final report

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ACC-MLA Joint Venture on Capture and Recycling of Spent Trough Water
Final Report

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Abstract

This project examined the opportunity to recover, treat and recycle spent trough water in feedlot operations. A project site was chosen for the study at Opal Creek Feedlot, located near Cecil Plains in the Darling Downs region of southern Queensland.

High quality bore water was supplied to livestock for consumption. Chemical analysis of spent trough water showed some accumulation of organic and biological contaminants compared with water that was supplied to stock initially. The concentrations of these analytes necessitates treatment of spent trough water before it can be safely re-used.

Water re-use options, vary depending on site specific circumstances and feedlot constraints. The sites, that are likely to benefit the most from a water recycling system are feedlots where capacity is constrained by water security limitations.

Costs associated with treatment systems are static. Accordingly, the return on investment recovers with increased feedlot capacity and the amount of water recover and re-used.

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1 Introduction

Quality water is one of the most crucial intakes for cattle wellbeing and productivity. The capacity of many Australian feedlots is constrained by the secure availability of quality water. Recycling spent trough water potentially offers significant value to the feedlot industry.

Australian Country Choice (ACC) own and operate Opal Creek Feedlot. The facility is expanding from a maximum capacity of 30,000 SCU to a new maximum capacity of 42,000 SCU. The water supply to the Opal Creek feedlot is limited and the security of the water supply threatened.

ACC and MLA are investing into research that is aimed at capturing, and treating spent trough water to deliver improved production efficiencies and improved environmental management.

'Spent Trough Water' is defined as water that is (a) dumped from the trough when it is cleaned, (b) overflows through the overflow drain, or (c) water overflowing from a continuous supply system'.

This project aimed to:

- Collate and review available data on the volume and quality of spent trough water
- Provide a comprehensive comparative analysis of water recovery and recycling systems;
- Perform a cost benefit analysis (CBA) to establish the strengths and weaknesses of the technologies, methods and associated costs of implementation of a spent water recovery system;
- Deliver a concept design including an implementation plan measuring the performance of the systems. Additionally, outlining findings of water quality samples collected; and
- Provide a desktop assessment of current systems and technologies for water capture and recycling.

Two milestone reports have previously been completed. Milestone 1 was a preliminary report detailing scope of works and reviewed spent trough water recycling options. Milestone 1 also outlined improvements to water management in feedlots. The second milestone report (Milestone 2) presented data on water quality obtained from testing and a comparative analysis of water recovery and recycling systems. This report includes a CBA establishing the viability of water recycling systems.

2 Project Objectives

The overall objective is to determine the most economically viable water management strategy for Australian feedlots by evaluating some specific water re-use options.

Specific objectives of the project will include estimating opportunities to:

- Better understand the limitations associated with the capture and recycling of spent trough water;
- Assess the economic viability of capture and treatment technologies currently available;
- Collate available information on capture and recycling technology to better facilitate research; and,
- Deliver water recovery and cost saving solutions to ACC sites.

3 Methodology

3.1 Overall Project Methodology

EnviroAg has adopted the following methods and approach during the project life cycle:

- Collate and review available data for spent trough water volumes and typical quality;
- Provide an initial concept design;
- Provide a preliminary costing;
- Provide a finalised concept design;
- Provide an implementation plan;
- Measure the performance of the systems (cost, water recovery, and energy use); and,
- Document the outcomes to meet the deliverables.

3.2 Methodology for Milestone 3

EnviroAg has adopted the following methods and approach to achieve Milestone 3:

- Carry out site assessment;
- Collate and review water quality measurements taken in Milestone 2;
- Provide detailed concept design and implementation plan; and,
- Review costings.

Table 1 outlines the water quality parameters tested during Milestone 2. Water samples were collected for spent trough water and the North Bore. Laboratory analysis was undertaken on each. Due to the high cost of particular biological laboratory analysis, a limited extent approach to sampling and analysis was adopted in Milestone 2

Table 1 Water quality parameters (chemical and biological) tested (Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) (ANZECC and ARMCANZ 2000)

Water Quality Parameter	Trigger value (low risk) (mg/L)
Metals	
Aluminium	5
Arsenic	0.5 – 5
Beryllium	To be defined
Boron	0.01
Cadmium	0.01
Chromium	1
Cobalt	1
Copper	1
Fluoride	2
Iron	To be defined
Lead	0.1
Magnesium	To be defined
Mercury	0.002
Molybdenum	0.15
Nickel	1
Selenium	0.02
Zinc	20
Major ions	
Calcium	1000
Phosphorus – ortho (reactive)	To be defined
Nitrate	100
Nitrite	10
Sulphate	1000
Total dissolved solids	5000
Biological indicators	
Total Coliforms	1000
Total Thermotolerant (faecal) coliforms	1000
Insecticides	N/A
Aldicarb	0.004
Carbofuran	45
Dimethoate	3
Herbicides	N/A
Bromoxynil	11
Cyanazine	10
Dicamba	122
Diclofop-methyl	9
Dinoseb	150
Glyphosate	280
Simazine	10
Tebuthiuron	130
Triallate	230
Trifuralin	45
Miscellaneous	
Turbidity	To be defined
Total Organic Carbon (TOC)	To be defined
Conductivity	To be defined
Chemical Oxygen Demand	To be defined

3.2.1 Cost Benefit Analysis

Consideration of economic factors is essential for determining the viability of a recycling trough water system. Valuable investment criteria must allow for comparison of inputs and outputs to obtain a best fit solution.

A cost benefit analysis (CBA) is a methodical approach to economic analysis that allows for interpretation of optimum use for the recycling system. The analysis addresses the return on the investment for the proposed system and the opportunity benefit.

The CBA has utilised the variables and parameters set out in the table below.

