Final Report

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AUSTRALIAN MEAT PROCESSOR CORPORATION

Behavioural Change Assessment for AI Monitoring of Animal Welfare

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1.0 Abstract

This project assessed whether AI-assisted welfare monitoring in a commercial beef processing facility led to measurable changes in animal handling and welfare outcomes. Monitoring provided a more complete view of handling practices than intermittent observation and revealed patterns that staff had not previously recognised. No sustained change in handling behaviour was measured, but the improvement in visibility was a useful outcome in its own right.

The main benefit was helping people see what was happening across the operation. Computer vision applied to CCTV footage, equipment sensors and operator records enabled that visibility. Their value lay in the information they provided and how staff could use it to investigate events, identify patterns and decide where to intervene. The technology supported staff observation and judgement. It did not replace the people responsible for animal welfare.

Businesses seeking better visibility do not need to wait for computer vision to become more reliable across every event type. Simple sensors can already provide useful event counts and timestamps at relatively low cost, while computer vision can add coverage where its performance is suitable. A relatively complete sensor set is provisionally estimated at around AUD $10,000, with installation and ongoing costs requiring confirmation. The financial case should consider the additional capability given to staff, rather than assume that monitoring will eliminate a labour position. Where assurance requirements do not call for continuous welfare data, businesses also have less external incentive to invest in that additional visibility.

The report recommends starting with the information a business needs, using practical combinations of sensors, CCTV and computer vision, and assigning staff time and responsibility to interpret and act on the findings. The Welfare Footprint Framework (WFF) is discussed as one option for assessing the impact of future changes, particularly by distinguishing brief, intense events from harms that persist during holding and lairage. Its application here is illustrative rather than a validated facility baseline.

2.0 Executive summary

Livestock welfare monitoring can extend what staff are able to observe across an operating day. This project examined whether that additional visibility changed handling practices and welfare outcomes, and what businesses could learn from the information collected.

The project examined a commercially available animal welfare AI system at an Australian cattle abattoir, building on an earlier AMPC trial (Project 2024-1093). The system combined computer vision with sensor inputs and operator records. The QA team used the information productively, and it revealed patterns that observation had missed. No sustained change in handling behaviour was measured, and engagement fell after the structured review period ended. The facility had no specific compliance gap to close, so the additional monitoring was being used to seek improvements beyond its existing assurance needs.

The central finding is that monitoring improved visibility. Technology made it possible to record more of the operation and identify where staff should look, while people supplied the context and decided how to respond. Better visibility and sustained behaviour change are distinct outcomes: the first was demonstrated here, while the second was not. This distinction should guide both technology selection and expectations of return on investment.

2.1 Key Findings

- Visibility was the main benefit. Continuous event records revealed patterns that staff and management had not recognised through intermittent observation. Reviewing footage at event timestamps helped them understand those patterns and identify possible responses. The useful outcome was the improved information available to people, rather than the use of a particular technology.
- Monitoring extends staff capability. Sensors and computer vision can widen coverage and direct attention to relevant events. Staff still need to check findings, interpret context and take action. Review workload and false positives affect the value of the system, but eliminating a staff role is not an appropriate measure of success.
- Useful visibility is available now. The most reliable event streams in this project came from sensors and operator records: goad activations, back-up captive bolt draws and logged ineffective stuns. These inputs required no vision-model training. Businesses can begin with such records while adding computer vision where it provides reliable additional information. Equipment checks and human review remain necessary.
- Timestamps helped staff find relevant footage. Sensor events narrowed the search through existing CCTV recordings, making incidents easier to investigate. Computer vision can also flag events for review where its detections are suitable for the task. The two approaches can complement each other.
- Electric goad use showed the limits of staff training alone. Short-term reductions after training were not sustained. Location-specific patterns and footage review suggested that race geometry and animal flow contributed to use in some sections.
- Visibility creates opportunities to act. Findings need to reach the people responsible for handling, maintenance and facilities. Clear management expectations and assigned responses help turn better information into operational changes; the technology does not perform that management function.
- The WFF offers one way to assess impact. It distinguishes the intensity of an experience from its duration, drawing attention to holding and lairage as well as acute events. No sustained behaviour change was measured, so this report discusses its potential use without claiming a measured welfare improvement or a validated numerical baseline.

2.2 Benefits to Industry

Businesses can gain a clearer view of their operations without waiting for comprehensive computer vision coverage. Event counts and timestamps from the stun box, back-up stunner, electric goads, receival ramp and lairage pens can reveal patterns and direct staff to relevant footage. A relatively complete sensor set is provisionally estimated at around AUD $10,000, subject to site requirements and confirmation of installation, integration and ongoing costs. This offers a practical starting point, with computer vision added where it supplies useful information that the business needs.

