen transfer pump (which was too big) and was relocated at ground level to eliminate the priming problem.

Distech D1003

Equipment design issues & response action:

There was a need to isolate the steam line condensate drain during machine warm-up as the heat melted the PVC pipes. During D1003 warm-up, no other clear water drained to the Distech sump. As a result the steam line condensate was not diluted with cool water and the resulting heat caused the pipework to melt. Steam line condensate can be directed to the Distech sump once the D1003 is operating on product.

Remote access was established for Distech to the D1003 via wireless modem. Tuning of the D1003, in terms of clear water/feed water supply and distillate/concentrate/clear water return, was now possible.

Distech D1003 PLC system

After the CPU and VSD issues experienced in 2007, the D1003 seemed to have had the difficulties with the control systems resolved. Brian Atkins (Distech) and Matt Boyce spent considerable time on the unit during June 2008 resulting in a successful re-commissioning of the unit.

During this time the D1003s performance on town water was assessed and it was concluded that the unit was again performing to specification. A distillation rate of in excess of 4KL/hour was achieved on a consistent basis.

Trials of the D1003 on pre-treated effluent showed that the unit was capable of effluent distillation and could match that of town water for around 2 hours. Water quality is shown in figures 5 & 6 below. It was concluded, however, that after 2 hours there was fouling of the EC plates of the D1003 unit. Causes of this plate fouling were identified as being likely to be residual solids and blood proteins post Baleen.

It was found that any fouling of the plates could be removed by running a Clean in Place (CIP) cycle. Following CIP the unit was run again on town water and found to be performing to specification. These results now gave us a good platform to assess the performance of the unit on differing effluent qualities.

Figure 5: L to R Pond, Feed, Distillate, Concentrate

Figure 6: L to R - Distillate, Concentrate

Further issues with the Distech control systems

As of June 2008, it was considered that the issues experienced with the faulty Siemens CPU & PLC modules had been resolved. These issues arose again however and a decision was made by Matt Boyce to remove the Siemens PLC and exchange it with Allen Bradley equipment. This decision was made due to the support for Allen Bradley equipment onsite and the availability of spare parts.

A significant delay was experienced while the Siemens program was converted for use in the Allen Bradley PLC. The program rewrite was completed by a local contractor as the original Distech programmer had since moved on, this was overseen and completed using Matt's knowledge of the unit operation. During this time the program was rewritten, with sections to be further altered as part of the re-commissioning process. The touch screen setup was replaced with a SCADA system allowing for extra functionality and increased parameter monitoring.

An overhaul of all pumps, valves and gasketing on the unit was completed while commissioning of the Allen Bradley PLC occurred. Distech's Director (Brian Davies) was unhappy with the heat exchange capacity of the existing steam heater and the ability to accurately control thermal decay of the unit. A heat exchanger with greater capacity was sought and implemented, allowing for improved control during normal operation and thermal decay.

The Distech D1003 was finally recommissioned by Matt Boyce and Brian Davies in March 2010 after the Allen Bradley PLC installation and unit overhaul. Performance of the unit was assessed on town water, as a control, during commissioning while operating parameters were being defined.

Following the successful commissioning of the unit on town water, effluent trials were run mid March 2010. The plant was now capable of providing pre-treated effluent quality consistent to allow for greater than 6hrs runtime of the D1003 unit.

The baleen screen (38micron) in conjunction with the installed chemical makeup/dosing & media filter setup continued to provide reliability in chemical makeup/dosing. Suspended solid reduction post the pre-treatment setup was consistently >98%, with solid concentrations remaining <10mg/L.

Successful operation of the D1003 on effluent occurred for periods of 5 hours up to 8.5hours.

The D1003 was considered to be fully operational on effluent and comparable to the operational control (town water), with a distillation rate of >4.5kL/hr. On each occasion the unit ran faultlessly with the limitation of operation being the transfer pump between the Baleen filter and the media filter. This pump was replaced with a larger capacity model.

Final water quality is shown in figure 7 below.

Sampling of both the Distech distillate & concentrate occurred during operation and the results are recorded in the table below. Where available the guideline value expressed in the Australian Drinking Water Guidelines is displayed alongside the distillate value as an indicator to the distillate quality.