Table 2 Economic analysis variables and parameters

Variable	Quantity/Value	Parameters
Value of Water (Capital)	$500/ML, $1,000/ML, $3,000/ML & $7,500/ML	The cost of water varies from state to state and site to site. The CBA has used four (4) values for cost of water that are indicative across industry
Infrastructure cost for the water capture and recycling system options	Defined by re-use Option	Bill of Quantities (BOQs) were built for each end use of the spent trough water. The BOQ provides an estimate of the capital cost.
Net Present Value of the discounted cash flows (NPV)		NPV is a calculation which compares the amount invested today to the present value of the future cash receipts from the investment. NPV is an important metric as this figure allows the ranking of opportunities.
Deduce a payback period (time taken to recover capital costs).		Payback period can be defined as the time taken to recover the initial capital outlays. The shorter the period, the more attractive the project is.
Discount Rate	3%	The Discount rate is the rate used to compensate for the time value of money. The Time Value of Money (TVM) is the idea that money available at the present time is worth more than the same amount in the future due to its potential earning capacity. In this instance we have used the inflation rate as the basis for determining an appropriate discount rate.
Size of Feedlot	10,000 SCU* 20,000 SCU 40,000 SCU	Three sizes of feedlot were considered at four differing costs of water.
		Financial impacts were addressed in terms of capital costs, operational and maintenance cost and return on investment timeframe (payback timeframe).

*SCU = standard cattle unit. A standard cattle unit is equivalent to a non-lactating animal with a live weight of 600 kg.

3.2.2 Design Rationale

Design features of the water recycling system were implemented to encompass topographic, economic, and geotechnical properties of the project site. A recycling system was designed to capture spent trough water for treatment and reuse. Drawings presented incorporate all aspects of best practice engineering principles ensuring a positive economic outcome. The proposed system offers the best case return on investment and opportunity benefit.

The following process has been applied to the system when developing the 2-D detailed concept design, process flow diagram and hydraulic grade (Appendix A).

1. Spent trough water will be captured within a sewer line system and diverted away from the sedimentation basin to a drive in settling pond.
2. Primary filtration via a side by side sieving system to separate particles of different sizes will occur within the settling pond.
3. Filtered water is transferred from the settling pond to a storage tank located below ground level adjacent to the settling pond.
4. Filtered water is transferred to the central distribution point located at the turkey's nest via solar pump whereupon it is stored.
5. Filtered water is transferred through a sterilisation plant located between two storages located at the turkey's nest.
6. The final stage sees the filtered and sterilised water reused.

4 Results

4.1 Water Quality Results

Trigger levels used were adapted from literature and recognised water quality guidelines.

A summary of water quality results is seen in Table 3

Table 3 Summary and comparison of water quality parameters

Parameter and Unit	Bore Water		Spent Trough water	
	Result	Comment	Result	Comment
EC µS/cm	380	The electrical conductivity (EC) of the "North Bore" water is commonly used as a syndicate for the salinity. The salinity threshold is provided in **Error! Reference source not found.**. As can be seen in Appendix B, the bore water salinity of the site is 380 µS/cm. This EC demand of the bore water can be considered as "excellent" and usable for all classes of livestock. Livestock drinking water with an electrical conductivity of less than 5000 µS will be suitable under most circumstances.	447.14	Appendix B shows that the spent trough water salinity varies between 390 – 600 µS/cm. This EC demand of the spent trough water can be considered as "excellent" and usable for all classes of livestock. Livestock drinking water with an electrical conductivity of less than 5000 µS will be suitable under most circumstances.
CoD (mg/L)	<20	Chemical oxygen demand (COD) is a measure of the quantity of oxygen required to oxidise all organic material into carbon dioxide and water. The test is an important parameter to determine the amount of organic pollution in water. The test procedure is based on the chemical decomposition of organic and inorganic contaminants which are dissolved or suspended in water. The test indicates the quantity of dissolved oxygen likely to be consumed by contaminants during two hours of decomposition from a solution of boiling potassium dichromate. As can be seen in Appendix B, the "North Bore" shows low levels of COD.	2032.86	As can be seen in Appendix B, the COD of the spent trough water ranges between 280 mg/L – 4,000 mg/L. Currently no trigger level listed, results to be as low as possible.
Fluoride mg/L	0.5	The bore water samples show no exceedances in water quality livestock trigger	<0.5	The spent trough water samples show no exceedances in water quality livestock trigger

Parameter and Unit	Bore Water		Spent Trough water	
	Result	Comment	Result	Comment
		levels for Fluoride.		levels for Fluoride
Nitrate	<0.02	The bore water samples show no exceedances in water quality livestock trigger levels for Nitrate	<0.02	The spent trough water samples show no exceedances in water quality livestock trigger levels for Nitrate.
Nitrite as N mg/L	<0.02	The bore water samples show no exceedances in water quality livestock trigger levels for Nitrite	<0.02	The spent trough water samples show no exceedances in water quality livestock trigger levels for Nitrite.
Ortho Phosphate as P mg/L	0.11	Currently no trigger level listed, results to be as low as possible.	1.67	Currently no trigger level listed, results to be as low as possible.
Sulphate as S mg/L	<5	The bore water samples show no exceedances in water quality livestock trigger levels for Sulphate	<5	The spent trough water samples show no exceedances in water quality livestock trigger levels for Sulphate
Total Dissolved Solids mg/L	270	The bore water samples show no exceedances in water quality livestock trigger levels for Total Dissolved Solids	402.86	The spent trough water samples show no exceedances in water quality livestock trigger levels for Total Dissolved Solids
Total Organic Carbon mg/L	<5	Water quality laboratory tests for Total Organic Carbon of the “North Bore” yielded a result equal to or lower than the limit of reporting (LoR). Water quality livestock trigger levels for Total Organic Carbon are to be defined. Results to be as low as possible.	67.43	Water quality livestock trigger levels for total Organic carbon are to be defined. Results to be as low as possible.
Turbidity NTU	3	Water quality livestock trigger levels for Turbidity are to be defined. Results to be as low as possible.	370.14	Water quality livestock trigger levels for Turbidity are to be defined. Results to be as low as possible. High turbidity levels can cause higher nutrient and pathogen concentrations.
Acid Herbicides	warfarin = 74 mg/L. All other acid herbicides were below detection limit. *	No water quality livestock trigger levels for Acid Herbicides has been determined according to reviewed literature. Water quality testing of the bore water yielded an acid herbicide level of equal to or less than the LoR as shown in Appendix B with the	Mean warfarin = 94 mg/L. All other acid herbicides were below detection limit. *	No water quality livestock trigger levels for Acid Herbicides has been determined according to reviewed literature. Water quality testing of the bore water yielded an acid herbicide level of equal to or less than the LoR as shown in Appendix B with the exception of

