Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Veritide Camera Scanner Prototype

PoC End-of-line Ovine Carcase Inspection/Contamination Management Prototype

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1.0 Executive Summary

Safe food supplies support national economies, trade and tourism, contribute to food and nutrition security, and underpin sustainable development.

The 2015 WHO report on the estimates of the global burden of foodborne diseases presented the first-ever estimates of disease burden caused by 31 foodborne agents (bacteria, viruses, parasites, toxins and chemicals) at global and sub-regional level, highlighting that more than 600 million cases of foodborne illnesses and 420 000 deaths could occur in a year (https://www.who.int/news-room/fact-sheets/detail/food-safety).

While the American food supply is among the safest in the world, the Federal government estimates that there are about **48 million cases of foodborne illness annually**—the equivalent of sickening 1 in 6 Americans each year. And each year these illnesses result in an estimated 128,000 hospitalizations and 3,000 deaths (https://www.fda.gov/food/consumers/what-you-need-know-about-foodborne-illnesses).

The safety of meat and meat products is impacted by the presence of microbiological or other pathogenic contaminants and continues to be one of the major societal concerns (Lianou 2017). Changes in animal production, product processing, and distribution; increased international trade; increased worldwide meat consumption; changing consumer needs for minimally processed foods; higher numbers of consumers at risk for infection; and increased interest, awareness, and scrutiny by consumers are contributing to the increasing importance of meat safety (Yoon & Sofos, 2008).

Contaminant Detection

Specific sources of contamination during the slaughter and boning process include faeces, pelts, oil, water, air, intestinal contents. Cattle and sheep can carry E. coli, Salmonella, Listeria and Clostridium strains in the intestinal tract which is excreted in the faeces or on the hide and pelt which can be transferred to the carcase during the slaughter process (Reid et al. 2002; Nightingale et al. 2004; Bell 1997). A primary focus of meat processing is the clean and hygienic dressing of carcases to present them acceptable and safe for human consumption. Sanitation processes, hygienic practices and application of food safety interventions such as visual inspection and trimming of carcases to remove identified contaminates are control points in management to acceptable food safety standards.

Green plant material contains chlorophyll which is optically very active and hence yields strong fluorescence signals. Veritide, a company based in New Zealand have developed sensors and models for use in red meat processing plants to identify chlorophyll as an indicator of faecal material or ingesta which have a strong correlation with the presence of E. coli, Salmonella and other pathogenic and spoilage bacteria. Several markets have zero tolerance for E. coli and if faecal contamination is detected the carcases are cleaned, trimmed or condemned. Bacterial contamination like E. coli is responsible for the majority of the meat industry recalls.

Veritide and the Australian Meat Processing Corporation (AMPC) have been collaboratively working on two projects to evaluate the effectiveness of the technology in Australian processing conditions and with the potential to further develop digitization and automation of end-of-line (slaughter-floor) carcase inspection; these initial projects were focused specifically on precision faecal contamination detection and management in real time at chain speed. For the purposes of this project, a site trial was undertaken at an export sheep processor for one week. The system was run at line speeds on hot and cold carcases and microbiological swab testing was done which confirmed Veritide is able to distinguish specific parts of carcases that are clean and those parts that are contaminated.

Veritide Technology Capability

Veritide' s existing hand-held BluLine Scanning technology has been developed into a wide-area, modular camera-scanner system (BluMax) that can be mounted or manipulated into various positions to inspect particular sections of an ovine carcass; or full ovine carcass sides, depending on the number of scanner modules deployed (Figure 1).

Figure 1: Localised BluLine Spot detection (bottom left). BluMax carcase detection (centre and right)

Identification of faecal contamination in real time provides opportunities for immediate intervention, along with a range of other benefits quantified during the project that are not possible with microbiological swabbing that informs one to two days post the event and negates many of the benefits Veritide can deliver on.

Processing trials involved the observation, testing and confirmation of the following technology capabilities:

Real-time detection and intervention – this is a proven feature of the Veritide technology. Trials run at line speeds easily identified, in real-time, the contamination locations. Swab trials taken from carcases at chain speed confirmed Veritide' s capacity to identify clean parts of a carcase and contaminated parts.

A correlative link between Veritide detections and TVC's, Coliforms, Salmonella and E. coli – is indicated, based on small microbiological trials undertaken during the project. The microbiological work involved small samples of 30 – 40 carcases over two hours and, although was not statistically robust across different livestock types, the results indicate a correlation between Veritide's ability to detect chlorophyll/faecal/ingesta contamination, and increased cell counts for E. coli, Salmonella, Coliforms and TVC's.

Calibration to regulatory inspection standards - The technology's detection capabilities and sensitivity controls can be adjusted to ensure inspection is better than current visual inspection standards, but not too sensitive to result

in excessive detection and removal beyond safe biological loads and practical plant processes approved by the Department. Calibration would require extensive baseline sampling trials across the range of Australian plants, livestock types, feeding regimes and seasonal nutrition variation but the capability to make these adjustments already resides within the technology.

Detection and display of specific contamination points on each carcase or primal product enable targeted visual inspection and precision contamination removal.

Value Propositions Delivered

Department managers across Operations, Human Resources, Quality Assurance, Finance and Engineering were involved in considering the range of value propositions and how they might be adapted to various processing environments and constraints. Modelling using values from the site visit was undertaken and then extrapolated across “average” small and large sheep processing plants to remove any confidential plant details. Note that values arising from the benefits described below will depend on each company’s market access, customer base and product mix and should be used indicatively:

Pre-Boning Room Trim reductions – provide a small yield benefit by focusing trimming inspection and removal on the specific contaminated portions. Installation of Veritide on the slaughter floor prior to final carcase inspection minimises cross-contamination of carcases during chiller sortation and chiller loading. This also minimises the labour required in the pre-trim area.

Labour Reduction for inspection and removal – would result in the pre-trim, prior to boning room entry, if Veritide confirmed carcases were clean prior to the grading scale. Furthermore, visual detection and identification would keep inspectors focused just on the removal in specific areas, thereby increasing the efficiency of each inspector.

Shelf-life benefits

- Reduction in airfreight
- Short life export Freezing due to delayed shipping schedules have resulted in freezing sea freight containers of chilled meat. The loss in value for some products can be significant.
- Markdowns and dumps at retail can exceed 8% of sales. As more product is centrally packaged as retail ready product and the control of shelf life moves from in-store butcher to cold store and logistics managers, shelf life becomes even more critical. Although this cost is more directly carried by the retailer, there is an impact on everyone in the supply chain. To maintain the conservative nature of this benefit case analysis the benefits have been estimated, but not included in the processors return on investment calculations for Veritide units.

Presumptive Downgrades reduced - as a result of market entry and microbiological testing requirements (particularly in the USA), a proportion of product is rejected due to contamination such as E. coli and other zero tolerance mandates. This is expected to reduce as more effective identification and removal of contaminants is enabled by the Veritide technology.

Risk of losing market access – due to detection of zero tolerance contaminants is a very real risk that all plants are concerned about. A single detection of ingesta contamination on a lamb shank (2 million lamb shanks in a year for the average processor) is a tremendous reliance on staff (with a turnover rate of 30-60%) to process effectively, and visually inspect and remove effectively if required. The value difference between market access and no access can

be significant. This value has been estimated. Given this is a risk, and hopefully not a reality, it has not been counted in the return-on-investment calculations.

Water usage, Waste treatment and Energy Cost savings – contribute 4.6% of the cost of operating in Australia. A portion of water usage, effluent treatment and water heating costs is due to carcase washing, inspection and waste removal.

- Given Veritide has mapped the locations on a carcase to be cleaned, targeted carcase washing could focus on the contaminated areas with a reduction in water usage while maintaining or increasing the effectiveness of that water application.
- Reduced water usage also reduces wastewater treatment.
- Energy costs used to heat wash water in some plants would also be saved. Although many plants consider hot water to be a product of existing boiler costs, the increased focus on energy reduction and environmental sustainability will increase the importance of hot water costs in future.

Training and Recruitment Costs – result from the associated labour reductions through more effective pre-trim inspection.

Training Support and Automated Corrective Action - is possible in real-time by live-streaming contamination detection results to operators at critical points in the slaughter process; providing real-time training, intervention and corrective actions. This type of improvement has been accounted as part of the Shelf-Life Improvement Benefits.

Process Improvement Benefits –using the same real-time feedback, enable testing, adjustment and acceptance of process improvements.

Return on Investment

Modelling using values from the site visit was undertaken. Based on current capital costs of the system, assuming configuration of two BluMax units and ongoing service and support, the system will deliver between $0.65 and $0.70/head for sheep (Table 1) assuming likely benefits in the left hand and middle scenarios.

The far-right scenario calculates the total potential benefit that could be possible along the whole supply chain. The left and middle scenarios assume a direct, realistic and conservative portion of that potential value that a small (left) and large (middle) processor could expect to receive in direct benefit from installing the Veritide system. The weighted portion of total potential benefit is highlighted in orange input cells to the right of the Product Benefit Descriptions. These scenarios are considered conservative and provide a payback of ~6 months for ovine plants.

Table 1: Cost Benefit Analysis (Sheep)

SHEEP INSTALLATION									
BluMax Manual System (2 x wide angle units installed)							Potential S.C. Benefit		
	Small Volume Plant		High Volume Plant				High Volume Plant		
Total Cap Ex (incl. Installation)	$361,000		$361,000				$361,000		
Gross return Per head	$0.74		$0.74				$3.43		
Total costs Per head	$0.10		$0.04				$0.04		
Net Benefit Per head	$0.65		$0.70				$3.39		
Annual Net Benefit (Plant / Supply Chain)	$568,313		$2,075,501				$10,005,534		
Pay back years	0.64		0.17				0.04		
Net Present Value (15 yrs.)	$2,989,497		$10,858,561						
Plant Specific Drivers									
	Small Volume Plant		High Volume Plant				High Volume SUPPLY CHAIN		
Useful working life	7		7				7		
Discount rate (for NPV)	7%		7%				7%		
Hours/Shift & Shifts/day	7.6 Hrs	1	7.6 Hrs	2			7.6 Hrs	2	
Chain speed (#/min) & #/day	8.0	3,648 Hd	13.5	12,312 Hd			13.5	12,312 Hd	
Weeks of operation/year	48		48				48		
Annual number of head	875,520		2,954,880				2,954,880		
Drivers									
			Small Volume Plant		High Volume Plant			High Volume Plant	
Item	Description		$/hd	$/ annum	$/hd	$/ annum		$/hd	$/ annum
Product Benefits	Pre-Boning Room Trim -	100%	$0.09	$75,312	$0.09	$254,177	100%	$0.09	$254,177
	Airfreight $/kg Differential	25%	$0.02	$13,274	$0.02	$44,800	100%	$0.06	$179,201
	Market Access Price Differential	0%	$0.00	$0	$0.00	$0	100%	$1.10	$3,257,318
	Short Life Export Freezing	25%	$0.45	$395,502	$0.45	$1,334,819	100%	$1.81	$5,339,274
	Markdowns	0%	$0.00	$0	$0.00	$0	100%	$0.18	$519,096
	Presumptive Downgrades	50%	$0.00	$4,374	$0.00	$14,763	100%	$0.01	$29,526
	Other		$0.00	$0	$0.00	$0		$0.00	$0
Operational Benefits	Labour		$0.18	$158,719	$0.18	$535,678		$0.18	$535,678
	Training & recruitment		$0.00	$4,356	$0.00	$8,712		$0.00	$8,712
	OH&S		$0.000	$0	$0.000	$0		$0.000	$0
	Existing operational costs		$0.000	$0	$0.000	$0		$0.000	$0
Total Benefits			$0.74	$651,537	$0.74	$2,192,949		$3.43	$10,122,982
System Costs	Capital Cost		$0.06	$49,000	$0.02	$49,000		$0.02	$49,000
	Service / maintenance		$0.04	$34,224	$0.02	$68,448		$0.02	$68,448
				$0		$0			$0
Total Annual Costs			$0.10	$83,224	$0.04	$117,448		$0.04	$117,448
Net Annual Benefit			$0.65	$568,313	$0.70	$2,075,501		$3.39	$10,005,534