Distech Analytical Results

Parameter	Units	Concentrate	Distillate	Drinking Water Guideline
pH	pH Units	6.5	8.8	6.5-8.5
Reactive Phosphorus	mg P/L	130	6.4	
Total Organic Carbon	mg/L	120	14	
Total Dissolved Solids	mg/L	5100	300	500
Turbidity	NTU	32	4.9	5
Fluoride	mg/L	1.1	0.08	1
Chloride	mg/L	1000	59	250
Sulphate	mg/L	39000	200	250
Sulphide	mg/L	<0.1	<0.1	
Total Alkalinity as CaCO3	mg CaCO3/L	130	200	
Bicarbonate Alkalinity	mg/L	150	110	
Carbonate Alkalinity	mg/L	<2	62	
Ammonia	mg N/L	760	76	
Nitrate	mg N/L	<0.01	<0.01	50
Reactive Silica	mg/l	34	2.4	
Non-Reactive Silica	mg/l	<0.1	<0.1	
Hardness as CaCO3	mg/l	200	12	200
Calcium	mg/l	36	2	
Magnesium	mg/l	26	2	
Potassium	mg/l	170	13	
Sodium	mg/l	720	39	180
Barium	mg/l	0.2	<0.1	
Iron	mg/l	0.6	<0.5	0.3
Manganese	mg/l	<0.1	<0.1	0.1
Silicon	mg/l	15	<1	

Figure 7: Final water qualities
L-R: Anaerobic Pond Sample, Pre-treated Effluent, Distech Distillate, Distech Concentrate

The plant was now assessed while being operated 4-5 days a week for 7-8 hours over the monitoring period. It should be noted that plant operation was limited to operator availability as the plant design did not allow for automatic operation.

Distillate produced during operation was blended with the municipal supply and used as cooling tower/boiler makeup water. Concentrate produced during operation was discharged via the wastewater irrigation system.

Operational Issues
Some problems remained relating to the original Siemens program which caused intermitant faults in the operation of the D1003, in particular process step run-ons from warm-up directly to the cleaning stage rather than processing distillate. It was determined that these minor operational issues could only be resolved by additional programming which would not be performed until commercial viability was assessed. While recognised as only minor operational issues they would be costly to resolve due to programming costs.

D1003 Cleaning
The D1003 clean frequency was analysed during the monitoring period. It was determined that a clean was required when the distillate production dropped below 4kL/hour. The clean frequency was determined to be a 1 hour cleaning cycle per 10 hours of operation. Sodium Hydroxide was assessed as the most appropriate cleaning chemical and was run as a dilution on a closed loop cycle for 1 hour. This cleaning frequency is compatible with the 4 hours of downtime per day which would be allocated under normal full-time operation.

Technical Viability
Over the course of the quarterly monitoring period the plant as a whole, and the D1003 in particular, had finally proven its ability to meet the technical performance specifications of the project, these being in water quality, distillate production rates, clean frequency and operational issues.

Commercial Viability
In order to assess the commercial viability of the project, the operating parameters were defined during the final quarter monitoring period and costed per kilolitre of recycled water.

In order for the project to be deemed commercially viable the cost per kilolitre of recycled water through the plant must be no greater than the cost per kilolitre to purchase potable water + the trade waste discharge cost per kilolitre.

For the 2010/11 financial year, the cost per kilolitre for potable from the Wannon Region Water Authority is $1.74

The assessed cost to discharge trade waste to the Wannon Region Trade Waste system based on the 2010/11 financial year charge rates is $2.25. This cost has been calculated from monthly analysis of trade waste parameters within the Midfield Co-Products pond system at the point of discharge and calculated by applying the 2010/11 Wannon Water Trade Waste charge rates.

The all in water cost for Midfield Co-Products per kilolitre would therefore by $3.99.

A summary spreadsheet showing commercial viability of the water reuse system is included as figure 8 below.

The economic viability was developed on the basis of operating costs only as the costs associated with the development of a trade waste pipeline to connect the site to the municipal system would be approximately equal to that of the capital required to purchase the treatment plant as a packaged unit.

Cost of operation per hour									
Operation	Power	Water	Air	Coag	Polymer	Acid	Caustic	Steam	Total
Baleen System	$0.20	$0.85	$0.51						$1.56
	2.2	490	0.5						
	kWh	L/hr	CFM						
Polymer dosing	$0.35	$0.85		$12.03	$1.01				$14.23
	3.89	490		3.25	0.117				
	kWh	L/hr		L/hr	L/hr				
De-carbonation	$0.24					$18.00	$0.00		$18.24
	2.62					20	0		
	kWh					L/hr	L/hr		
Distech D1003	$5.30					$0.00	$0.56	$9.59	$15.44
	58.87					0.0	0.7	557	
	kWh					L/hr	L/hr	kg/hr	
					Hourly Distillate produced			4.2	kL
Net Hourly Operating Cost			$49.47						
Net Cost Per kL of reused water			$11.78						

Figure 8: Reuse system operational costs

This makes the cost of reuse water via this process $7.79 per kilolitre greater than that of the calculated all in water cost for Midfield Co-Products from the Wannon Region Water Authority system, ($3.99 per kilolitre).