Parameter and Unit	**Bore Water**		**Spent Trough water**	
	Result	Comment	Result	Comment
		exception of Warfarin.		Warfarin.
Glyphosate & AMPA mg/L	<0.01	Water quality testing of the bore water yielded a glyphosate & AMPA level of equal to or less than the LoR as shown in Appendix B.	<0.01	Water quality testing of the spent trough water yielded a glyphosate & AMPA level of equal to or less than the LoR as shown in Appendix B.
Organophosphorus Pesticides mg/L	<0.02	No water quality livestock trigger levels for Organophosphorus Pesticides has been determined according to reviewed literature. Water quality testing of the bore water yielded an Organophosphorus Pesticides level of equal to or less than the LoR as shown in Appendix B.	<0.02	No water quality livestock trigger levels for Organophosphorus Pesticides has been determined according to reviewed literature. Water quality testing of the spent trough water yielded an Organophosphorus Pesticides level of equal to or less than the LoR as shown in Appendix B.
Thermotolerant and total Coliforms MPN/100ml	Thermotolerant coliforms = <1 MPN/100 ml Total coliforms = 1 MPN/100 ml	Water quality testing of the bore water yielded a thermotolerant and total coliform concentration level of equal to or less than the LoR as shown in Appendix B. This is consistent with the concentration level that you would expect to find in artesian water.	>240,000	Concentrations of thermotolerant coliform bacteria were identified in the spent trough water. The acceptable concentration limit for coliforms for drinking water has been determined to be 1000 bacteria per 100mL of water. Water quality results of spent trough water indicate an excess of 240,000 per 100mL, which is in exceedance of the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 1996). *Visually, troughs coupled with surface barriers located over the surface were of a cleaner appearance with less material located on the bottom surface.*

*warfarin detected in sampling is a possible cross contaminant – Further investigation is required.

4.1.1 Biological Parameters

Water Supplies were tested for the presence of thermotolerant coliforms (also referred to as faecal coliforms) to provide an indication of the faecal contamination and presence of microbial pathogens. Results were compared against trigger values provided in the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 1996). It was found that North Bore had a concentration level of equal to or less than the limit of reporting (LoR), with levels being consistent with artesian water.

Spent Trough water displayed high levels of thermotolerant coliform bacteria. These levels were in exceedance of the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 1996). Troughs coupled with surface barriers were of a cleaner appearance.

4.1.2 Water Chemistry

Elevated concentrations of specific compounds may cause significant detrimental toxic effects in livestock. Ions of note include calcium, magnesium, nitrate and nitrites, sulphate and total dissolved solids (salinity).

In some instances, values exceeding trigger levels may be tolerated. This is dependent on dietary factors and environmental factors.

Both North Bore and Spent Trough water showed no exceedance in water chemistry triggers for livestock water quality. In most instances water chemistry levels were of equal to or lower than the LoR.

4.1.3 Pesticides and Other Organic Contaminants

Levels recorded for organophosphorus pesticides for both spent trough water and North Bore yielded a level equal to or less than the LoR. Warfarin was detected in both Samples. This indicates that contamination of the samples occurred. Further investigation is required to determine the cause of this.

4.2 Concept Design

The conceptual design has been completed factoring in various constraints including; cost, geotechnical properties and topography. This design is a two dimensional model which documents the location of the proposed system and the components that comprise that system.

A process flow diagram (PFD) was created to indicate the flow of the spent trough water recycling process. The PFD displays the interrelationship between the major infrastructure and the piping design. The water is captured, collected, filtered, processed and stored. The simplicity of the system ensures minimal implications for infrastructure and power.

4.3 Detail Design

The detailed drawings are presented in Appendix A. Table 4 and Table 5 provide the costs for the installation of the systems on the southern and northern pen areas at the site.

Table 4 Summary of Southern Pen Area bill of quantities

Item No	Project Area	Sub Item No	Task / Activity	Unit	Bill of Quantities	Indicative Cost
1	Sewer Pipeline	1.1	Supply and install PVC 150mm Class 6 RRJ Pipe from cattle pens to settling pond and settling basin	m	432	$7,512.00
2	Settling Pond & Storage Tank	2.1	Concrete drivable 9,000lt settling pond c/w screen filter, bypass and outlet	Item	1	$8,000.00
		2.2	Concrete storage tank 9000lt c/w solar pump with duty 11 m³hr @ 26mt	Item	1	$5,250.00
3	Solar Pump Station	3.1	Solar pump with duty 11 m³hr @ 26mt	Item	1	$15,000.00
4	Recycled Water Pipeline	4.1	Supply and install PVC 80mm Class 6 RRJ pipe from storage tank to holding tank at Turkey's nest dam	m	1,320	$12,050.00
5	Holding Tank, Sterilization Plant, Header Tank & Control System	5.1	Supply and install 25,000lt Holding Tank c/w isolation valves, base to manufacturers specification and overflow pipework	Item	1	$4,250.00
		5.2	Supply and install sterilization plant with capacity 11 m³hr	Item	1	$8,000.00
		5.3	Supply and install 25,000lt Holding Tank c/w isolation valves, base to manufacturers specification, overflow pipework and pipe interconnection with Turkey's Nest Dam pump system	Item	1	$5,000.00
		5.4	PLC based control system controlling high/low water levels and valve operation	Item	56,815	$8,000.00
Total						**$73,062.00**

Table 5 Summary of Northern Pen Area bill of quantities

Item No	Project Area	Sub Item No	Task / Activity	Unit	Bill of Quantities	Indicative Cost
6	Sewer Pipeline	6.1	Supply and install PVC 150mm Class 6 RRJ Pipe from cattle pens to settling pond and settling basin	m	260	$4,500.00
7	Settling Pond & Storage Tank	7.1	Concrete drivable 9,000lt settling pond c/w screen filter, bypass and outlet	Item	1	$8,000.00
		7.2	Concrete storage tank 9000lt c/w solar pump with duty 11 m³hr @ 26mt	Item	1	$5,250.00
8	Solar Pump Station	8.1	Solar pump with duty 11 m³hr @ 26mt	Item	1	$15,000.00
9	Recycled Water Pipeline	9.1	Supply and install PVC 80mm Class 6 RRJ pipe from storage tank to holding tank at Turkey's nest dam	m	1,020	$9,300.00
Total						**$42,050.00**

4.3.1 Sewer System

A sewer system is directly plumbed into the outlet of each trough. Upon removal of the trough bung, spent trough water enters into the sewer system and flows to the drive in settling pond through a process termed gravity feed.