Recommendations

The harnessing of the technology requires industry to consider the implications of increased rigour in identification of potential E. coli contamination, interventions, changes in policies and processes, as well as validating extension in shelf life which is possible through improved hygiene standards. It is recommended that a whole of industry approach be taken to integration of the Veritide technology into industry. This should assess the utility and management of the data created when deploying the Veritide modular camera and handheld scanners, and how the previously identified digital modernisation reforms could be enabled. A number of further bodies of work have been described in the report and summarised here:

Research Area 1: Baseline detection standard established to calibrate Veritide technology and integrate with appropriate data management strategies

Auditing, real-time feedback and continuous improvement in a controlled environment. This project or components of the project should consider how to integrate directly with the AEMIS Meat Modernisation Working Group and consider how this could directly support the programs objectives.

Research Area 2: In plant development and validation of Veritide system location(s) and uses

Veritide technology can scan at different points in the chain which provides opportunities for the entire red meat processing industry to revolutionise the identification, treatment and record keeping around carcase contamination. The benefits of real time feedback are numerous including identifying immediate process, procedural, equipment

and staff training issues. The early identification and removal of faecal matter reduces cross contamination further down the chain, improving shelf life and food safety while reducing risk in regard to product recall and or loss of market access.

Research Area 3: Define operational efficiency opportunities enabled by Veritide

Within the plant there are opportunities to improve operational efficiencies with some tweaking of plant design and or current standard operating processes. The project will investigate and validate gains identified in the report and test the far-reaching positive implications for the industry that could eventuate.

Research Area 4: Develop Veritide automated inspection and automated carcase cleaning

Removing contamination from carcases is still a laborious process, even after Veritide inspection identifies what parts of carcases require trimming of contaminants. The Veritide system contains x/y/z coordinates for each carcase scanned, and the locations in that 3D matrix that require cleaning. The project proposes to investigate how this 3D data could be used to drive some form of automation that removes contaminants.

Research Area 5: Whole of supply chain impact arising from Veritide validated to support adoption

It is expected that the reduction in microbiological contamination (spoilage bacteria) and improved plant hygiene will result in increased shelf life and reduced dumping and mark downs. The extended shelf life will provide a range of value propositions; in particular, the export of additional product by sea freight would reduce the cost of airfreight and reduce the need to freeze product to extend shelf life (which impacts negatively on price).

Research Area 6: Research and development of system extensions to remove labour

The opportunities and constraints in scanning specific cuts and products will be reviewed with the development of system extensions; for example, a rolling table for lamb shanks and an auto-rejection or alert system so staff remove the lamb shank for additional treatments. Another option may include a clear conveyor belt for offal to review both sides of the offal pieces, with a separate chute when the presence of chlorophyll is detected.

Commercial Version of Veritide's Single Module BluMax Scanner

2.0 Introduction

Cattle and sheep are ruminants, thus faecal samples contain green plant material. At a cellular level the green plant material contain chlorophyll. Chlorophyll is optically very active and hence yields strong fluorescence signals. Veritide have developed sensors and models which identify chlorophyll, which by default is faecal material and faecal material has a strong correlation with the presence of E. coli. Several international export markets have zero tolerance for E. coli and/or faecal contamination; if detected, carcases are cleaned, trimmed or condemned with costs borne by the exporter. Bacterial contamination like E. coli is responsible for the majority of the meat industry recalls.

Veritide has developed proprietary IP that enables them to identify/isolate specific organic substances or contaminants (using fluorescent spectroscopy) with a high degree of specificity and sensitivity down to a “parts per billion” (ppb) scale. The company has subsequently developed proprietary scanning technology to detect faecal contamination on red meat products. The first iteration of this technology, a single beam, hand-held scanner known as the BluLine Scanner, is currently manufactured and marketed by Veritide internationally.

At the end of the slaughter process carcases must be free from contaminants such as hair, wool, dust, ingesta, faeces, bile, urine, Salmonella, E. coli and Listeria (examples only) prior to entering the chiller network. Currently, processing plants use a variety of intervention techniques, operational staff and quality management/laboratory resources to identify, quantify and manage contamination risk on the slaughter floor. Visual contamination is manually removed (either with knives and/or steam vacuum systems) and are often backed up with whole of carcase decontamination wash units (using high volumes of hot/cold water or acid-based chemical solutions). Detailed swab sampling and laboratory testing regimes occurs as prescribed by regulatory agencies which deliver results in days. This combination of approaches, although theoretically producing the required outcome from a food safety perspective, requires considerable labour, and uses considerable energy and water resources. All of the current approaches have a well-understood cost: benefit profile; the challenge now, is to assess if Veritide’s newly developed systems can further enhance or optimise current processes and provide value that accrues to processors and cascades through the supply chain.

Industry quality control measures, market access requirements and zero tolerance requirements for certain country listings make the importance of controlled processes paramount to company profitability. Many pressures including operational costs, labour shortages and aging equipment place more pressure on quality control measures. The value that Veritide can deliver is significant but has not yet been thoroughly quantified.

Veritide is interested to understand the potential value creation and technical, labour and cost saving opportunities for different protein processing plants and any impacts size, species, market and potential other factors have on the return on investment in these technologies. Furthermore, the value created, and costs saved from use of Veritide technology has not been well quantified.

Veritide and the Australian Meat Processing Corporation (AMPC) have been collaboratively working on two projects that will enable the meat processing sector to re-evaluate and further develop past approaches to the digitization and automation of end-of-line (slaughter-floor) carcase inspection; these initial projects are focused specifically on automated, precision faecal contamination detection and management.

This project has involved expanding Veritide’s existing hand-held BluLine Scanning technology into a wide-area, modular camera-scanner system (BluMax) that can be mounted or manipulated into various positions to inspect particular sections of ovine carcass; or full carcass sides, depending on the number of BluMax scanner modules deployed.

As part of the project outputs, Veritide and AMPC wish to explore the commercial benefits that might accrue to industry as a result of deploying automated, precision contamination management solutions within the slaughter-floor environment. Given the technology advancements Veritide are investing in the development and integration of other data driven technologies, and the increasing connectivity of data and products along the protein supply chain, new value propositions are emerging to support companies. Part of this project is to consider the what-if of other new value propositions for Veritide to diversify into.

Veritide is looking to increase the efficiency and capacity for detection of contamination, intervention methods as well as enable early contamination prevention with its larger scanning system. The current project is looking to quantify the value proposition for this system. Careful consideration to future value propositions is an opportunity to leverage the technology to support industry on a wider supply chain level.

3.0 Project Objectives

Primary Project Objectives:

The output of this project was the detailed design and delivery of a functional, single-module camera scanner (product prototype; the BluMax Scanner), sufficient to:

(1) demonstrate to AMPC staff, and the Australian Lamb Company, the working functionality of Veritide's Ovine contamination scanning system.

(2) validate the utility of the scanning system by assessing its ability to deliver on all (or some of) the "Primary Goals" articulated below.

Please review the video link attached to see the BluMax Scanning System in action:

BluMax Scanner Prototype Video

In addition to the objectives detailed above, primary goals, related to Value Validation, were contemplated as follows:

1. Could the technology assist in reducing labour resources, or enable more efficient labour use within the primary processing sector?
2. Could the technology assist in the reduction of carcase trim waste and/or enhance carcass yields?
3. Could the technology lower energy and/or water or chemical utilisation rates – enhancing environmental and sustainability objectives?
4. Can the technology demonstrably lower pathogenic and spoilage bacteria cell counts (vs current contamination detection and management practices)?
5. Can the technology contribute positively to an extended product shelf-life; and what are the commercial benefits that this could deliver to industry?
6. Scope and further refine the list of benefits to be included in Stage 2 of the program of works – Enabling industry systems

4.0 Methodology

- **Concept Design:** In consultation with AMPC (and The Australian Lamb Company, Colac) Veritide developed a detailed concept design of a single-module camera-scanning system. This included defining in-plant requirements for the BluMax Scanner footprint, H&S, washdown, mechanical support system, data capture, etc. Veritide consulted with AMPC & the processor to understand how best to handle and locate the carcasses for inspection/testing.

- **Detailed Design Finalised and specified internal componentry acquired for validation and testing:** Over the course of 2021, while navigating the impact of Covid 19, Veritide produced detailed mechanical and electrical drawings of the BluMax System that contemplated all of the relevant Safety and HAZOP requirements. Optical componentry, lighting componentry, PCBs, were ordered/ acquired (from a wide selection of international suppliers) for internal assemblies, validation, quality assessment and testing.

- **Build:** External components/housings were built and integrated with the internal assemblies/camera scanning system and functional testing was conducted; initially at Veritide NZ.

- **Factory run-off and acceptance testing:** Within the limitations of the Covid travel restrictions, Veritide set up the BluMax system in a local, New Zealand processing environment with Alliance Pukeuri to ensure the system was functionally working. This was achieved in November 2021.

- **Installation & Commissioning:** After consultation with The Australian Lamb Company and AMPC we installed the BluMax Camera Scanning System in multiple locations through the facility including: a) Pre-trim; b) Post-trim; c) Post-chilling/pre-boning.

- **Testing On site:** The BluMax System was set up for 4 days starting with a small number of full carcasses and increasing steadily whilst ensuring reproducibility, accuracy and improving cycle time; this work was conducted on the main chain.

- **Production ready & validation trials:** In conjunction with Greenleaf Enterprises (our mutually agreed 3rd party testing and validation agency), we conducted a battery of agreed test protocols to determine the efficacy and utility of the Veritide contamination scanning system; enabling us to objectively assess, in the broadest terms, how the Veritide technology could contribute to the achievement of our Primary Goals. These are reported, and expanded on, in detail below.