The quality of effluent treated by the Distech unit at Midfield Co-Products is vastly contaminated in comparison to sources such as steriliser overflow water and evisceration table wash water. The economic viability of treating these 'clean streams' is greatly increased due to limited chemical pretreatment and steam requirements. In essence the use of flocculation chemicals and acid for decarbonation can be avoided. Warm to hot clean streams would also require little to no heating, reducing the steam consumption and increasing economic viability.

In the case of sterilizer overflow water at 75°C, the Distech unit could be used in conjunction with a pre-treatment screening step without the need for chemical flocculation or decarbonation. Heating costs would also be alleviated due to the supply temperature. Costs for the treatment of this effluent type may then be as low as the electrical operating costs of the Distech unit $5.30 per hour, plus pumping costs of approx $0.50 -$0.70 per hour. The maximum per kL treatment cost for this system would then be reduced to $1.42, $0.32 less than the 2010/11 per kL potable supply cost for the Wannon Region Water Authority.

Water Quality

Further analyses have been carried out on both the distillate and concentrate streams. Emphasis is placed on the distillate quality as this is the stream intended for use within the facility. Results are shown in figure 9 below with a comparison to Drinking Water Guidelines.

While the analysis to date indicates that the distillate water meets the requirements of the Australian Drinking Water Guidelines it is not likely to be suitable as a potable source without further analysis and possibly further treatment. Consideration should be given to assessment of organoleptic properties including taste and odour. However in its current state it has proven useful as plant washdown water and as boiler make-up water.

Parameter	**Units**	**Concentrate**	**Distillate**	**Drinking Water Guideline**
pH	pH Units	6.5	8.8	6.5-8.5
Reactive Phosphorus	mg P/L	130	6.4	
Total Organic Carbon	mg/L	120	14	
Total Dissolved Solids	mg/L	5100	300	500
Turbidity	NTU	32	4.9	5
Fluoride	mg/L	1.1	0.08	1
Chloride	mg/L	1000	59	250
Sulphate	mg/L	39000	200	250
Sulphide	mg/L	<0.1	<0.1	
Total Alkalinity as CaCO3	mg CaCO3/L	130	200	
Bicarbonate Alkalinity	mg/L	150	110	
Carbonate Alkalinity	mg/L	<2	62	
Ammonia	mg N/L	760	76	
Nitrate	mg N/L	<0.01	<0.01	50
Reactive Silica	mg/l	34	2.4	
Non-Reactive Silica	mg/l	<0.1	<0.1	
Hardness as CaCO3	mg/l	200	12	200
Calcium	mg/l	36	2	
Magnesium	mg/l	26	2	
Potassium	mg/l	170	13	
Sodium	mg/l	720	39	180
Barium	mg/l	0.2	<0.1	
Iron	mg/l	0.6	<0.5	0.3
Manganese	mg/l	<0.1	<0.1	0.1
Silicon	mg/l	15	<1	

Figure 9 - Water quality results

5 Conclusions and recommendations

5.1 Ability to eliminate pathogenic micro-organisms

Pilot studies with the Distech D50 found that Cryptosporidium, viruses, E. coli, Enterococci and coliforms spiked into tap water were inactivated in both the product and waste streams. In the case of Cryptosporidium, there were no oocysts in the product water (except for when the cross-connection occurred between the waste and product streams) and there was evidence of physical destruction of some of the oocysts in the waste stream.

For spiked waste water, E. coli and coliforms were still efficiently inactivated in the waste stream, but some Enterococci were still able to survive. The waste water used for Phase 3 would represent the poorest quality that would be used in the D50. The conditions in the D50 were not able to inactivate spores of Clostridium perfringens.

The data from the pilot plant trials suggest that during the testing the D50 integrity was affected and that some cross-connection was established between the waste and product streams (most likely the main seal separating the two phases).