- Southern pen area comprising 84 troughs @ 700lt/ trough capacity
- Total drained effluent water per cleaning event: 58,800 lt
- Time allocated to emptying troughs 6hours, between 8.00am- 2.00pm
- Draining each trough and replacing trough riser,4.3 mins/ trough
- Calculated flowrate over six hours 9.79 m3hr or 2.72 l/s
- Northern pen area comprising 45 troughs @ 700lt/ trough capacity
- Total drained effluent per cleaning event: 31,500 lt
- Time allocated to emptying troughs 3.23 hrs, between 8.00am-12.00pm
- Draining each trough and replacing trough riser, 4.3 mins/ trough
- Calculated flowrate over 3.23 hrs: 9.76 m3hr or 2.71 l/s

4.3.2 Storage Tank and Pump

A sump storage tank located below ground level collects filtered spent trough water delivered from the drive in settling pond.

This water has experienced primary filtration and is pumped back to header Tank 1 situated at the turkey's nest (central distribution point). The central distribution point is in close proximity to the headworks for the trough system. Consequently, reducing power and infrastructure requirements associated with the transfer of water for reuse. Water which has undergone primary filtration is transferred from the sump storage tank to header tank 1 via a solar pump with a pumping capacity of 3L/s. The pump will operate on average between 6-8 hours per day depending on the season and available light intensity.

- The solar pump is being expected to maintain a discharge rate equal to or exceeding the inflow rate of effluent water from the drive in settling pond of approximately 2.7 l/s. On this basis a discharge rate of 3 l/s was chosen for the solar pump
- With a height of 15 meters from the storage tank to the treatment plant, friction loss in 1,312 meters of 80mm Class 6 PVC pipe of 6 meters and a pressure requirement at the treatment plant tank of 50 Kpa the total pump duty required for the solar pump is 3 l/s @ 260 Kpa

4.4 Cost Benefit Analysis

4.4.1 Net Present Value

The NPV presents various options to ACC. The recovered spent trough water represents the ability to run additional cattle.

Based upon the water requirement of 0.024 ML/SCU as stipulated in the National Guidelines for Beef Cattle Feedlots in Australia (MLA 2012), and based upon a conservative water savings of 12 ML from a 20,000 SCU feedlot, this equates to an additional carrying capacity of 500 SCU.

Assuming a weight gain of 1.5 kg/day and a value of $5/kg for 140 days this equates to a value gain of $1,050 per SCU. This is crude gross income which does not take into account the cost of feed etc. Notwithstanding this, if one multiplies this figure by 500 SCU then the opportunity benefit equates to $525,000 (of income) less direct cost per draft of cattle.

For the benefit of completing the calculation it is assumed that the profit on this extra production capacity is >10% and thus an annual financial gain of $52,500 per draft is realised. It is further assumed that with two drafts of stock being able to put through the feedlot the annual beneficial cost of the recovered water is $105,000 (per annum).

Thus the use of the returned water in direct replacements for feedlot water supply (drinking water, washing water etc.) significantly increase the financial returns.

Other opportunity benefits are harder to define. The use of a sewer and capture system allows a feedlot to maintain its drains in a dry state, and most importantly stops a daily inflow of water to the sediment systems that seriously impedes drying of sediments and subsequently cleaning. Wet sediment basins also generate a lot more odour than dry sediments. Thus there is a significant intangible opportunity benefit in improved environmental conditions

4.4.2 Sensitivity Analysis

The CBA calculation allows for a sensitivity analysis to be undertaken. Essentially the capital cost for the recovery system is “fixed” for feedlots >10,000 SCU. A larger feedlot may require some system upscaling but generally their use of the system is about rotating the trough cleaning more and simply leveraging a greater use out of a common system.

A relationship exists between feedlot size and cost of water. A large feedlot with a high cost of water will benefit more from a water recycling system compared to a small feedlot with low cost of water. The benefit lies with the savings from the water usage and as such both the volume and value have a direct influence of the perceived viability of the project. Increasing either will directly effect the return of the project.

5 Discussion

5.1 Water Quality

Recycled water has a myriad of uses for the feedlot industry and can be tailored to specific requirements. Quality of spent trough water changed compared with the quality of bore water that was initially provided for animal consumption. In particular, there was an addition of organic contaminants and pathogens. Removal of these analytes is essential before water can be reused. Recovery and filtering can be focused on the removal of these. Questions remain around the presence of Warfarin in both samples. The source of this material should be investigated further.

Pesticide residues present a significant concern for rural environments. These residues have the capacity to contaminate water supplies through surface runoff, spills, spray drift and direct application to water supplies. Guidelines specifically targeted at livestock do not exist, consequently results are compared to Australian Drinking Water Guidelines (NHMRC & ARMCANZ 1996). These trigger values are quite conservative as livestock can commonly tolerate higher concentrations of water quality analytes than recommended for humans.

Recycled water has the potential to cause some consumer backlash, with potential retailers being hesitant to accept beef that has been produced using recycled water. This may be apparent regardless of any scientific merit.

5.2 Design

The design of a recovery, recycling and treatment system is attainable. A PFD and detailed design has been developed for the study site.

The level of system engineering is dependent on the specific re-use option and as such is to be tailored for individual feedlots.

5.3 Cost Benefit Analysis

The most advantageous option is the use of recycled water in secondary feedlot processes. This enables outcomes to be monitored, with significantly reduced risk of direct ingestion per se.

Feedlots constrained by water present the best opportunity to value add to their current systems.