  The bullet points above were progressively delivered upon over the course of June 2021 through June 2022 as all parties navigated their way through project Milestones 1 - 5; against the backdrop of Covid 19.

In summary the activities for developing the business model included visiting a lamb processing facility and measuring the impact, from which analysis and modelling was undertaken. Face to face interviews of industry experts involved in using and developing the Veritide technology were conducted in Australia and New Zealand. A design led thinking workshop was held with Greenleaf Enterprises technical staff. Each of the activities are further described in this section.

4.1 Model development

An excel based business model was developed to quantify the potential benefits for lamb processing. To develop this model raw data was collected from plant. Where information was considered confidential, industry desensitised data was utilised, and plant specific data was summarised so as not to release plant confidential data. Costs and value gains for each specific area were considered. Commercial matters listed in the section below were considered as part of the model costings and value creation assumptions. A sensitivity analysis around each set of value drivers was included in the model where applicable.

Operational staff across plant were consulted on current challenges, potential interventions using Veritide Technology that could address those challenges, and what degree of impact could be achieved on an ongoing commercial basis if implemented. Processing staff involved in consultation included managers from Operations, Human Resources and Training Development, Quality Assurance, Finance and General Management.

Questions which were considered when undertaking the research and developing the model:

1) Can the technology demonstrably lower pathogenic and/or spoilage bacteria cell counts (vs current contamination detection and management practices)?
   a) Assess the efficacy of the Veritide precision contamination detection technology vs the current, operational, visual inspection and contamination management practices; empirically comparing the two techniques.
   b) Collect detailed laboratory data from the two sample sets above and determine if there is a difference in risk profile for the Veritide system vs current practices i.e., are contaminated carcasses passing through the slaughter floor inspection process (deeper into the processing environment) using current techniques and can the Veritide system lower this risk in any way?
   c) Determine if faecal contamination is detected at dispatch/packaging (pre-shipment) using the BluLine Scanners – random sampling of cartons for export and domestic consumption. Lab test positive detections. Back-trace detections through the processing facility and determine if cross-contamination is occurring elsewhere through the processing facilities.
   d) Assess the potential impact of precision contamination detection using the Veritide system vs local or international regulatory guidelines and export standards (MPI/Food Safety standards in NZ, AEMIS System in Australia, ESAM/NCMMP programs, MHA programs and the Product Hygiene Index - PHI), import restrictions (e.g., US/FSIS or Chinese border control agencies assessing ZFT standards), etc.
   e) If regulatory sampling was conducted using the precision Veritide systems, what would the potential impact be on TVC, E. coli and Salmonella rates vs currently deployed sampling/testing practices.

2) Could the technology assist in reducing labour resources, or enable more efficient labour use within the primary processing sector?
   a) If precision contamination detection is automated, rather than conducted manually, explore if there are potential opportunities to lower or optimise labour resources on the slaughter floor?
   b) In the event that contamination detection + contamination removal was both automated solutions (e.g., Veritide scanning + precision auto-sanivac or precision auto-trim), how might this impact on the labour units involved in contamination detection and removal?
   c) Evaluate the costs associated with operator contamination detection, manual contamination trimming, manual sanivac practices.
   d) A detailed cost analysis of current contamination management practices will be required to determine a baseline cost/head or cost/carcass.

3) Could the technology assist in the reduction of carcase trim waste and/or enhance carcass yields?
   a) Empirically compare the quantities of trim using the precision detection (and precision trimming) technique afforded by Veritide vs current techniques (to statistically significant standards)
   b) Assess the commercial benefits of clean, saleable trim (that won't be de-valued further down the supply chain) vs contaminated trim that will be heat-treated and then devalued (in export sales).
   c) Assess the commercial impact of rejected product and/or shipments and containers (due to ZFT standards) to the US & China.

4) Could the technology lower energy and/or water or chemical utilisation rates – enhancing environmental and/or sustainability objectives and lowering operating costs?
   a) Assess the operational/input costs (excluding labour……see 2 above) associated with current contamination detection, management and removal practices and determine if there are material commercial benefits in moving to an automated detection system whereby water, steam, energy, chemical costs (and associated environmental management costs) might be lowered or reduced or further optimised. Consider various plant processes such as pre-slaughter washing and spray-chilling practices.
   b) Detailed baseline rates (per head) for water use, carcass cleaning, steam energy costs, sanivac treatments, chemical treatment costs, manual trimming costs, wastewater management and treatment, etc will need to be disclosed in order to determine if the Veritide system could positively impact on these variables e.g., is there a lower requirement for washing and/or spraying if the Veritide system is in place? Can sanivac processes be applied with more precision and cost-effectiveness?

5) Can the technology contribute positively to an extended product shelf-life; and what are the commercial benefits that this could deliver to industry?
   a) Conduct detailed sampling and testing (on a comparative basis) to determine if precision contamination removal provides a superior shelf-life profile for processors and down-stream supply chains vs current practice. Can additional value be created in domestic or export sales?
   b) Assess the differences between chilled, vacuum-packed cuts and manufacturing meat products – if applicable.

5.0 Project Outcomes

5.1 Business Case Value Propositions

The business case modelling was developed to capture the value opportunity that could be created by Veritide contamination detection in the following areas:

- Carcase inspection and trimming
- Extension of shelf-life with the following commercial impact areas:
    - Enabling some airfreight product to be sea freighted
    - Reduced risk of freezing chilled product in destination country due to longer shipping times
    - Reduced markdowns and dumps at retail
- Reduction in downgrade or disposal due to presumptive E-coli testing
- Risk of losing market access due to ZT incidents
- Trimming labour saving
- More effective training of staff
- Yield savings due to reduced carcase inspection trimming
- The specific potential benefits are presented in

Table 2. They are broken into two key areas:

- Preservation of value
- Cost reduction

Table 2: Summary of potential benefits by type of benefit (Ovine)

Benefit Type	Summary Tables		$/hd	%
Value add	Pre-Boning Room Trim Savings		$0.09	3%
Value add	Airfreight $/kg Differential		$0.06	2%
Value add	Market Access Price Differential		$1.10	32%
Value add	Short Life Export Freezing		$1.81	53%
Value add	Markdowns		$0.18	5%
Value add	Presumptive Downgrades		$0.01	0%
Cost Saving	Labour		$0.18	5%
Cost Saving	Training & recruitment		$0.00	0%
Cost Saving	OH&S		$0.00	0%
Cost Saving	Existing operational costs		$0.00	0%
	Total		**$3.43**	**100%**

	Summary Tables		$/hd	%
	Product Value Preservation		$3.24	95%
	Reduced Process / Distribution Costs		$0.18	5%
	Total		**$3.43**	**100%**

5.2 Cost Saving Related Benefits

5.2.1 Trimming Labour Saving

Sheep processing plants traditionally have an inspection and trimming process after carcase chillers and prior to entry into the boning room or carcase load out. This final check involves visual inspection and trimming to remove any defects or contamination that was not picked up on the slaughter floor prior to the carcase grading station. The number of people involved in this process will vary depending on the size of plant and speed of the chain.

This visual inspection process is quite a challenge when attempting to remove 100% of the foreign material. The effectiveness of the trimming process is also variable given operator error, operator fatigue and speed of the chain. Identification and removal of one point of contamination is about all the time an operator can remove before the next carcase is presented. Effectiveness of inspection is then replaced with repetitive motions.

During the trials it was quite difficult to distinguish contamination such as wool; that was able to be identified by the Veritide BluMax system. This inspection support could help trimmers to only focus on areas identified by Veritide as needing trimming. The use of Veritide to support operators could have the following benefits:

- Reduce the area of carcases that need to be focused on for inspection and treatment, giving existing trimmers more time where it is needed
- Focus trimmers, reducing their inspection fatigue
- Use of Veritide on the slaughter floor prior to grading scale to identify carcases that were not properly trimmed. Remove these carcases for further trimming on the retain rail, thereby transferring trimming processes from pre-boning to pre-grading scale.

These adjustments to increase effectiveness of the inspection and trimming process would reduce the number of people required. Based on the trials undertaken, it is feasible to reduce staffing by 2 people as summarised in Table 4 and Table 5.

Table 4: Carcase inspection trimming labour savings

Labour		
Shift	BluMax Manual	BluMax AUTO
FTE's saved/shift	2.0	6.0
Hourly Rate	$43.51	$43.51
Hrs./ shift	7.6	7.6
Days worked	240	240
Hours worked	1824	1824
Saving/Wage Type	$158,719	$476,158
Total/shift	$158,719	$476,158
Saving per head	**$ 0.18**	**$ 0.54**

Table 5: Detailed staffing assumptions and savings

Current Position	Description	FTE's (Slaughter man)	FTE's (Knife Hand)	SCENARIO - High Volume Slaughter Capacity	FTE's (Slaughter man)	FTE's (Knife Hand)	Scenario - BluMax Automation Enhancements - Auto contamination removal	FTE's (Slaughter man)	FTE's (Knife Hand)
Retain Rail Operator			1			1			1
Retain Rail Trimmers	Fluctuates & Still have other requirements		4	Move Pre-bone trim to Slaughter & provide more targeted, more effective inspection and manual trim.		5	BluMax Auto trim removal		3
Pre-grade inspection			3	More effective with BlueMax but assume same manning.		3	BluMax Contamination Inspection		2
Pre-boning inspection			4	Still require some trimming for grass-seed missed etc.		2	Current contamination removed hot		1
Boning Room Product Inspection			2	BluMax Inspect and auto-reject belt		1	BluMax Inspect and auto-reject belt		1
Sub Total		**0**	**14**		**0**	**12**		**0**	**8**
Total		**14**			**12**			**8**	
Labour FTE savings (per shift & per day)					**0**	**2**		**0**	**6**
Processing rate/min		8.0			8			8.0	
Shifts / day		1			1			1	
Processing rate/day		3,648			3,648			3,648	
Labour Cost/day		$ 4,629			$ 3,968			$ 2,645	
Labour Cost/head		$ 1.27			$ 1.09			$ 0.73	

5.2.2 Training cost savings for reduced labour

Discussions with plant HR managers indicated there would be a marginal savings in training costs as a result of reducing the number of trimmers required. These savings are summarised in Table 6 based on industry average training costs and staff turnover rates.

Table 6: Training and Recruitment cost assumptions

Training & recruitment

Recruiting	
Turnover	58%
FTE recruited / yr.	1.16
Cost of Recruitment	$1,400
Total Recruitment saving	$1,624
Recruitment saving /hd	$0.002

Cost of Training	
No weeks training / recruit	2
Training rate	$ 45
Trainees/trainer	8
Weekly cost	$428
Training Course Accreditation	$1,500
Total training cost	$2,355
Total annual cost	$2,732
Saving per head	$0.003
Total Training and recruiting	$ 0.005

5.2.3 Carcase Inspection and Trimming

Carcase trimming is the output from carcase inspection to remove any foreign material (Figure 2) prior to the grading scale on the slaughter floor and pre-boning in the carcase chillers. The intention is to remove contaminated product from the carcase prior to the boning room.