The benefit is greater capability for the people already responsible for welfare: wider observation, more informed investigation and a clearer basis for decisions. Section 9 sets out how to assess that value, select a practical sensor set and organise the response to findings. Section 11 recommends how assurance programs could recognise useful monitoring evidence and reduce duplicated review.

3.0 Introduction

Animal welfare at Australian export processing establishments is managed against state regulation, export requirements, the Australian Animal Welfare Certification System

(AAWCS) and retailer programs. These requirements shape assurance activity, including CCTV recording and review. Recording footage, however, does not by itself tell a business what is happening throughout the day. The distinction is between having a record available and giving staff useful visibility into that record.

A QA officer reviewing a daily sample of footage sees only part of the operating day. Computer vision can analyse CCTV footage and flag events, while equipment sensors can record activations and movements and direct staff to relevant recordings. The earlier AMPC trial (Project 2024-1093) demonstrated installation and operation of an AI-assisted system in an Australian abattoir and wider monitoring coverage. It also identified false positives, review workload and uncertainty about audit acceptance, and did not demonstrate financial savings within the six-month trial (Impetus Animal Welfare, 2025). Those findings distinguish improved monitoring capability from a demonstrated financial return.

This project asked whether continuous monitoring changes behaviour and improves welfare outcomes. The system was already in use before the August to November 2025 analysis period, and some QA staff had engaged with it consistently. This limited the ability to establish a baseline before monitoring began.

This report considers what the additional visibility enabled staff to understand and how that information was used. It then considers which technologies can provide useful information now, how they support human review and response, and why the commercial demand for additional welfare data may be limited where it is not required for assurance. Management follow-through remains necessary to achieve improvements, but its absence does not remove the informational value of seeing the operation more clearly.

The project also explored the Welfare Footprint Framework (WFF; Alonso & Schuck-Paim, 2025) as a way to assess the welfare impact of behaviour change. As no sustained change was measured, its application is presented qualitatively, with emphasis on the difference between acute events and harms that accumulate over time.

4.0 Project objectives

4.1 Achievement Against Project Objectives

The table below summarises performance against the objectives defined in AMPC Research Agreement 2026-1031 (Variation Agreement #1), based on the evidence generated in this project.

Project Objective	Outcome	Supporting Evidence
Benchmark key animal handling behaviours using Welfare Footprint Framework-aligned metrics	An illustrative WFF assessment was developed to distinguish acute events from duration-driven harms. The public report explains this approach qualitatively; facility-specific material is held in the confidential annex.	Section 8 and Appendix 2
Quantify changes in staff behaviour and welfare outcomes following AI-assisted monitoring implementation	Behavioural patterns and trends were identified. No sustained change in handling behaviour was measured, and a full pre/post comparison was constrained by the available dataset.	Section 6; confidential data annex
Validate the effectiveness of animal welfare AI as a driver for measurable welfare improvements	The system improved visibility and supported investigation of events. A sustained welfare improvement attributable to monitoring alone was not demonstrated. Interpreting findings and implementing changes remained human responsibilities.	Sections 6, 7 and 9
Demonstrate the feasibility of integrating WFF methodology into routine operational data evaluation	The project identified how timestamps and event counts could support a WFF assessment. Estimating welfare impact also requires evidence on intensity, duration and the proportion of animals affected; routine use was not validated.	Section 8
Evaluate staff performance outcomes related to animal welfare post-AI implementation to determine value to industry	The staff perception survey identified themes including workload, perception gaps and barriers to adoption. Results are indicative due to the small sample size (n = 4).	Section 7
Deliver industry guidance and a roadmap for sector-wide adoption of AI-enhanced welfare monitoring	Guidance was developed on improving operational visibility, using sensors and computer vision to support staff, assessing value without assuming labour replacement, and organising responses to findings.	Sections 9 and 11

Table 1. Achievement against project objectives.

The project generated monitoring analysis, staff feedback and industry guidance. It demonstrated improved visibility into handling patterns, but did not demonstrate sustained behaviour change or validate the system as a driver of welfare improvement. The limited pre-intervention baseline also constrained attribution. These are separate findings: monitoring helped staff understand the operation, while achieving and sustaining change required further action.

5.0 Methodology

The project used a mixed-methods retrospective data review and early-phase evaluation, comprising planning, monitoring and final evaluation. Monitoring and data collection took place from August to November 2025, when the system was fully functional and actively reviewed. The methodology comprised three components, each reported separately in the Results sections below.