It appears that the process was able to remove most chemicals but sulphate, aluminium and ammonia remain of concern. In hindsight, it would have been useful to have conducted chemical analyses on the waste stream to allow for mass balance analysis to fully trace the fate of the key chemicals

Considering that heat is efficient at inactivating the E. coli and coliforms, it is suggested that Clostridium spores would be a more useful indicator (along with metals analyses) for validating the performance capability of the equipment and for identifying any cross connection between waste and product streams.

5.2 Ability to produce to water to meet potable water standards

Analysis to date indicates that the distillate water meets the requirements of the Australian Drinking Water Guidelines however it can not be recommended as suitable as a potable source without further analysis and possibly further treatment. Further assessment should include organoleptic properties including taste and odour.

Water sourced from Midfield Co-Products #3 pond is currently able to produce a distillate stream of adequate quality for a range of non-potable uses. To produce water of potable quality, application of the validation requirements of AQIS Meat Notice 2008/06 “Efficient Use of Water in Export Meat Establishments” will be essential.

5.3 Reliability

This project has been significantly delayed by a number of issues including computer based problems with the Distech equipment. However, the most recent trials have proven the entire treatment plant, including the Distech Vapour Compression Vacuum Distillation (VCVD) equipment can perform reliably on a daily basis.

As the Distech unit was only the second of this capacity and the pre-treatment and support equipment had not previously been used as a complete process with the Distech unit, the trials were a development concern for all involved in the project. In particular the computer based controls required significant development.

5.4 Economic viability

As the project was targeted at recycling water to eliminate load off the existing effluent ponds and irrigation system, the economics of the process were measured against alternate disposal methods. The alternative to reusing water from the ponds at Midfield Co-Products rendering plant was to construct a pipeline to provide discharge to the municipal treatment facility. An assessment of project economics did identify that the cost for this pipeline was approximately equal to the cost of the entire Distech plant. On this basis operating costs for the Distech plant could be compared with the cost for municipal supply and disposal of potable water. The Distech plant failed to be economically competitive on this basis, producing water at almost 3 times the expected all-in cost per kilolitre.

In most Australian meat industry scenarios the disposal of wastewater is not likely to be the main concern. Instead the issue is likely to be a shortage of potable water and the need for recycling of wastewater streams on an economically viable basis to produce potable water for use in processing areas. If other, higher quality wastewater streams from meat processing plants are considered, the economics are considerably more favourable. With “clean stream” wastes from a meat processing plant such as steriliser overflow and some evisceration table wash streams, pre-treatment would be minimised and possibly eliminated. With good quality “clean streams” pre-treatment may be avoided. In this case the cost of operating the Distech unit alone may be feasible and certainly more economically competitive.

Establishment of this technology at other processing plants would require assessment of the economic viability on a case by case basis dependent on the waste stream to be treated. Consideration should also be given to future security and costs of both potable supply and wastewater discharge. Price signals from the Wannon Region Water Authority show expected prices increases of approx 14% and 5-6% per annum for potable supply and trade waste discharge consecutively.

These price increases are representative of the infrastructure requirements for an expanding population base and replacement or historical supply systems which have now reached capacity. The increases also show the shift in attitude of regulators with regards to security of water resources especially in drought periods. Future potable and trade waste price increases, or alternative treatment technologies, do have the potential to increase the economic viability of the Distech system, particularly as supply security and pricing varies on a region by region basis in Australia.

6 Reference list

AQIS Meat Notice 1999/15 “Water testing requirements for EU listed meat establishments (including game/farmed game establishments and coldstores)”

AQIS Meat Notice 2003/03 “Protocol for Alternative Procedures and New Technology Approvals” - Archived

AQIS Meat Notice 2008/06 “Efficient Use of Water in Export Meat Establishments”

Australian Drinking Water Guidelines - 2004 revision

7 Appendices

7.1 Appendix 1 - Application to AQIS for Alternative Procedures and New Technology

Appendix 7.1 - Application to AQIS for Alternative Procedures and New Technology

SUBJECT:
Application for Alternative Procedures and New Technology
Water reuse and recycling –Distech

PURPOSE
To advise AQIS of a proposed project co-funded by Meat & Livestock Australia (MLA), Australian Meat Processor Corporation (AMPC) and Midfield Meat and to seek your agreement in principle to the proposed reuse and recycling of water on export abattoirs. The project is designed to establish guidelines for water reuse and recycling, to show that an equivalent food safety/potable water outcome can be achieved with this technology and to create a framework for assessment of treated water. The project will at no time use treated water at a human consumption meat processing plant

INTRODUCTION
Water shortages, drought and pressure from environmental authorities with respect to waste-water has put increasing pressure on the meat industry to be more efficient in its water usage.
The Distech equipment is a highly sophisticated water distillation system that is capable of producing distilled water from any source water at a cost comparable to a town water supply.
When validation trials on the Distech equipment have been completed, it is anticipated that the introduction of the technology will have no adverse effects on:

- Food safety
- Animal welfare
- OH&S of AQIS officers or process staff
- The implementation of inspection and regulatory requirements

But there may be some consequences with respect to overseas market requirements.