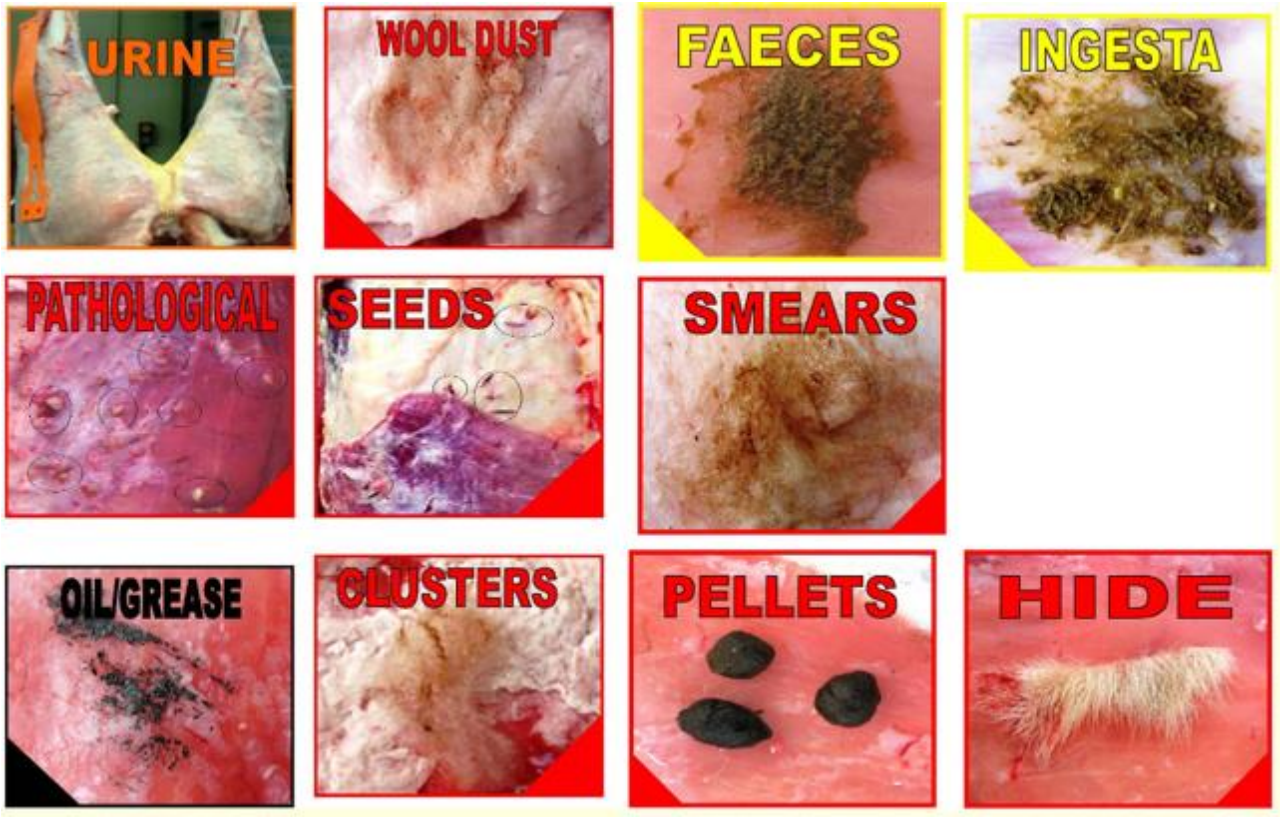

Figure 2: Carcase contamination examples to be removed as part of visual inspection

The process is labour intensive and results in manual trimming of defects identified from visual inspection. There is a yield loss as parts of the carcase are trimmed and discarded, as well as a labour cost in doing this. The yield component is captured in this section. Trials were undertaken on site to capture the amount of trim removed from carcases.

While Veritide was being trialled on site, trimming samples were measured at intervals throughout production. Based on the number of carcases inspected and the weight of trim collected, an indicative weight and cost of trimming was determined. Table 7 indicates that 22 grams was trimmed on average from every carcase at a value of $8.00/kilogram.

Veritide technology cannot pick up some substances such as seeds and traditional oil/grease (although some companies use oils that contain chlorophyl which does make it detectible). The assumption is that 40% of current contamination will not be detectible. Of the contamination that is detected, it is assumed that 80% could be transferred to removal on the slaughter floor prior to carcase grading. The benefit realised in this scenario equates to $0.08/head. This value is used later in the ROI calculations for different sized processing plants.

Labour savings also result from more targeted identification of contaminated areas that require trimming. These benefits are covered in the Trimming Labour Saving section on page 14.

Table 7: Pre-boning room trim yield loss transferred to slaughter floor

Pre-Boning Room Trim - Detection on Slaughter Floor (Reduce Trim OR Transfer to Slaughter Floor)				
Carcase	Calculation	CURRENT		
Carcase weight (kgs)		24.00		
Weight Collected	Average CCW	Trim Weight	Starting Carcases	Carcase Weight
Tub Weight - 9:29	29	12.86	2,219	50,406
Tub Weight - 11:12	28	8.94	2,820	67,621
Tub Weight - 1:13	23	17.76	3,985	99,807
Total Carcases Inspected	28	39.56	1,766	49,401
Yield Loss	**0.022**	**0.08%**		
Averagre trim value		$ 8.00		
% of Pre-trim not detected by Veritide	40.0%	$0.07	/head	
% of remaining Pre-trim moved to Pre-Hot Grade	80.0%			
Yield loss/gain by moving to Pre-Hot Grade	48.00%	$0.09	/head	
Savings / hd (current v's system)				**$0.086**
Annually				**$ 75,312**

5.2.4 Water Reduction and Energy Savings

Water usage and reduction in water required for red-meat processing continues to be a point of focus for the industry. Rising energy costs add further pressure to cost of production. The importance of environmental sustainability is increasing the importance that already exists for reduction in water and energy use in processing.

Power, water and waste disposal expenditure (including environmental management activities) represented about 6 per cent of total processing costs for both species in Australia (Heilbron cost of processing report).

Final carcase wash systems observed in plant during trials used various methods of cold or hot water spray post the final carcase inspection on the slaughter floor. In all cases water was distributed generally across the entire carcase in the wash cabinets and applied equally to all carcases. A sensor indicated when a carcase was entering the wash, at which point the entire carcase was sprayed.

Water costs include the initial cost of water application, but also need to take into account the costs for heating water and the cost of treatment and disposal of wastewater post treatment.

The Veritide system detects in real-time which carcases are carrying bacterial load and which locations on the carcase. The x/y/z dimensional data collected by Veritide for each carcase could be used to selectively target points on each carcase requiring washing.

This could result in a reduction in water usage, or in the least, cleaner carcases, resulting in an increased product shelf life.

Given the capital cost to install targeted spraying has not been included in this business case analysis, the benefits of improved washing have been reflected as an increased product shelf life, which is discussed in the next section.

5.3 Shelf-Life Related Product Benefits

Most of the product value related benefits arising from reduced carcase contamination relate to product shelf life, market access, overseas inspection requirements, customer mix and product price differentials. All these factors vary widely between processors. The assumptions used in the following scenarios should be used as an indication only and should be adapted to each processors specific supply chains. Sensitivity modelling for alternative supply chain scenarios is included in Appendix 9.3. These sensitivities provide a clear understanding of the impact that each area of benefit will have on the overall investment in Veritide's technology.

The next sections explain the broad assumptions underpinning each benefit area.

5.3.1 Extension of shelf life – Converting some airfreight to sea freight

Some chilled product for some customers requires air freight shipment to provide the minimum required shelf life. If shelf life was extended some customers would be able to accept sea freight shipment and would reduce the supply chain cost. This will only apply to some products and customers. See appendix 9.2 for detailed assumptions.

5.3.2 Extension of shelf life – Reduced risk of freezing due to longer shipping times

Length of shipping transit times has always been a juggle for certain products and some international destinations. With the recent freight logistic challenges this has had a negative impact on processors with accounts of boats being cancelled, transit times to the USA increasing from 50 days to 75 days as examples.

Processors have had to freeze chilled containers of product due to limited remaining shelf life. This has been an increase in processing and storage costs and a reduction in product value.

This benefit area has not included any additional processing costs. Reduced product sales value assumptions are included in appendix 9.2.

5.3.3 Extension of shelf life – Reduced markdowns and dumps for retail product

Retailers' markdown product when it comes close to end of shelf life to try and sell it before it has to be dumped (disposed of). This process varies between retailers but can sit around 6-9% of sales. Markdowns range from 5-50% depending on days shelf life remaining.

The benefit is received by the retailer, not the processor. However, it does reflect on the processor brand and does contribute to the effectiveness of the whole value chain.

The assumptions used to estimate the benefit to the supply chain can be seen in Appendix 9.2.

5.3.4 Market access risk due to Zero Tolerance (ZT) incidents

Export markets are very important for Australian meat processors. Companies that have market access to these countries gear their livestock purchasing, operations and pricing to these customer requirements which then underpins company profitability. Importing country inspection requirements are strict in terms of food safety. The United States and China are two of these very important markets. They have zero tolerance of certain types of contamination (included in Figure 2) during product inspection at port of entry. If contamination is found a company will be put on heightened sampling regime, more rigorous plant audits and risk losing their export license.

The financial risk to a company is significant. Modelling calculations have been included in appendix 9.2

5.3.5 Reduction in E. coli contamination

Veritide detection capability

As part of the on-site trials of the Veritide BluMax and BluLine systems, swab testing was undertaken to ascertain the level of coliforms, E. coli and total bacterial load that Veritide is able to identify.

A series of swab checks were collected and sent off-site for independent microbiological testing. Veritide BluMax was used to identify carcases with contamination. Veritide Bluline was then used to hone in on the exact carcase location to take the swabs from. Each carcase was swabbed on a contaminated location, and as a control, in a location where Veritide did not detect anything.

There was a significant differential between the Veritide detected samples and the controls. Results are included in Appendix 9.1 – Independent Microbial Tests.

Note in both sets of sample swabs, detected TVC, Coliform, and in some cases E.coli was much greater where Veritide identified the need for trimming (Table 12) than in the control samples (Table 11) where Veritide identified carcase surfaces as clean.

Application of Veritide for E. coli reduction

All trim exported to the United States (37% of trim exports) is tested for the O157 strain of *E. coli* as well as a non-specific E. coli test. Product that returns a positive result cannot be exported unless heat or fermented treated to achieve a 5 Log bacteria reduction. This product is normally sold into pet food production at a heavily discounted price which use retort pressure cooking to achieve desired microbial levels. The cost of downgraded product is a considerable cost to the industry each year. Processors are responsible for managing their sampling programs, but their results are not available to the public.

The presumptive results obtained from the Department of Agriculture's mandatory sampling program reflect the frequency of presumptive positive results expected across the whole industry. These rates have been extrapolated to the total volume of product exported to the USA and have been included in Table 8.