5.1 Monitoring Data and Behavioural Change Analysis

The animal welfare AI system was fully operational at the facility from early 2025. As the project operated in a commercial facility with existing use of the system, this event data was incorporated into the project with the agreement of all parties. This provided a cleaner dataset than the later project period, during which engagement with the system was reduced, although it made it difficult to establish a baseline before intervention. There was also no specific animal welfare compliance gap at the facility, so behaviour change was sought to achieve better outcomes rather than to address a deficit.

The system combined CCTV-based computer vision with sensor inputs. Electric goad use was recorded by sensors fitted to each goad, back-up captive bolt use by a sensor on the bolt holder, and ineffective stuns by an operator button at the restraint box. Vision-based detections covered events such as truck arrival, cattle counts at unloading, time in pens and handling interactions.

A dedicated facility system operator validated daily detections, classified true positive events, removed false positives and added operational context notes. Fortnightly review meetings involving QA personnel, livestock management, plant management and Impetus project management provided the forum for turning detections into operational findings. The analysis assessed event trends over time, patterns by time of day and day of week, relationships between event types, and the degree to which detections were reviewed, validated and converted into corrective actions. This last measure, the conversion of detections into action, was the main indicator of whether monitoring was driving change.

5.2 Staff Perception Survey

A structured online survey (Appendix 3) was distributed to staff with direct experience of AI monitoring systems in use across the participating business. It assessed perceived usefulness and accuracy, workload impacts, attitudes toward monitoring (supportive versus punitive), confidence in the technology, and barriers to adoption and suggestions for improvement. Four responses were received. This is a small sample and results are treated as indicative themes rather than statistically representative findings.

5.3 Welfare Footprint Framework Analysis

The Welfare Footprint Framework (WFF; Alonso & Schuck-Paim, 2025) estimates the time animals spend in negative affective states at different intensities. A Pain-Track describes how an experience changes over time (Alonso & Schuck-Paim, 2021). Duration and the estimated probability of each intensity are combined, then adjusted for the proportion of animals affected. Event records are inputs to this assessment; they are not direct measurements of pain intensity.

The framework describes four intensity categories: Annoying, Hurtful, Disabling and Excruciating, reflecting increasing disruption of attention and normal functioning. Time in each category is reported separately. Assigning an experience to these categories requires evidence and explicit assumptions; a sensor count or physiological response alone does not establish an intensity category.

The WFF was included in the project design to assess the welfare impact of any behaviour change. With no sustained change measured and no validated numerical baseline presented here, Section 8 focuses on what the approach could contribute to future evaluation.

6.0 Results Part A: Monitoring Data and Behavioural Change

The results draw on a retrospective and early-phase monitoring dataset from August to November 2025, when the system was actively used and reviewed. The available data constrained a full pre/post comparison, but showed how continuous event records and targeted footage review improved staff visibility into the operation. No sustained change in handling behaviour was measured.

6.1 What the Data Showed That Observation Did Not

Before systematic monitoring, staff and management held views about handling patterns, including when goad use was highest, which operators were associated with incidents and the balance of precautionary and ineffective stuns. The records provided a more complete picture and, in several cases, challenged those expectations. This was a practical benefit of increased visibility even where a sustained change in handling was not subsequently measured.

Continuous monitoring extends the periods and locations staff can observe and helps them identify patterns across shifts and days. Computer vision and sensors can both contribute, subject to camera coverage, functioning equipment and consistent records. People still need to assess what those patterns mean.

Electric Goad Use (Day-of-Week Pattern)

Case study analysis of goad use in October 2025 identified a consistent pattern of relatively elevated goad events toward the end of the working week. This pattern, not previously identified through observation or QA spot checks, suggests a combination of factors that may include stock class variation across the week and accumulated staff fatigue. In businesses, results like these allow more targeted monitoring at the times that matter, or links between stock lines and outcomes.

Morning versus Afternoon Goad Use

Management believed the morning shift used the goad more. A week of location-specific data showed no clear difference in goad use by time of day.

Precautionary vs. Ineffective Stuns

The data provided the first reliable breakdown of re-stun events by type, distinguishing precautionary stuns (operator initiated as a precaution following a standard stun) from ineffective stuns (the stun operator's own assessment of a failed stun). Precautionary stuns showed a slight reduction from October to November 2025, while ineffective stuns remained low. The distinction matters because the cause and response to a high precautionary stun rate differ from those for a high ineffective stun rate, where there is potential for a conscious animal after the stun. Quantifying this difference is useful to support reviews od audited programs. The ineffective stun record did not come from image analysis, and it is likely that this will remain challenging to feasibly assess. It came from an operator button at the restraint box, pressed to log an ineffective stun and matched to the event by its timestamp.