The project is funded jointly by MLA, AMPC and Midfield Meats.

Independent organisations and people nominated for cooperative development, technical input and scientific validation include:

- The Australian Water Quality Centre, Bolivar, South Australia
- Food Processing Equipment, Main North Rd, Pooraka, South Australia
- Chris Sentance, Food Safety Services, Flagstaff Hill, South Australia – Project Manager
- Eddie Andriessen, Food Safety Consultant, Port Adelaide, South Australia

The Area Technical manager (ATM) responsible for the Establishment is Kazal Zorah, Victoria

The company contact person is:

Andrew Westlake
Midfield Group
PO Box 412
Warrnambool
Victoria 3280

The contact person for this phase of the project is:

Dr Eddie Andriessen
PO Box 3322
Port Adelaide
South Australia 5015
Phone 0417 853 428
Safemeat@tpg.com.au

It is important to note that there is no intention of installing the equipment or using the water at an export registered establishment during the two-year project. The equipment will be installed at the Australian Water Quality Centre during validation trails and later at the by-products plant at Midfield Meat Warrnambool. The by-products plant is located some three kilometres from the export-registered establishment and has no direct links to the establishment.

DEFINITIONS

There are a couple of terms that are used in this document that need to be clearly defined. These definitions are based on international usages of the terms.

Re-use of water is the use of effluent water for a range of potable purposes after primary, secondary and/ or tertiary treatment

Recycling of water is the use of water for the same potable purpose as first used.

BACKGROUND

Most of the initial research on this equipment has been on other products including milk, run-off from landfill and water purification for high tech industry such as photography and metal finishing. No research has been done that is directly applicable to the meat industry. From the results of the limited research work that has been conducted and the fact that this is a distillation process, it is anticipated that the product water from the process is likely to be sterile no matter what the source of the water. The first step in the project after AQIS consultation, is in fact to perform detailed research with spiked samples at the Australian Water Quality Centre to determine the capabilities and validate the effectiveness of the technology. Ongoing sampling and testing of product water over a 12-month trialling period will verify that this commercial sterility can be maintained.

Since the technology is fairly new there are no prior approvals by any regulatory authority available.

There may be regulatory exemption/approvals required to the following legislation

- EMO 12.3 Equipment approval
- EMO 94.1, 94.2 Uses of non potable water
- EMO 105 Reuse of potable water
- EMO part 32 Alternative procedures
- EMO Part 17 Approved Arrangements
- Part 21.6b of the Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption

Market Access requirements are difficult to determine. The following are some indicators of the range of restricted/ permitted uses internationally.

- Halal markets probably will not accept reuse of water but are silent on recycling.
- The Codex Alimentarius volume 10 requires water to be “appropriate to the operation” and also state that “Water that falls outside the standard for potable water because of

physical and/or chemical characteristics may be used where there is no risk of contamination of meat"

- The EU permits recycling of water.
- The United States FSIS already approve various levels of recycling.
- Recycled water is permitted in beef and pig carcase pasteurisation (decontamination) equipment.
- Recycled water is permitted in a number of poultry operations under regulation 216.2

Note: AQIS has already approved the recycling of water in carcase decontamination equipment.

Reuse of water from effluent for human consumption as the potable town water supply has been practiced in Windhoek Namibia since 1986. A 200 – 500 head per day beef plant operates using this supply at Windhoek and was listed by the EU in 1990.

EXPERIMENTAL DESIGN

Project title

Optimising integrated water reuse and waste heat recovery in rendering plants and abattoirs.

Project Objectives

The trial and implementation of innovative eco-efficiency technologies and practices regarding water minimisation through reuse is critical to the future of the Australian meat processing industry, from both economic and environmental perspectives. The recent drought and Government focus on eco-efficiency measures has clearly demonstrated this.

Water reuse must however not put at risk the industry's reputation for producing clean product under exacting standards of food safety.

To this end a new vacuum distillation process that produces distilled water at an acceptable price (Distech) has the potential to greatly minimize the cost of water to the meat industry yet maintain food safety standards.