It is likely that application of Veritide BluMax system at continuous lines speeds, coupled with detection for heightened intervention is likely to reduce the frequency of presumptive E. coli results where testing is required for export markets. This could be achieved through application of the technology in the following ways:

- Automated process for detection and retention of carcases for further trimming contamination
- Used in line on product inspection belts with automatic exclusion of suspect product.

Table 8: Lamb export downgrades and lost opportunity due to presumptive positive testing at port of entry

Lamb - Manufacturing Meat Volumes and Bacteria Testing/Rejection Levels									Export Downgrade Incidence		
Year	US destination	MT non-O157 Presumptive	MT O157 Presumptive	MT non-O157 Presumptive	Total downgrades	Value of O157 Presumptive	Value of non-Presumptive	Value opportunity	MT O157 Presumptive	MT non-O157 Presumptive	Total downgrades
2008	1,344	6,156	12	7	19	$ 31,482	$ 17,315	$ 48,796	0.92%	0.11%	0.25%
2009	1,558	7,137	14	8	22	$ 36,496	$ 9,264	$ 45,760	0.92%	0.11%	0.25%
2010	1,772	8,117	16	9	25	$ 41,510	$ 10,536	$ 52,046	0.92%	0.11%	0.25%
2011	1,834	8,402	17	9	26	$ 42,964	$ 10,905	$ 53,869	0.92%	0.11%	0.25%
2012	1,768	8,102	16	9	25	$ 41,434	$ 10,517	$ 51,950	0.92%	0.11%	0.25%
2013	1,866	8,549	17	9	27	$ 43,716	$ 11,096	$ 54,812	0.92%	0.11%	0.25%
Average	1,690	7,744	15	9	24	$ 39,600	$ 11,605	$ 51,206	0.92%	0.11%	0.25%

5.4 Existing Operational Costs

Water usage, Waste treatment and Energy Cost savings – contribute 4.6% of the cost of operating in Australia. A portion of water usage, effluent treatment and water heating costs is due to carcase washing, inspection and waste removal.

- Given Veritide has mapped the locations on a carcase to be cleaned, targeted carcase washing could focus on the contaminated areas with a reduction in water usage while maintaining or increasing the effectiveness of that water application.
- Reduced water usage also reduces wastewater treatment.
- Energy costs used to heat wash water in some plants would also be saved. Although many plants consider hot water to be a product of existing boiler costs, the increased focus on energy reduction and environmental sustainability will increase the importance of hot water costs in future.

This is a strong value proposition for the reduction in energy and water usage which would be further enhanced with an automated carcase trimming system that Veritide is currently designing and developing.

Given specific water usage and energy cost data associated with heating of carcase wash water was not available during the project, there have not been any savings included with the intent on keeping the benefit calculation conservative.

5.5 Cost Benefit Assessment

The configuration of the BluMax wide angle modules will depend on each processors approach to inspection and intervention. Aspects that need to be considered is location on the chain, portion the carcase to be scanned, processes for decontamination and possibly secondary inspection post trimming among other options.

For this initial assessment it is assumed two BluMax modules are installed for a lamb processing plant with no post-inspection re-assessment. On-plant installation costs have been allowed for to integrate the BluMax units including an allowance for power, mounting frames and miscellaneous expenses.

Allowance has been made for monthly digital support license and annual maintenance contract. Details are included in Table 9 for Ovine processing to cover the required inspection area on the carcase.

Table 9: Capital and service costs for a standard Ovine installation

Capital Cost	Units	Cost/Unit	Shift Basis	Life span	Annual cost	Cost /hd
Capital Cost of BluMax Technology	2	$150,000	$300,000	7	$42,857	$0.05
Essential and insurance spares	1	$1,000	$1,000	7	$143	$0.00
Other Capital install (Client install allowance)	2	$30,000	$60,000	10	$6,000	$0.01
Total		**$181,000**	**$361,000**		**$49,000**	**$0.06**
Service maintenance		Units	Units	Unit	Annual cost	Cost /hd
Estimated - COSTS			0.00%			
Cleaning labour		$22.00 /hr	0.17 hr/day	$ 18	$880	$0.00
Cleaning materials (Alcohol Wipes)		52	$20.00 /week		$1,040	$0.00
Maintenance labour (Daily)		$35.00 /hr	0.00 hr/day	$ -	$0	$0.00
Maintenance labour (Preventative)		$35.00 /hr	0.00 hr/wk	$ -	$0	$0.00
Maintenance labour (Breakdown)		$35.00 /hr	0.00 hr/wk	$ -	$0	$0.00
Service Contract		$1,000 /mth	$1,000	12	$12,000	$0.01
Service and Maintenance Agreement (Annual)			$18,000	1	$18,000	$0.02
Maintenance materials		1	$100		$100	$0.00
Electricity		1.50 KW	$0.22 /KWH	$ 25	$1,204	$0.00
Ongoing training		1	$1,000		$1,000	$0.00
Annual Sub Total (excluding major overhaul costs)					**$34,224**	**$0.04**
Major maintenance			Total	Life span	Annual cost	Cost /hd
					$0	$0.00
					$0	$0.00
					$0	$0.00
Other					$0	$0.00
Sub Total: Operating Expense					$0	**$0.00**
Combined Total: (cap ex + operating)					**$83,224**	**$0.10**
Total Annual Estimated Expenses					$ 83,224	$0.10

Based on the assumptions outlined and current approximate capital investment costs, the Veritide BluMax system can provide a strong return on investment. Based on current assumptions and sensitivity analysis the system is likely to give a payback of ~ 6 months, as summarised in Table 10.

Table 10: Financial Analysis and return on investment (Ovine)

SHEEP INSTALLATION		
BluMax Manual System (2 x wide angle units installed)		
	Small Volume Plant	High Volume Plant
Total Cap Ex (incl. Installation)	**$361,000**	**$361,000**
Gross return Per head	**$0.74**	**$0.74**
Total costs Per head	**$0.10**	**$0.04**
Net Benefit Per head	**$0.65**	**$0.70**
Annual Net Benefit (Plant / Supply Chain)	$568,313	$2,075,501
Pay back years	**0.64**	**0.17**
Net Present Value (15 yrs.)	$2,989,497	$10,858,561

Plant Specific Drivers				
	Small Volume Plant		High Volume Plant	
Useful working life	7		7	
Discount rate (for NPV)	7%		7%	
Hours/Shift & Shifts/day	7.6 Hrs	1	7.6 Hrs	2
Chain speed (#/min) & #/day	8.0	3,648 Hd	13.5	12,312 Hd
Weeks of operation/year	48		48	
Annual number of head	875,520		2,954,880	

6.0 Discussion

The development of the Veritide technology into a range of scanning systems for use at different points in the chain provides opportunities for the entire red meat processing industry to revolutionise the identification, treatment and record keeping around carcase contamination and maintenance of safe food processes. The opportunities include identification in real time, as opposed to swabs which come back hours/days later. The benefits of real time feedback are numerous including identifying immediate issues, process, procedure, equipment issues. The early identification and removal of faecal matter reduces cross contamination further down the chain improving shelf life and food safety while reducing risk in regard to product recall and or loss of market access.

The positive benefits of use could include a digital audit trail with future cooperation recommended between Industry, AMPC and DAFF inspectors. The trials undertaken in this project demonstrate that processing plants are now able to identify and manage issues in a more proactive way than is currently possible. The Meat Modernisation Working Group, formed between industry and the Department to accelerate the modernisation of the Australian Export Meat Inspection System (AEMIS) commissioned a high-level digital transformation roadmap. A snapshot of that roadmap has been included in Figure 3. The current Veritide technology and digital capability has the potential to be integrated into Australian processing plants in a way that could address all 7 items in the AEMIS roadmap highlighted in the figure.

The risk in implementing a system which is fully automated and has far greater accuracy than the current visual inspection is the temptation to increase compliance requirements at great cost to industry, without necessarily increasing food safety. It is recommended a baseline/benchmark be established with the Veritide system that calibrates detection sensitivity to the current industry standards which ensure bacterial loads are well within those required for safe food consumption. To develop this benchmark system it is recommended that AMPC work with processors to help build a constructive system which supports improved inspection processes and can aid in the digital transformation reforms already agreed between Industry and the Department.

Recommendations on how this could be initiated are outlined in the next section.

Figure 3: The red-meat industry and Daff's collaborative vision for modernisation of risk-based regulation of the supply chain

7.0 Conclusions / Recommendations

In conclusion this project identified the immediate value propositions created through utilising the Veritide technology to identify in real time chlorophyll-based contamination which is the main source of E. coli and other bacteria.

Direct Processing Benefits - undertaken through trials in Australian plants in collaboration with AMPC demonstrate immediate value from the Veritide technology in the following areas:

- Carcase inspection and trimming
- Extension of shelf-life impacting freight costs, product value and reducing wastage
- Reduction in downgrade or disposal due to presumptive E-coli testing
- Reducing risk of zero tolerance incidents
- Labour saving
- More effective training of staff
- Yield savings due to reduced carcase inspection trimming

Return on investment is less than 12 months – giving a solid payback on capital expenditure including plant integration costs. The value created has a net per head benefit of between $0.65 and $0.70 for sheep depending on the plants supply channels, market access and product mix.

Veritide's technology development roadmap has far reaching impact - to further develop the benefits including automated removal of contamination, digital analytics (to informing inspection effectiveness, worker skill, process control, livestock variation etc.), and benchmark reporting all have far reaching benefits for the Australian red-meat industry. Furthermore, the technology appears to be an enabler to support inspection reform including benefits for market access between countries in the future.

Further research has greater benefit for the wider industry - This project was a preliminary trial and validated that the technology can differentiate clean and dirty areas accurately on Australian sheep carcases. Further validation is required to build underpinning baseline calibration standards if the potential value for industry is to be realised. Given plant processes are intertwined with Department Inspection requirements, and with international market access and overseas inspection policies, it is recommended that a more holistic industry-based approach is undertaken to integration of the Veritide Technology.

Five areas of work have been identified and described below that support wider industry benefit.

Research Area 1: Baseline detection standard established to calibrate Veritide technology and integrate with appropriate data management strategies

Purpose: Auditing, real time feedback and continuous improvement in a controlled environment. This project or components of the project should consider how to integrate directly with the AEMIS Meat Modernisation Working Group and consider how this could directly support the programs objectives.

Result 1: A baseline system established

It is recommended a baseline / benchmark system be established for red meat processing facilities. The Veritide technology is superior to the current visual inspection system and will identify contaminants at a much more detailed level than required to meet approved safe food inspection requirements. The Veritide system should be calibrated to deliver the same, or slightly better accuracy than current approved standards.

Activities will include

(1) identifying how many contaminants are picked up by the Veritide technology which aren't picked up by the current system,

(2) identifying which and where contaminants are not picked up by the Veritide technology but are picked up by the current system,

(3) developing a baseline which becomes the "zero" when using the Veritide technology,

(4) developing new protocols and procedures for use of the Veritide technology which are accepted by QA inspectors and customers – for example visual inspection is now only required on inside flaps rather than the whole carcase as the technology only scans the surface and can't see under folded skin.