6 Conclusions and Recommendations

Data collected from spent trough water indicated the need for further treatment. In most instances, samples showed no exceedance in water quality trigger levels for consumption by livestock. The exception to this was the presence of thermotolerant coliforms in the spent trough water.

A recovery, recycling and treatment system for spent trough water is possible. The specific use of this water is dependent on individual feedlot requirements and as such designs for re-use systems are to be tailored for specific requirements.

Use of recycled water for secondary processes in place of high quality drinking water presents the lowest risk and best return on investment for feedlots.

Consumer backlash may exist if recycled water is to be used for livestock consumption. This may involve retailer's refusal in accepting beef produced using recycled water regardless of scientific merit.

The real benefit for a recycling system lies with the water constraints for individual feedlots, and if these constraints are limiting the production of the feedlot.

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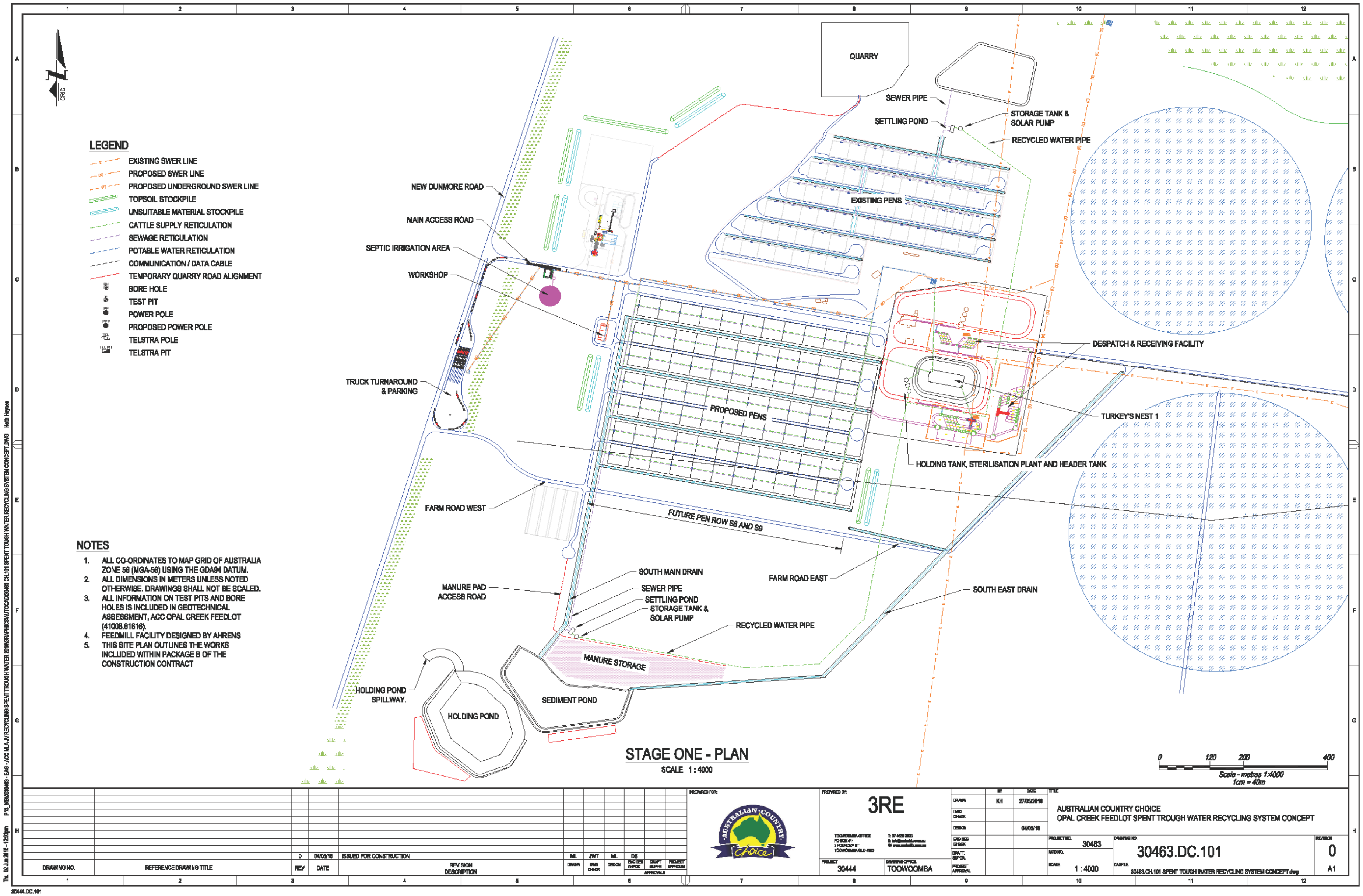
8 Appendix A - Design