Project Milestones

There are nine milestones to the project:

Milestone 1: To establish with regulatory authorities (AQIS) the criteria for the approval of water from non-standard sources for firstly non–potable and secondly potable use.

Failure to establish suitable criteria will terminate the project at this point.

Milestone 2: Data collection of various flows on both the rendering site and the abattoir site to create a baseline for a range of potential source waters for the Distech treatment process.

Milestone 3: A pilot plant will be installed at the Australian Water Quality Laboratory Bolivar SA to assess the performance of the technology by the application of a range of microbiological and chemical assessments. These validation trials have been designed by the Australian Water Quality Centre, being a leading NATA accredited laboratory for water testing in Australia. Input to, and confirmation of, this trial protocol is expected from AQIS prior to the commencement of validation trials.

Milestone 4: Installation and commissioning of the equipment at the by-products plant.

Milestones 5-8: Quarterly evaluation and reporting of the performance of the plant during on-going operations. This includes routine testing of water by the AWQC under normal operating conditions.

Milestone 9: Final report to MLA and regulatory authorities (AQIS). This will include any discussions with AQIS with respect to reuse and recycling of water from the equipment.

Legislative requirements for water use at an abattoir

Division IX – Water supplies. Export Meat Orders 91-105 detail the requirements for water usage at an abattoir.

EMO 94.1 details the uses of non- potable water. Subject to 94.2 the uses of non-potable water is restricted to:

- Ammonia condensers
- Vapour lines serving cookers rendering inedible material
- Cleaning of condemned material or material not fit for human consumption.
- Stockyard washing
- Moving solid materials in sewer lines

EMO 94.2 states that where potable water is used for the final wash non- potable water may be permitted for initial washing of live animals.

The only reuse of water that is permitted is detailed in EMO 105. This basically only allows reuse in vapour lines from deodorisers and in pig scald units.

The Australian Standard for The Hygienic Production and Transportation of Meat and Meat products for Human Consumption is almost exactly the same. The relevant parts of it are detailed below:

Water

21.4 There is an effective program in place for the supply of water that is sufficient and appropriate to the operations undertaken.

21.5 There is a continuous supply of hot and cold potable water at a volume and pressure that enables hygienic practices for the production of meat and meat products to be met.

21.6 Only potable water is used for the production of meat and meat products unless:

(a) the water is only used:

(i) for steam production (other than steam used or to be used in direct or indirect contact with meat and meat products), fire control, the cleaning of yards, the washing of animals (other than the final wash) and other similar purposes not connected with meat and meat products; or

(ii) in other circumstances where there is no risk of the water coming into contact with or contaminating meat and meat products; and

(b) the approved arrangements expressly provides for the use of the non-potable water in the circumstances in which it is used.

21.7 Potable water is supplied in lines that:

(a) are used only for potable water; and

(b) are physically separate from the supply of non potable water; and

(c) are identified for use for potable water if any non-potable water is used at the business.

21.8 Non-potable water is supplied in lines that:
(a) are used only for non potable water; and
(b) are identified for use for non-potable water.

21.9 The reticulation system prevents the back siphonage of used or contaminated water.

21.10 Ice is made from potable water and is protected from contamination during its making, storage and handling.

21.11 Steam used or to be used in direct or indirect contact with meat and meat products is produced from potable water and does not contain substances which may create a food safety hazard or jeopardise the wholesomeness of meat and meat products.

21.12 Only potable running water that is not recycled is used for immersion thawing or cooling.

Waste water sources
There are a number of waste- water sources that have the potential for reuse or recycling after suitable treatment. These are ranked in order of relative cleanliness:

- Sterilizer water –Lavatory Steriliser Units (LSUs)
- Sterilizer water- 2nd bank viscera table
- Carcase wash
- Red offal wash
- Sterilizer water- 1st bank viscera table
- Edible area wash down
- Green offal wash
- Live animal wash
- Inedible area wash down
- Lairage wash down
- Combined waters from all areas

The use of suitably treated waters from some of these sources may be acceptable for specific uses. Some others may be limited to existing non-potable uses whatever the treatment. AQIS's input on the limitations of reuse or recycling of specific streams is sought.

Water supply
Under current legislation areas 1-8 require only potable water to be supplied.

The proposal

The Distech equipment produces distilled water from any source water supplied to it. Depending on the size of the equipment the various models are capable of a wide range of outputs from 50 to 4000 litres an hour.