Result 2: Development and utilisation of real time feedback and continuous improvement for QA, HR and Operations managers

The installation of the Veritide technology generates new data for the processing facility. Data in itself isn't useful and needs to be converted into information to help make decisions. The information generated is of interest across the processing plant including QA and HR departments as well as production, operations and processing managers.

This project identified, in collaboration with departmental managers at plant, a number of ways that the information from Veritide could be used to support business operations beyond the direct inspection process. These include new approaches to training and real-time feedback. Research is needed to understand who (which department, position, person) needs what data, how frequently it is needed, and in what form the data and information should be presented in for the appropriate decisions and interventions to be made in a timely manner.

The new data and information generated provides an opportunity to upgrade and change processes and procedures on the floor, with interventions and continuous improvement processes. Research is needed to identify which policies, procedures, processes and interventions the new information will impact. Assistance will be needed to support the utilisation of the information within the plant including training materials, revision of policies and procedures together with the development and implementation of new training materials for staff. It is possible that processing plants will be able to identify and manage issues in a more proactive way than is currently possible. However, part of the research is determining where focus should be prioritised, and value could be realised.

Activities could include:

(1) Mapping data generated and information flows – current and future (who needs what, when, why, how often)
(2) Identification and updated undertaken to policies, procedures, processes and interventions as a result of the data collection and new information available which supports data based decisioning.
(3) Developing training materials and training programs to support utilisation of information to help support data-based decisions
(4) Mentoring and support in development of a positive continuous improvement process to enhance adoption and utilisation of technology and information within the processing plant and the entire supply chain.
(5) Depending on the findings above, consider the application of technologies like augmented reality glasses to support operational staff in the above contexts.

Result 3: Managing the flow and usage of data and information generated from the Veritide technology

The generation of new data creates opportunities within a business however it also creates risks which need to be identified, understood and managed. Protocols (as per Result 1) need to be in place to ensure the data which provides additional details do not negatively impact on QA standards, QA reporting and market access. It is imperative the flow and usage of the data and information generated from the Veritide technology is validated and third parties using and accessing the data understand the baseline and improved accuracy. The Australian red-meat industry has the opportunity to further strengthen its world class hygiene standards by enabling continuous process improvement with Veritide' s real-time feedback.

Industry needs to carefully plan and consider how the data could be used and shared. Positive benefits of use could include a digital audit trail for individual carcase inspection and a digital audit trail for QA inspections. The digital audit trail feedback will be more detailed, accurate and up to date than the current processes.

Activities could include:

(1) Sensitisation and consultation with government officials on the development and application of the new technology
(2) Design, implement and review (the risks and benefits) of a system for QA reporting used internally and with external third-party inspectors.
(3) Recommendations on how to facilitate collaboration, coordination and overall QA system, reporting and inspection improvements between auditors, government agencies, importing countries and inspectors.

Research Area 2: In plant development and validation of Veritide system location(s) and uses

Veritide technology can scan at different points in the chain which provides opportunities for the entire red meat processing industry to revolutionise the identification, treatment and record keeping around carcase contamination. The benefits of real time feedback are numerous including identifying immediate process, procedural, equipment and staff training issues. The early identification and removal of faecal matter reduces cross contamination further down the chain improving shelf life and food safety while reducing risk in regard to product recall and or loss of market access.

Possible project:

Carcase scanners will be installed in the chain at the normal inspection site, coming out of the chiller and (handheld or fixed) scanners will be used for high-risk cuts e.g. shanks. Handheld and fixed scanners will be used at multiple locations in the chain for example at offal stations to see what additional benefits there might be for multiple scanning locations. Potential uses of the technology will be explored for the different points in the chain to validate if suitable and or useful. Processing plants will not adopt the technology until the cost benefits are validated and understood. This project will measure and financially quantify the economic, labour, shelf life, market access benefits as a result of using the Veritide technology. The project will also identify perceived and actual barriers to adoption at a plant level and what is required to overcome these barriers.

Research questions:

RQ 1: What technology applied in what location in the chain provides the best feedback to reduce faecal contamination at a (1) carcase and (2) cut / product level?

RQ 2: What quantifiable benefits at the plant and chain level were observed from the installation and use of Veritide technology at the different points in the chain?

RQ 3: What is the cost benefit analysis for using the technology on carcases, specific cuts and other (plant/equipment contamination)?

RQ 4: What were the barriers to adoption from a people and infrastructure perspective and how where they overcome at a plant level?

Research Area 3: Define operational efficiency opportunities enabled by Veritide

Within the plant there are opportunities to improve operational efficiencies with some tweaking of plant design and or current processes. The project will investigate and validate gains and how these can be achieved. Gain creators to be reviewed include:

- Identifying what impacts the contamination levels (type of stock, where stock are bought from, treatment pre-slaughter, activities on the chain, different techniques used or available).
- Identification of the entry points of contamination to develop new systems and processes
- Can all trimming be done prior to HSCW scale (early in the chain to reduce cross contamination), thereby reducing labour costs and increasing confidence in contaminate free carcases.
- Can the technology be used to scan belts for contamination during the shift
- Impact on training and possibility to provide specific (re-)training, with immediate feedback
- A second chain where carcases with certain level of contamination are (automatically) transferred to enable specialist treatment (hot washing, additional time to remove contamination) and the benefit/cost of this additional intervention
- Real time information reporting to line supervisors, plant and production managers with an alert system if levels are beyond acceptable.

Research Area 4: Develop Veritide automated inspection and automated carcase cleaning

Removing contamination from carcases is still a laborious process, even after Veritide inspection identifies what parts of carcases require trimming of contaminants. The Veritide system contains x/y/z coordinates for each carcase scanned, and the locations in that 3D matrix that require cleaning. The project proposes to investigate how this 3D data could be used to drive some form of automation that removes contaminates.

Activities to be undertaken in the project include:

(1) Determine how carcases could be presented on the carcase chain in the correct orientation to a 3D grid that retains carcases coordinates and can direct some form of intervention to the correct location accurately.
(2) Trial a number of decontamination methods to determine their effectiveness in contaminate removal, including for example laser, hot water jet, robotic knife or some other interventions.
(3) Consider carcase chain orientation required to reject contaminated carcases onto another rail, stabilise and treat, and whether further inspection is necessary.
(4) Underpin development with cost benefit scenarios so they are commercially viable for widespread adoption.

8.0 Bibliography

Included in the full Greenleaf Report Appended separately

9.0 Appendices

9.1 Appendix – Independent Microbial Test Results

The following independent microbial test results indicate that Veritide identifies and differentiates between carcase tissue that carries a bacterial load (including E. coli) and tissue that has low microbial load.

Table 11: Control Carcase Sample Swabs - Identified by Veritide as clean

[redacted]

NATA
WORLD RECOGNISED ACCREDITATION

All tests have been conducted in accordance with the procedures detailed in the laboratory manual according to Australian Standards and AOAC requirements.
TVC: AOAC 990.12 E.coli/ Coliform: AOAC 991.14 Salmonella: AS 5013.10 - 2004
Results pertain only samples as received and tested in the laboratory.

[redacted]

Breakdown samples- control
Certificate ID: 230622
For the Day of: 23/06/2022
Reported on: 26/06/2022
Establishment Name and Number:
Address:

Laboratory Number	Kill Date	Swab Collection Date	Swab Collection Time	Temp. at Arrival Arrival	Test Performed Date	Lot No.	Species and Body No.	TVC CFU/ sq cm	E.coli CFU/ sq cm	Coliform CFU/ sq cm	Salmonella spp. Pass/ Fail	Initial
115357	23/06/2022	23/06/2022	7.30	2.3	23/06/2022	control	Lamb 1	1.7	<0.33	<0.33	N/A	ZN
115358	23/06/2022	23/06/2022	8.15	2.3	23/06/2022	control	Lamb 10	0.3	<0.33	<0.33	N/A	ZN
115359	23/06/2022	23/06/2022	8.20	2.3	23/06/2022	control	Lamb 11	9.0	<0.33	<0.33	N/A	ZN
115360	23/06/2022	23/06/2022	8.25	2.3	23/06/2022	control	Lamb 12	86.7	9.30	<0.33	N/A	ZN
115361	23/06/2022	23/06/2022	8.30	2.3	23/06/2022	control	Lamb 13	2.0	<0.33	<0.33	N/A	ZN
115362	23/06/2022	23/06/2022	8.35	2.3	23/06/2022	control	Lamb 14	17.7	<0.33	<0.33	N/A	ZN
115363	23/06/2022	23/06/2022	8.40	2.3	23/06/2022	control	Lamb 15	9.7	<0.33	<0.33	N/A	ZN
115364	23/06/2022	23/06/2022	8.45	2.3	23/06/2022	control	Lamb 16	11.3	2.30	<0.33	N/A	ZN
115365	23/06/2022	23/06/2022	8.50	2.3	23/06/2022	control	Lamb 17	9.3	<0.33	<0.33	N/A	ZN
115366	23/06/2022	23/06/2022	8.55	2.3	23/06/2022	control	Lamb 18	120.0	<0.33	<0.33	N/A	ZN
115367	23/06/2022	23/06/2022	9.00	2.3	23/06/2022	control	Lamb 19	1.0	<0.33	<0.33	N/A	ZN
115368	23/06/2022	23/06/2022	7.35	2.3	23/06/2022	control	Lamb 2	38.0	0.33	<0.33	N/A	ZN
115369	23/06/2022	23/06/2022	9.05	2.3	23/06/2022	control	Lamb 20	80.0	6.00	1.70	N/A	ZN
115370	23/06/2022	23/06/2022	9.10	2.3	23/06/2022	control	Lamb 21	15.7	<0.33	0.70	N/A	ZN
115371	23/06/2022	23/06/2022	9.15	2.3	23/06/2022	control	Lamb 22	24.3	0.33	0.33	N/A	ZN
115372	23/06/2022	23/06/2022	9.20	2.3	23/06/2022	control	Lamb 23	1.0	<0.33	<0.33	N/A	ZN
115373	23/06/2022	23/06/2022	9.25	2.3	23/06/2022	control	Lamb 24	5.0	0.33	<0.33	N/A	ZN
115374	23/06/2022	23/06/2022	9.30	2.3	23/06/2022	control	Lamb 25	9.3	<0.33	<0.33	N/A	ZN
115375	23/06/2022	23/06/2022	7.40	2.3	23/06/2022	control	Lamb 3	17.0	<0.33	<0.33	N/A	ZN
115376	23/06/2022	23/06/2022	7.45	2.3	23/06/2022	control	Lamb 4	25.3	<0.33	<0.33	N/A	ZN
115377	23/06/2022	23/06/2022	7.50	2.3	23/06/2022	control	Lamb 5	126.7	0.70	<0.33	N/A	ZN
115378	23/06/2022	23/06/2022	7.55	2.3	23/06/2022	control	Lamb 6	32.0	<0.33	<0.33	N/A	ZN
115379	23/06/2022	23/06/2022	8.00	2.3	23/06/2022	control	Lamb 7	13.7	<0.33	<0.33	N/A	ZN
115380	23/06/2022	23/06/2022	8.05	2.3	23/06/2022	control	Lamb 8	42.0	<0.33	<0.33	N/A	ZN
115381	23/06/2022	23/06/2022	8.10	2.3	23/06/2022	control	Lamb 9	28.7	<0.33	<0.33	N/A	ZN