LEGEND
EXISTING SWER LINE
PROPOSED SWER LINE
PROPOSED UNDERGROUND SWER LINE
TOPSOIL STOCKPILE
UNSUITABLE MATERIAL STOCKPILE
CATTLE SUPPLY RETICULATION
SEWAGE RETICULATION
POTABLE WATER RETICULATION
COMMUNICATION / DATA CABLE
TEMPORARY QUARRY ROAD ALIGNMENT
BORE HOLE
TEST PIT
POWER POLE
PROPOSED POWER POLE
TELSTRA POLE
TELSTRA PIT
NOTES
1. ALL CO-ORDINATES TO MAP GRID OF AUSTRALIA ZONE 56 (MGA-56) USING THE GDA94 DATUM.
2. ALL DIMENSIONS IN METERS UNLESS NOTED OTHERWISE. DRAWINGS SHALL NOT BE SCALED.
3. ALL INFORMATION ON TEST PITS AND BORE HOLES IS INCLUDED IN GEOTECHNICAL ASSESSMENT, ACC OPAL CREEK FEEDLOT (41008.81616).
4. FEEDMILL FACILITY DESIGNED BY AHRENS
5. THIS SITE PLAN OUTLINES THE WORKS INCLUDED WITHIN PACKAGE B OF THE CONSTRUCTION CONTRACT
QUARRY
SEWER PIPE
SETTLING POND
STORAGE TANK & SOLAR PUMP
RECYCLED WATER PIPE
EXISTING PENS
NEW DUNMORE ROAD
MAIN ACCESS ROAD
SEPTIC IRRIGATION AREA
WORKSHOP
TRUCK TURNAROUND & PARKING
PROPOSED PENS
DESPATCH & RECEIVING FACILITY
TURKEY'S NEST 1
HOLDING TANK, STERILISATION PLANT AND HEADER TANK
FARM ROAD WEST
FUTURE PEN ROW S8 AND S9
SOUTH MAIN DRAIN
FARM ROAD EAST
MANURE PAD ACCESS ROAD
SEWER PIPE
SETTLING POND
STORAGE TANK & SOLAR PUMP
SOUTH EAST DRAIN
RECYCLED WATER PIPE
MANURE STORAGE
HOLDING POND SPILLWAY.
HOLDING POND
SEDIMENT POND
STAGE ONE - PLAN
SCALE 1 : 4000
0 120 200 400
Scale - metres 1:4000
1cm = 40m
0 04/05/18 ISSUED FOR CONSTRUCTION ML JWT ML DS
DRAWING NO. REFERENCE DRAWING TITLE REV DATE REVISION DESCRIPTION
3RE
TOOWOOMBA
30444
KH 27/05/2018
04/05/18
AUSTRALIAN COUNTRY CHOICE
OPAL CREEK FEEDLOT SPENT TROUGH WATER RECYCLING SYSTEM CONCEPT
30463
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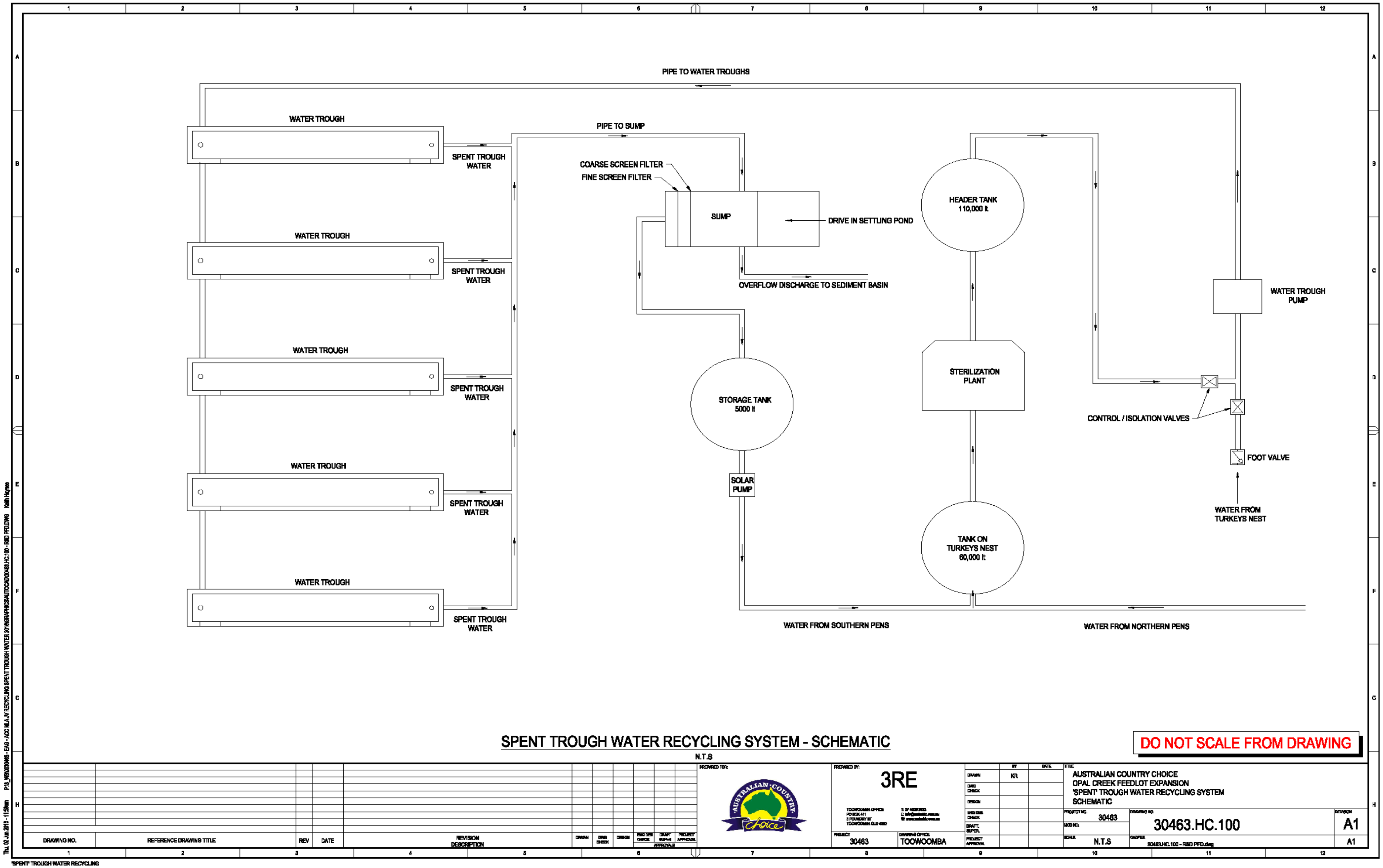
A1
30463.DC.101 SPENT TROUGH WATER RECYCLING SYSTEM CONCEPT.dwg