The equipment is also capable of using a range of waste heat sources for the purpose of distillation, making it extremely economical to use.

The validation trials will demonstrate the ability of the equipment to eliminate a range of microorganisms.

-From earlier studies there is strong evidence that the equipment is capable
of producing sterile water that meets all potability standards.

The Australian Water Quality Centre, being a leading NATA accredited laboratory for water testing in this country, has been included in the project to design the water testing protocols and to conduct the validation testing

The equipment for on-going process verification trials is to be installed at the by-products plant, so that the company can honour its commitment to the Environmental Protection Agency (EPA) to reduce effluent from that plant. The project team is using the equipment as part of this project to assess its capabilities in other areas on an abattoir. Trialling at the remote rendering plant ensures that accidental contamination of existing potable supplies at a human consumption meat processing plant can not occur.

It is important to note that it is not the project's intention of using abattoir or by-products plant effluent as fully potable water for direct plumbing into the water supply of the establishment. The intention is recycling rather than reuse.

Some possible options include, but are not limited to:

- Recycling of sterilizer water, LSUs and 2nd bank viscera table, for the same purpose
- Recycling of carcase wash water for the same purpose (Already approved)
- Recycling of red offal wash
- Reuse of combined flows for green offal washing
- Reuse of combined flows for live animal washing without the need for a final potable wash

Before the validation work at the Australian Water Quality Laboratory can go ahead the MLA require some sort of assurance from AQIS that subject to satisfactory operation of the equipment, some or all of the options described are likely to be approved. This is to ensure that the project expenditure is justified.

On completion of the validation trials at the Australian Water Quality Laboratory, a formal application will be made to AQIS for approval of new technology/procedures as per AQIS Meat Notice 2003/3.

SUMMARY
Abattoirs are coming under increasing pressure from a range of authorities to become more efficient in water usage. The recent drought and environmental pressures have contributed to these pressures.

The Distech equipment is capable of producing distilled water from a range of water sources. The indications are that the water produced is sterile. Validation work and field trials need to be conducted to confirm this.

It is important to recognise that this validation and field trialling is expensive and MLA, AMPC and Midfield are not prepared to back the project unless there is some real benefit to the industry, not only in waste-water reuse but also in recycling.

Current legislation with respect to water use on an abattoir is based on a superseded scientific base and old philosophies that provide few options for reuse and recycling.

The advent of modern technology such as the Distech equipment means that the same food safety/ water potability outcomes can be achieved in a different and more efficient way. It allows a shift in the way potable water supply is determined, not based on source point but on measurable chemical, physical and microbiological quality.

To this end the project team are asking AQIS to consider the proposed uses of the range of treated source waters outlined in this application for reuse and recycling and to provide an agreement in principle to this effect so that the project can proceed.

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Attachment 1 Support document from Australian Water Quality Centre including validation trial protocol

1 AWQC Background

1.1 Summary

The Australian Water Quality Centre (AWQC) is a business unit of the South Australian Water Corporation and is a specialist water quality management service provider. AWQC provides analytical, advisory and research services to a range of clients across Australia and internationally. The core operation of the analytical business is to undertake sampling and analysis of water and to provide advice of a technical nature based on the interpretation of those results and other available information.

The AWQC has an international reputation in water quality analysis, advice and research. Our approach to water quality issues is based on innovation, quality and continuous improvement, allowing us to offer our clients the following advantages;

NATA accreditation for Cryptosporidium and Giardia testing (1 of only 4 accredited laboratories in Australia and the only one in South Australia)

NATA accreditation for a wide range of Microbiological tests

AWQC is NATA accredited for Biological and Chemical testing and operates under a Quality System certified to ISO 9001:2000

AWQC's Partnership with the Cooperative Research Centre for Water Quality and Treatment provides access to leading edge technology and expertise

1.2 Capability

AWQC is one of the largest specialist water laboratories in Australia, processing over 120,000 samples and in excess of 800,000 tests each year. The AWQC's scientists have an international reputation for water quality expertise providing considerable flexibility in meeting peak demands and providing emergency responses. AWQC has formal agreements with many of its major customers in the form of specific contracts and service agreements.

1.3 Accreditation/Certification

AWQC has held NATA registration for almost 30 years and has supplemented this external recognition with formal certification of its quality system to ISO 9001:2000. Some of the tests associated with this project may be outsourced to non-NATA accredited laboratories.