Breakdown samples- control 2
Certificate ID: 230622
For the Day of: 23/06/2022
Reported on: 27/06/2022
Establishment Name and Number:
Address:

Laboratory Number	Kill Date	Swab Collection Date	Swab Collection Time	Temp. at Arrival Arrival	Test Performed Date	Lot No.	Species and Body No.	TVC CFU/ sq cm	E.coli CFU/ sq cm	Coliform CFU/ sq cm	Salmonella spp. Pass/ Fail	Initial
115388	23/06/2022	23/06/2022	8.30	2.3	23/06/2022	control	Lamb 26	186.7	1.00	1.30	N/A	ZN
115389	23/06/2022	23/06/2022	8.35	2.3	23/06/2022	control	Lamb 27	2.0	0.33	<0.33	N/A	ZN
115390	23/06/2022	23/06/2022	8.40	2.3	23/06/2022	control	Lamb 28	3.3	<0.33	<0.33	N/A	ZN
115391	23/06/2022	23/06/2022	8.45	2.3	23/06/2022	control	Lamb 29	<0.3	<0.33	<0.33	N/A	ZN
115392	23/06/2022	23/06/2022	8.50	2.3	23/06/2022	control	Lamb 30	3.0	<0.33	<0.33	N/A	ZN

Table 12: Dirty Carcase Sample Swabs - Identified by Veritide as requiring trimming

Breakdown samples 2 — **Establishment Name and Number:** — **Address:**

Certificate ID: 230622
For the Day of: 23/06/2022
Reported on: 26/06/2022

Laboratory Number	Kill Date	Swab Collection Date	Swab Collection Time	Temp. at Arrival Arrival	Test Performed Date	Lot No.	Species and Body No.	TVC CFU/ sq cm	E.coli CFU/ sq cm	Coliform CFU/ sq cm	Salmonella spp. Pass/ Fail	Initial
115382	23/06/2022	23/06/2022	8.30	2.3	23/06/2022	Sample	Lamb 26	180.0	60.00	46.70	N/A	ZN
115383	23/06/2022	23/06/2022	8.35	2.3	23/06/2022	Sample	Lamb 27	140.0	0.33	<0.33	N/A	ZN
115384	23/06/2022	23/06/2022	8.40	2.3	23/06/2022	Sample	Lamb 28	246.7	53.30	53.30	N/A	ZN
115385	23/06/2022	23/06/2022	8.45	2.3	23/06/2022	Sample	Lamb 29	73.3	3.00	2.30	N/A	ZN
115386	23/06/2022	23/06/2022	8.50	2.3	23/06/2022	Sample	Lamb 30	86.7	8.00	2.00	N/A	ZN

Breakdown samples — **Establishment Name and Number:** — **Address:**

Certificate ID: 230622
For the Day of: 23/06/2022
Reported on: 26/06/2022

Laboratory Number	Kill Date	Swab Collection Date	Swab Collection Time	Temp. at Arrival Arrival	Test Performed Date	Lot No.	Species and Body No.	TVC CFU/ sq cm	E.coli CFU/ sq cm	Coliform CFU/ sq cm	Salmonella spp. Pass/ Fail	Initial
115332	23/06/2022	23/06/2022	7.30	2.3	23/06/2022	Sample	Lamb 1	86.7	3.00	0.70	N/A	ZN
115333	23/06/2022	23/06/2022	8.15	2.3	23/06/2022	Sample	Lamb 10	240.0	<0.33	<0.33	N/A	ZN
115334	23/06/2022	23/06/2022	8.20	2.3	23/06/2022	Sample	Lamb 11	42.0	<0.33	<0.33	N/A	ZN
115335	23/06/2022	23/06/2022	8.25	2.3	23/06/2022	Sample	Lamb 12	200.0	<0.33	<0.33	N/A	ZN
115336	23/06/2022	23/06/2022	8.30	2.3	23/06/2022	Sample	Lamb 13	260.0	<0.33	<0.33	N/A	ZN
115337	23/06/2022	23/06/2022	8.35	2.3	23/06/2022	Sample	Lamb 14	120.0	3.70	<0.33	N/A	ZN
115338	23/06/2022	23/06/2022	8.40	2.3	23/06/2022	Sample	Lamb 15	73.3	<0.33	<0.33	N/A	ZN
115339	23/06/2022	23/06/2022	8.45	2.3	23/06/2022	Sample	Lamb 16	286.7	93.30	40.00	N/A	ZN
115340	23/06/2022	23/06/2022	8.50	2.3	23/06/2022	Sample	Lamb 17	246.7	76.60	58.60	N/A	ZN
115341	23/06/2022	23/06/2022	8.55	2.3	23/06/2022	Sample	Lamb 18	220.0	86.70	33.30	N/A	ZN
115342	23/06/2022	23/06/2022	9.00	2.3	23/06/2022	Sample	Lamb 19	73.3	0.33	<0.33	N/A	ZN
115343	23/06/2022	23/06/2022	7.35	2.3	23/06/2022	Sample	Lamb 2	173.3	<0.33	<0.33	N/A	ZN
115344	23/06/2022	23/06/2022	9.05	2.3	23/06/2022	Sample	Lamb 20	220.0	96.70	15.00	N/A	ZN
115345	23/06/2022	23/06/2022	9.10	2.3	23/06/2022	Sample	Lamb 21	39.3	0.33	<0.33	N/A	ZN
115346	23/06/2022	23/06/2022	9.15	2.3	23/06/2022	Sample	Lamb 22	260.0	120.00	13.30	N/A	ZN
115347	23/06/2022	23/06/2022	9.20	2.3	23/06/2022	Sample	Lamb 23	193.3	60.00	10.00	N/A	ZN
115348	23/06/2022	23/06/2022	9.25	2.3	23/06/2022	Sample	Lamb 24	120.0	4.30	<0.33	N/A	ZN
115349	23/06/2022	23/06/2022	9.30	2.3	23/06/2022	Sample	Lamb 25	16.7	<0.33	<0.33	N/A	ZN
115350	23/06/2022	23/06/2022	7.40	2.3	23/06/2022	Sample	Lamb 3	186.7	0.70	<0.33	N/A	ZN
115351	23/06/2022	23/06/2022	7.45	2.3	23/06/2022	Sample	Lamb 4	286.7	0.70	0.70	N/A	ZN
115352	23/06/2022	23/06/2022	7.50	2.3	23/06/2022	Sample	Lamb 5	260.0	2.30	1.30	N/A	ZN
115353	23/06/2022	23/06/2022	7.55	2.3	23/06/2022	Sample	Lamb 6	120.0	<0.33	<0.33	N/A	ZN
115354	23/06/2022	23/06/2022	8.00	2.3	23/06/2022	Sample	Lamb 7	113.3	18.70	6.00	N/A	ZN
115355	23/06/2022	23/06/2022	8.05	2.3	23/06/2022	Sample	Lamb 8	140.0	<0.33	0.70	N/A	ZN
115356	23/06/2022	23/06/2022	8.10	2.3	23/06/2022	Sample	Lamb 9	260.0	<0.33	<0.33	N/A	ZN

Note in both sets of sample swabs, detected TVC, Coliform, and in some cases E.coli was much greater where Veritide identified the need for trimming (Table 12) than in the control samples (Table 11) where Veritide identified carcase surfaces as clean.