PIPE TO WATER TROUGHS
WATER TROUGH
SPENT TROUGH WATER
PIPE TO SUMP
COARSE SCREEN FILTER
FINE SCREEN FILTER
SUMP
DRIVE IN SETTLING POND
OVERFLOW DISCHARGE TO SEDIMENT BASIN
HEADER TANK 110,000 lt
STERILIZATION PLANT
WATER TROUGH PUMP
CONTROL / ISOLATION VALVES
FOOT VALVE
WATER FROM TURKEYS NEST
STORAGE TANK 5000 lt
SOLAR PUMP
TANK ON TURKEYS NEST 60,000 lt
WATER FROM SOUTHERN PENS
WATER FROM NORTHERN PENS
SPENT TROUGH WATER RECYCLING SYSTEM - SCHEMATIC
N.T.S
DO NOT SCALE FROM DRAWING
DRAWING NO.
REFERENCE DRAWING TITLE
REV
DATE
REVISION DESCRIPTION
PREPARED FOR:
PREPARED BY:
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PROJECT
30463
DRAWING OFFICE
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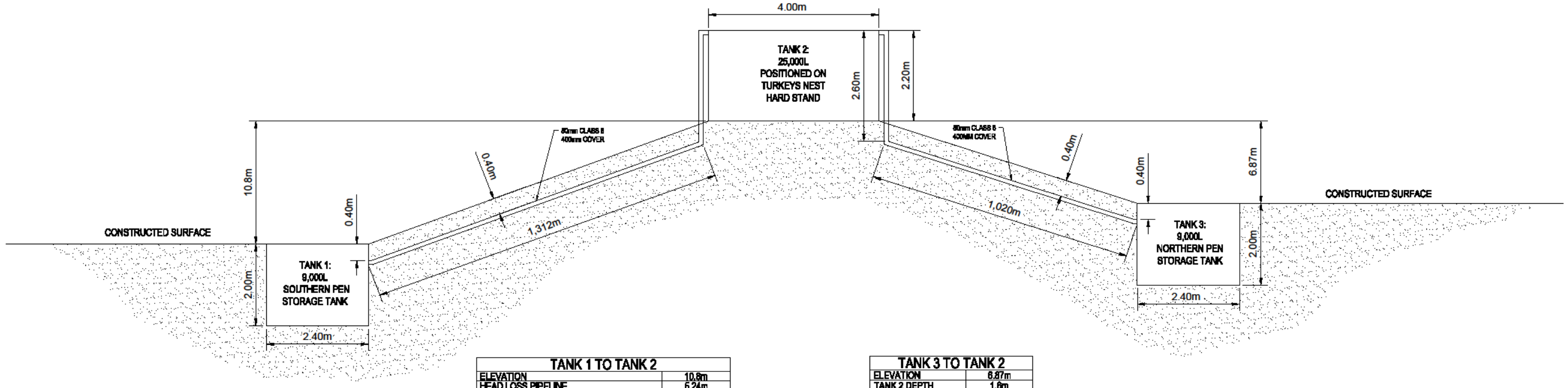
TITLE
AUSTRALIAN COUNTRY CHOICE
OPAL CREEK FEEDLOT EXPANSION
'SPENT' TROUGH WATER RECYCLING SYSTEM
SCHEMATIC
PROJECT NO. 30463
DRAWING NO. 30463.HC.100
REVISION A1
SCALE N.T.S
'SPENT' TROUGH WATER RECYCLING



TANK 1 TO TANK 2	
ELEVATION	10.8m
HEAD LOSS PIPELINE	6.24m
TANK 1 DEPTH	1.6m
TANK 2 HEIGHT	2.6m
HEAD LOSS REQUIRED @ TANK 2 OUTLET	5.0m
HEAD LOSS FITTINGS	0.76m
TOTAL Q: 3L/S @	26.0m

TANK 3 TO TANK 2	
ELEVATION	6.87m
TANK 2 DEPTH	1.6m
TANK 3 HEIGHT	2.6m
HEAD LOSS	4.07m
HEAD REQUIRED	5.0m
HEAD LOSS FITTINGS	0.86m
TOTAL Q: 3L/S @	21m

SPENT TROUGH WATER RECYCLING SYSTEM - HYDRAULIC GRADIENT SCHEMATIC

N.T.S

DO NOT SCALE FROM DRAWING

PREPARED FOR: AUSTRALIAN COUNTRY CHOICE

PREPARED BY: 3RE

PROJECT: 30463 | DRAWING OFFICE: TOOWOOMBA

DRAWN: KR 17/06/2019 | DES. CHECK: KH 17/06/2019

TITLE: AUSTRALIAN COUNTRY CHOICE
OPAL CREEK FEEDLOT EXPANSION
'SPENT' TROUGH WATER RECYCLING SYSTEM
HYDRAULIC GRADIENT SCHEMATIC