1.4 Innovation

The Australian Water Quality Centre has long recognised the need to provide innovative solutions to its customers. This innovation is reflected in the structure of the business with approximately 20% of the organisation's activity being dedicated to research and development. Whilst the research is designed specifically to deal with operational issues, innovative approaches have led to ground breaking discoveries and exciting new approaches.

As mentioned above, AWQC's Partnership with the CRC provides access to leading edge technology and expertise, which ensures our approach to water quality issues, is based on innovation, quality and continuous improvement.

1.5 Confidentiality

The increase in competition and commercialisation in the water industry has strengthened the need to maintain confidentiality of all aspects of water quality management. The AWQC can clearly demonstrate its track record in maintaining absolute confidentiality of client information, in accordance with the guidelines drawn by AWQC's clients. This experience includes ongoing service provision to commercial competitors, to regulators as well as license holders and with trade and public media.

1.6 Validation Protocol for Distech Equipment

The following protocol is broken up into laboratory-scale pilot studies followed by analysis of samples collected from on-site equipment operation. The protocol is summarized in the attached table.

A panel of indicator organisms has been chosen for the laboratory-scale studies, which will represent the types of organisms assessed under the Australian Drinking Water Guidelines for potable water. The samples will also be tested in accordance with AQIS Notice Meat: 99/15 "Water testing requirements for EU listed meat establishments (including game/farmed game establishments and coldstores)" to determine the microbiological and chemical quality. Additional tests could be incorporated following further discussion with relevant authorities.

The purpose of the laboratory-scale testing is to demonstrate the effectiveness of the distillation apparatus to produce potable water from waste water.

It is proposed to conduct this in three phases:

- Phase 1 will be a preliminary assessment using spiked tap water to assess the removal of a panel of microorganisms (E. coli, Coliforms, Enterococci, enteric virus, Cryptosporidium, Giardia). This panel has been chosen to represent the organisms likely to be present in waste water.

- Phase 2 will be a rigorous assessment using spiked tap water to assess the removal of a panel of microorganisms (E. coli, Coliforms, Enterococci, enteric virus, Cryptosporidium, Giardia). This phase will involve 3 separate tests of the distillation device and all analyses will be conducted in triplicate by NATA accredited laboratories where appropriate.

- Phase 3 will involve testing the device using 5 waste water samples (unspiked). The samples will be tested pre and post treatment in accordance with AQIS Notice Meat: 99/15 "Water testing requirements for EU listed meat establishments (including game/farmed game establishments and coldstores)" to determine the microbiological and chemical quality. In addition, further testing could be conducted for Campylobacter, Salmonella, Cryptosporidium, Giardia, viruses, Helminths and bacteriophage.

The purpose of the on-site field trial testing is to demonstrate the effectiveness and reproducibility of the distillation apparatus to produce potable water from waste water under full operating conditions.

Table 1

AWQC Laboratory Trial
PHASE 1 - Single Assay Pre & Post treatment of samples with Distech 50™ series

E. coli (n - 2 - 4 – 6 dilutions) Coliforms (n - 2 - 4 – 6 dilutions) Enterococci (n - 2 - 4 – 6 dilutions)	Enteric protozoa Enteric virus
PHASE 2 - NATA & ISO 9001 TRIPLICATE ASSAY Pre & Post treatment of samples with Distech 50™ series	
E. coli (n - 2 - 4 – 6 dilutions) Coliforms (n - 2 - 4 – 6 dilutions) Enterococci (n - 2 - 4 – 6 dilutions)	Enteric virus Enteric protozoa
PHASE 3 - 5 Abattoir Waste Water Samples	
Pre & Post treatment samples	

Microbiology		
E coli / Coliforms Colony Counting	Enterococci	Sulfate Reducing Clostridia
Chemistry		
Aluminium	Ammonium	Colour
PH	metal prep	Iron
Nitrate	Arsenic	Boron
Bromate	Chloride	Cyanide
Fluoride	Lead	Nickel
Oxidisability	OC pesticides	OP & Triazine pesticides
Acidic herbicides	Sulphate	THMs
Chlorinated	TDS	Chlorophenols
Selenium	Copper	Hardness
Sodium	Polynuclear aromatic	

On site field trial	
AQIS & NHMRC - WASTE WATER GUIDELINES - ONE ASSAY Maximum Working Load - 10 working day trial	
E. coli / Coliforms	Colony Counting
Enterococci	Sulfate Reducing Clostridia
10 working days - 2 tests per 5 working days	
Cryptosporidium & Giardia	Full Chemistry