Appendix 9.2 – Shelf-life Benefit Scenario Assumptions and Calculations

Sheep Assumptions

							Market Access Value						hort Life Export Freezing		Markdowns				Freight Saving		Presumptive	
Item	Yield %	Kg's/CCW	Export Share %	Domestic Share	Portion of Export Markets Lost	Predominantly Chilled	$/kg Export Market (Chilled)	$/kg Export Market (Frozen)	Domestic Market $/kg	Market Access Price Differential	Current Shelf Life	Potential Shelf Life	Risk of Freezing Export Chilled (Short Shelf Life)	Frozen Price Differential	Client Markdown $/kg	Client % Markdown	Reduced Markdowns	Reduced Markdown Value ($/kg)	Pdct % Airfreight (% decrease w/ shelf life increase)	Airfreight $/kg Differential	E.coli Presumptive Downgrade	
Assumptions			75%		25%			70%	90%				10%		25%	10%	25%		20%	$ 1.73	0.254%	
																			50%			
Neck	2.3%	0.50	75.0%	25.0%	25.0%		$ 7.19	$ 7.19	$ 6.47	$ 0.07			-	$ -	-	10.0%	25.0%	$ -	-	$ 0.09		-
Neck Bone	2.0%	0.43	75.0%	25.0%	25.0%		$ 7.39	$ 7.39	$ 6.65	$ 0.06			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Neck Fillet Roast	1.5%	0.32	75.0%	25.0%	25.0%		$ 20.26	$ 20.26	$ 18.23	$ 0.12			-	$ -	-	10.0%	25.0%	$ -	-	-		-
B/L Square Cut Shoulder	6.6%	1.44	75.0%	25.0%	25.0%	Y	$ 15.13	$ 10.59	$ 13.62	$ 0.41			10%	$ 4.54	$ 3.78	10.0%	25.0%	$ 0.09	50%	$ 0.25		-
Shoulder Square Cut B/IN	12.5%	2.75	75.0%	25.0%	25.0%		$ 8.53	$ 8.53	$ 7.68	$ 0.44			-	$ -	-	10.0%	25.0%	$ -	-	-		-
B/L Shoulder Oyster cut	0.7%	0.15	75.0%	25.0%	25.0%	Y	$ 13.39	$ 9.37	$ 12.05	$ 0.04			10%	$ 4.02	$ 3.35	10.0%	25.0%	$ 0.08	50%	$ 0.03		-
B/L Shoulder Rolled	0.1%	0.01	75.0%	25.0%	25.0%		$ 14.93	$ 14.93	$ 13.44	$ 0.00			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Shoulder Meat Pieces	2.7%	0.60	75.0%	25.0%	25.0%		$ 8.97	$ 8.97	$ 8.07	$ 0.10			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Foreshank	3.7%	0.81	75.0%	25.0%	25.0%	Y	$ 10.13	$ 7.09	$ 9.12	$ 0.15	75	95	10%	$ 3.04	$ 2.53	10.0%	25.0%	$ 0.06	50%	$ 0.14		-
Breast and Flap	0.2%	0.04	75.0%	25.0%	25.0%		$ 6.99	$ 6.99	$ 6.29	$ 0.00			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Breast and Flap Pieces	8.8%	1.94	75.0%	25.0%	25.0%		$ 10.41	$ 10.41	$ 9.36	$ 0.38			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Flap - 8 Rib	4.3%	0.94	75.0%	25.0%	25.0%		$ 11.56	$ 11.56	$ 10.41	$ 0.20			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Rib Set	0.7%	0.16	75.0%	25.0%	25.0%		$ 7.96	$ 7.96	$ 7.16	$ 0.02			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Thick Skirt & Thin Skirt	0.6%	0.12	75.0%	25.0%	25.0%		$ 8.55	$ 8.55	$ 7.69	$ 0.02			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Spare Ribs 8 Rib	0.2%	0.05	75.0%	25.0%	25.0%		$ 15.01	$ 15.01	$ 13.51	$ 0.01			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Rack Cap On - Frenched 8 Rib	5.9%	1.30	75.0%	25.0%	25.0%	Y	$ 32.08	$ 22.46	$ 28.87	$ 0.78			10%	$ 9.62	$ 8.02	10.0%	25.0%	$ 0.20	50%	$ 0.22		-
Rack Cap On 8 Rib	0.4%	0.09	75.0%	25.0%	25.0%	Y	$ 27.07	$ 18.95	$ 24.36	$ 0.05			10%	$ 8.12	$ 6.77	10.0%	25.0%	$ 0.17	50%	$ 0.02		-
B/L Rack Cap	0.9%	0.20	75.0%	25.0%	25.0%		$ 4.78	$ 4.78	$ 4.31	$ 0.02			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Back Bone	1.4%	0.30	75.0%	25.0%	25.0%		$ 3.66	$ 3.66	$ 3.30	$ 0.02			-	$ -	-	10.0%	25.0%	$ -	-	-		-
B/L Short Loin	1.5%	0.33	75.0%	25.0%	25.0%	Y	$ 32.12	$ 22.48	$ 28.91	$ 0.20			10%	$ 9.64	$ 8.03	10.0%	25.0%	$ 0.20	50%	$ 0.06		-
Short Loin - 1 Rib	1.1%	0.24	75.0%	25.0%	25.0%	Y	$ 16.50	$ 11.55	$ 14.85	$ 0.07			10%	$ 4.95	$ 4.13	10.0%	25.0%	$ 0.10	50%	$ 0.04		-
Short Loin Pair	0.3%	0.07	75.0%	25.0%	25.0%	Y	$ 16.24	$ 11.37	$ 14.61	$ 0.02			10%	$ 4.87	$ 4.06	10.0%	25.0%	$ 0.10	50%	$ 0.01		-
Short Loin Pair - 1 Rib	0.9%	0.21	75.0%	25.0%	25.0%	Y	$ 13.47	$ 9.43	$ 12.12	$ 0.05			10%	$ 4.04	$ 3.37	10.0%	25.0%	$ 0.08	50%	$ 0.04		-
Backstrap Membrane	0.1%	0.02	75.0%	25.0%	25.0%		$ 5.57	$ 5.57	$ 5.01	$ 0.00			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Tenderloin	0.5%	0.10	75.0%	25.0%	25.0%	Y	$ 21.90	$ 15.33	$ 19.71	$ 0.04			10%	$ 6.57	$ 5.47	10.0%	25.0%	$ 0.14	50%	$ 0.02		-
Rump	1.2%	0.27	75.0%	25.0%	25.0%	Y	$ 18.23	$ 12.76	$ 16.41	$ 0.09			10%	$ 5.47	$ 4.56	10.0%	25.0%	$ 0.11	50%	$ 0.05		-
Chump B/In	2.2%	0.49	75.0%	25.0%	25.0%		$ 6.78	$ 6.78	$ 6.10	$ 0.06			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Leg Femur Bone Chump Off	2.0%	0.44	75.0%	25.0%	25.0%	Y	$ 12.58	$ 8.80	$ 11.32	$ 0.10			10%	$ 3.77	$ 3.14	10.0%	25.0%	$ 0.08	50%	$ 0.08		-
Leg Chump Off ABO	1.6%	0.35	75.0%	25.0%	25.0%	Y	$ 11.82	$ 8.28	$ 10.64	$ 0.08			10%	$ 3.55	$ 2.96	10.0%	25.0%	$ 0.07	50%	$ 0.06		-
Leg Chump Off	8.3%	1.83	75.0%	25.0%	25.0%	Y	$ 9.45	$ 6.61	$ 8.50	$ 0.32			10%	$ 2.83	$ 2.36	10.0%	25.0%	$ 0.06	50%	$ 0.32		-
B/L Leg Chump Off Shank Off	7.9%	1.73	75.0%	25.0%	25.0%	Y	$ 13.93	$ 9.75	$ 12.54	$ 0.45			10%	$ 4.18	$ 3.48	10.0%	25.0%	$ 0.09	50%	$ 0.30		-
B/L Leg Chump On	0.3%	0.06	75.0%	25.0%	25.0%	Y	$ 17.79	$ 12.45	$ 16.01	$ 0.02			10%	$ 5.34	$ 4.45	10.0%	25.0%	$ 0.11	50%	$ 0.01		-
Leg Chump On ABO	0.5%	0.12	75.0%	25.0%	25.0%	Y	$ 11.41	$ 7.99	$ 10.27	$ 0.03			10%	$ 3.42	$ 2.85	10.0%	25.0%	$ 0.07	50%	$ 0.02		-
Leg Mixed Cuts	0.6%	0.14	75.0%	25.0%	25.0%		$ 7.32	$ 7.32	$ 6.59	$ 0.02			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Leg Shank Bone	0.2%	0.05	75.0%	25.0%	25.0%		$ 9.86	$ 9.86	$ 8.88	$ 0.01			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Leg Bones	3.4%	0.75	75.0%	25.0%	25.0%		$ 3.62	$ 3.62	$ 3.26	$ 0.05			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Leg Tip	0.9%	0.20	75.0%	25.0%	25.0%		$ 6.36	$ 6.36	$ 5.72	$ 0.02			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Hindshank	2.4%	0.52	75.0%	25.0%	25.0%	Y	$ 10.54	$ 7.38	$ 9.49	$ 0.10			10%	$ 3.16	$ 2.64	10.0%	25.0%	$ 0.07	50%	$ 0.09		-
Carcase 6 Way	0.2%	0.04	75.0%	25.0%	25.0%		$ 9.40	$ 9.40	$ 8.46	$ 0.01			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Assorted Cuts	0.0%	0.01	75.0%	25.0%	25.0%		$ -	$ -	$ -	$ -			-	$ -	-	10.0%	25.0%	$ -	-	-	Y	$0.0000
Bone	2.8%	0.62	75.0%	25.0%	25.0%		$ 5.81	$ 5.81	$ 5.22	$ 0.07			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Trimmings	3.9%	0.86	75.0%	25.0%	25.0%		$ 6.12	$ 6.12	$ 5.51	$ 0.10			-	$ -	-	10.0%	25.0%	$ -	-	-	Y	$0.0100
Render			75.0%	25.0%	25.0%		$ -	$ -	$ -	$ -			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Commercial value of Defect Trim			75.0%	25.0%	25.0%		$ -	$ -	$ -	$ -			-	$ -	-	10.0%	25.0%	$ -	-	-		-
Value Created / Head	**57%**	**21.58**				**10.05**		**$193.09**	**$ 57.93**	**$ 1.10**				**$ 3.61**	**$ 40.15**			**$ 1.00**		**$ 0.76**		**$ 0.010**
						46.6%		**$251.02**		**0.4%**					16%			0.4%				

Appendix 9.3: SHEEP Sensitivity modelling of value realisable (Right Column = Total Supply Chain Value that could be generated with retail customers)

SHEEP INSTALLATION			
BluMax Manual System (2 x wide angle units installed)			Potential S.C. Benefit
	Small Volume Plant	High Volume Plant	High Volume Plant
Total Cap Ex (incl. Installation)	**$361,000**	**$361,000**	**$361,000**
Gross return Per head	**$0.74**	**$0.74**	**$3.43**
Total costs Per head	**$0.10**	**$0.04**	**$0.04**
Net Benefit Per head	**$0.65**	**$0.70**	**$3.39**
Annual Net Benefit (Plant / Supply Chain)	$568,313	$2,075,501	$10,005,534
Pay back years	**0.64**	**0.17**	**0.04**
Net Present Value (15 yrs.)	$2,989,497	$10,858,561	

Plant Specific Drivers						
	Small Volume Plant		High Volume Plant		High Volume SUPPLY CHAIN	
Useful working life	7		7		7	
Discount rate (for NPV)	7%		7%		7%	
Hours/Shift & Shifts/day	7.6 Hrs	1	7.6 Hrs	2	7.6 Hrs	2
Chain speed (#/min) & #/day	8.0	3,648 Hd	13.5	12,312 Hd	13.5	12,312 Hd
Weeks of operation/year	48		48		48	
Annual number of head	875,520		2,954,880		2,954,880	

Drivers									
			Small Volume Plant		High Volume Plant			High Volume Plant	
Item	**Description**		**$/hd**	**$/ annum**	**$/hd**	**$/ annum**		**$/hd**	**$/ annum**
Product Benefits	Pre-Boning Room Trim -	100%	$0.09	$75,312	$0.09	$254,177	100%	$0.09	$254,177
	Airfreight $/kg Differential	25%	$0.02	$13,274	$0.02	$44,800	100%	$0.06	$179,201
	Market Access Price Differential	0%	$0.00	$0	$0.00	$0	100%	$1.10	$3,257,318
	Short Life Export Freezing	25%	$0.45	$395,502	$0.45	$1,334,819	100%	$1.81	$5,339,274
	Markdowns	0%	$0.00	$0	$0.00	$0	100%	$0.18	$519,096
	Presumptive Downgrades	50%	$0.00	$4,374	$0.00	$14,763	100%	$0.01	$29,526
	Other		$0.00	$0	$0.00	$0		$0.00	$0
Operational Benefits	Labour		$0.18	$158,719	$0.18	$535,678		$0.18	$535,678
	Training & recruitment		$0.00	$4,356	$0.00	$8,712		$0.00	$8,712
	OH&S		$0.000	$0	$0.000	$0		$0.000	$0
	Existing operational costs		$0.000	$0	$0.000	$0		$0.000	$0
Total Benefits			**$0.74**	**$651,537**	**$0.74**	**$2,192,949**		**$3.43**	**$10,122,982**
System Costs	Capital Cost		$0.06	$49,000	$0.02	$49,000		$0.02	$49,000
	Service / maintenance		$0.04	$34,224	$0.02	$68,448		$0.02	$68,448
				$0		$0			$0
Total Annual Costs			**$0.10**	**$83,224**	**$0.04**	**$117,448**		**$0.04**	**$117,448**
Net Annual Benefit			**$0.65**	**$568,313**	**$0.70**	**$2,075,501**		**$3.39**	**$10,005,534**