PROJECT NO. 30463 | DRAWING NO. 30463.HC.103 | REVISION A1

SCALE N.T.S | CADFILE 30463.HC.100 - R&D PFD.dwg | A1

DRAWING NO. | REFERENCE DRAWING TITLE | REV | DATE | REVISION DESCRIPTION

HYDRAULIC GRADIENT

9 Appendix B - Water Quality Measurements

Project Number: 90062
Site: Opal Creek
Matrix: Water

Sample Date: 20/08/2015

				Location ID							
Analyte Grouping/Analyte	**Units**	**LOR**	**Livestock Trigger Level**	**North Bore**	**Trough 1**	**Trough 2**	**Trough 3**	**Trough 4**	**Trough 5**	**Trough 6**	**Trough 7**
Chemical Oxygen Demand (COD)	mg/L	20	To be defined	< 20	3900	2600	2200	280	620	4000	630
Conductivity (at 25Â°C)	uS/cm	1	To be defined	380	480	460	390	390	400	600	410
Fluoride	mg/L	0.5	2	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nitrate (as N)	mg/L	0.02	100	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite (as N)	mg/L	0.02	10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate ortho (as P)	mg/L	0.05	Not Determined	0.11	4.1	2.6	< 0.05	0.14	0.08	4.5	0.24
Sulphate (as S)	mg/L	5	1000	< 5	< 5	< 5	< 5	< 5	< 5	5	< 5
Total Dissolved Solids	mg/L	10	5000	270	560	470	290	290	310	570	330
Total Organic Carbon	mg/L	5	To be defined	< 5	92	120	91	11	33	92	33
Turbidity	NTU	1	To be defined	3	930	260	97	84	140	910	170
Acid Herbicides											
2.4.5-T	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
2.4.5-TP	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
2.4-D	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
2.4-DB	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Actril (Ioxynil)	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Dicamba	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Dichlorprop	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Dinitro-o-cresol	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Dinoseb	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
MCPA	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
MCPB	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Mecoprop	mg/L	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Warfarin (surr.)	mg/L	0.001		74	90	90	112	105	91	78	91
Alkali Metals											
Calcium	mg/L	0.5	1000	2.1	4.4	13	3.2	5.9	11	78	7.6
Magnesium	mg/L	0.5	Not sufficiently toxic	0.7	1.3	3.8	1	1.4	1.8	13	2
Potassium	mg/L	0.5	To be defined	2.7	3.7	11	3.7	4	4.2	24	4.3
Sodium	mg/L	0.5	To be defined	82	83	110	110	84	89	86	110
Glyphosate & AMPA											
AMPA	mg/L	0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Glyphosate	mg/L	0.01	280	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Heavy Metals											
Arsenic (filtered)	mg/L	0.001	5	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.002	0.004	< 0.001
Cadmium (filtered)	mg/L	0.0002	1	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0005	0.0004	< 0.0002
Chromium (filtered)	mg/L	0.001	1	< 0.001	0.001	0.001	< 0.001	0.002	< 0.002	0.015	< 0.001
Copper (filtered)	mg/L	0.001	2	< 0.001	0.83	0.81	0.43	1.1	9	1.3	4.5
Lead (filtered)	mg/L	0.001	0.1	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.002	0.01	< 0.001
Mercury (filtered)	mg/L	0.0001	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0002	< 0.0001	< 0.0001
Nickel (filtered)	mg/L	0.001	1	< 0.001	0.001	< 0.001	< 0.001	0.001	< 0.002	0.014	< 0.001
Zinc (filtered)	mg/L	0.005	20	0.021	0.13	0.12	0.039	0.23	0.12	1.7	0.073
Organophosphorus Pesticides											
Azinphos-methyl	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Bolstar	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Chlorfenvinphos	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Chlorpyrifos	mg/L	0.02	-	-	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Chlorpyrifos-methyl	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Coumaphos	mg/L	0.02	-	-	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Demeton-O	mg/L	0.02	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Demeton-S	mg/L	0.002	-	-	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Diazinon	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Dichlorvos	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Dimethoate	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Disulfoton	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
EPN	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Ethion	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Ethoprop	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Ethyl parathion	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Fenitrothion	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Fensulfothion	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Fenthion	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Malathion	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Merphos	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Methyl parathion	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Mevinphos	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Monocrotophos	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Naled	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Omethoate	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Phorate	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Pirimiphos-methyl	mg/L	0.02	-	-	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Pyrazophos	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Ronnel	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Terbufos	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Tetrachlorvinphos	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Tokuthion	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Trichloronate	mg/L	0.002	-	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002	< 0.002
Triphenylphosphate (surr.)	%	1	To be defined	-	59	55	79	113	65	63	57
Pathogens											
Thermotolerant Coliforms	MPN/100ml	1	1000	<1	>240000	>240000	>24000	>24000	>24000	>240000	>24000

10 Appendix C - Cost Benefit Analysis

Economic Analysis **Project 90062 - Recyling of Spent Trough Water**

Summary Table

Friday, 29 July 2016

Capacity - 10,000 SCU **NPV**

Water Cost (Normalised Capex & Ops Exp)	Option 1 (Drinking Water Chlorine)	Option 2 (Drinking Water UV)	Option 3 (Irrigation Water)	Option 4 (Grey Water)	Option 5 (Feed Processing)	Option 6 (Stock Washing)	Option 7 (Effluent Management)	Option 8 (Gen Cleaning)	Option 9 (Fire)
$500 / ML / Yr	(215,471)	(162,037)	74,155	(372,025)	(180,150)	(188,150)	(382,525)	(215,684)	(177,874)
$1,000 / ML / Yr	(136,401)	(82,967)	153,225	(292,955)	(101,080)	(109,080)	(303,455)	(172,457)	(98,804)
$3,000 / ML / Yr	179,881	233,315	469,507	23,327	215,202	207,202	12,827	451	217,478
$7,500 / ML / Yr	891,514	944,948	1,181,141	734,961	926,835	918,835	724,461	389,493	929,111

Capacity - 20,000 SCU **NPV**

Water Cost (Normalised Capex & Ops Exp)	Option 1 (Drinking Water Chlorine)	Option 2 (Drinking Water UV)	Option 3 (Irrigation Water)	Option 4 (Grey Water)	Option 5 (Feed Processing)	Option 6 (Stock Washing)	Option 7 (Effluent Management)	Option 8 (Gen Cleaning)	Option 9 (Fire)
$500 / ML / Yr	147,930	150,890	6,096	(287,585)	158,890	150,890	(298,085)	(92,790)	(82,598)
$1,000 / ML / Yr	304,855	307,814	163,020	(130,661)	315,814	307,814	(141,161)	(7,001)	74,327
$3,000 / ML / Yr	932,552	935,511	790,717	497,036	943,511	935,511	486,536	336,154	702,024
$7,500 / ML / Yr	2,344,871	2,347,830	2,203,036	1,909,355	2,355,830	2,347,830	1,898,855	1,108,252	2,114,343

Capacity - 40,000 SCU **NPV**

Water Cost (Normalised Capex & Ops Exp)	Option 1 (Drinking Water Chlorine)	Option 2 (Drinking Water UV)	Option 3 (Irrigation Water)	Option 4 (Grey Water)	Option 5 (Feed Processing)	Option 6 (Stock Washing)	Option 7 (Effluent Management)	Option 8 (Gen Cleaning)	Option 9 (Fire)
$500 / ML / Yr	813,878	816,878	215,109	(78,572)	824,878	816,878	(89,072)	146,387	354,903
$1,000 / ML / Yr	1,117,995	1,120,995	519,226	225,545	1,128,995	1,120,995	215,045	312,644	659,020
$3,000 / ML / Yr	2,334,463	2,337,463	1,735,694	1,442,013	2,345,463	2,337,463	1,431,513	977,673	1,875,488
$7,500 / ML / Yr	5,071,515	5,074,515	4,472,745	4,179,065	5,082,515	5,074,515	4,168,565	2,473,988	4,612,540