Indicator	Baseline Trend (Aug–Nov 2025)	Management Action Required
Electric goad use (total)	Consistent but variable through week. No sustained reduction	Infrastructure review of high-use race sections. Staffing review for late week staff schedules or training
Excessive goad use	Directly mirrors total goad use trend	Define an escalation threshold and differentiate infrastructure from training drivers by location.
Precautionary re-stuns	Slight reduction Oct–Nov 2025	Monitor trends. Align this with stunner maintenance schedule
Ineffective stuns	Low. Consistent	Continue monitoring. No immediate intervention indicated.
Captive bolt use	Variable. Spikes identify maintenance/anomaly events	Use as an indicator of risk or operational issues; footage review is important.
Total detections	Increasing as system matures and has the capability of detecting more	Increasing detections may reflect system calibration improvement, not deteriorating welfare
Verified findings vs. detections	Slight decrease in total findings despite increasing detections	Finding rate is driven by time allocated to system review which is a management resourcing question

Table 2. Baseline trends and management actions for key indicators (August to November 2025).

6.2 Which Data Streams Were Most Reliable

Sensors and operator records supplied the most dependable event streams in this project. Goad sensors recorded activations, duration and device identity, allowing use to be linked to locations and checked against device performance. An operator button logged ineffective stuns, while a device holder sensor flagged back-up captive bolt draws for review. Each stream made a part of the operation more visible without requiring staff to observe it continuously in person.

These streams required no vision-model training and were not affected by camera lighting or position. They still depended on device function, data transmission and, for operator logs, consistent recording. In the earlier trial, almost all reviewed goad detections were confirmed, while the re-stun stream, which combined sensor inputs with vision classification, included around one false positive for every four detections (Project 2024-1093). These results support matching the technology to the event being measured, rather than treating either sensors or computer vision as sufficient for every task.

The monitoring system helped staff identify which footage to review. Human interpretation of that footage provided the context needed to investigate events and choose a response. This combination of automated records and human judgement was a main source of value.

6.3 Electric Goad Use: The Infrastructure Ceiling

Electric goad use is the clearest example in this dataset of the difference between a training problem and an infrastructure problem, and the risk of applying training-based interventions only. During the reporting period the business was working towards elimination of goad use.

The data enabled location-specific analysis, identifying that some devices were associated with higher use rates than others and that certain physical sections of the race consistently generated more goad events. Staff training was applied at periods during the project, and short-term reductions were measured following training sessions, but these reductions were not sustained.

During direct senior livestock management oversight of the race, goad use was lower and more stable. It rose again the following week, particularly towards the end of the week. Use continued even under direct oversight, suggesting that race design may have contributed alongside handling practices. These observations support further investigation rather than isolating a single cause.

Discussion with staff and management, informed by footage review, suggested that race geometry or flow design constrained cattle movement and increased the likelihood of goad use. Training can improve handling, but physical constraints may also need to be addressed.

The value of the data here was to identify the problem (by location, time of day and device), document the effect of training, and make the case for a different type of intervention. It is difficult to have the same level of confidence from spot check observation or periodic audits.

6.4 Footage Review and Knowing Where to Look

Many of the most useful findings came from staff reviewing footage at the timestamps of flagged events. The records showed where to look; footage review helped establish the circumstances. Events with the same classification could have different causes and require different responses. This illustrates how monitoring extends staff observation rather than replaces their judgement.

Examples from this project illustrate the point:

- A spike in back-up captive bolt draws was reviewed on footage at those timestamps. The events related to euthanasia of a compromised animal at the edge of the camera view, which vision detection alone was unlikely to have identified. The holder sensor on the back-up stunner became an important indicator of an event that needed review.
- Footage of excessive goad use in one race section showed repeated hesitation at a particular point. The pattern suggested a visual obstruction or lighting issue and prompted an infrastructure discussion.
- Captive bolt stun events reviewed on footage allowed differentiation between stuns performed on the cradle and stuns performed in the box, a distinction that matters for both welfare interpretation and equipment attribution that the detection data alone could not provide.

An event timestamp helps staff find relevant footage, investigate what happened and decide on a response. The visibility comes from combining the record with human review.

6.5 From Detection to Action

The QA team reviewed detections, validated events and flagged issues. This gave the business information it had not previously had at the same level of coverage. The regular meetings also showed that acting on that information required involvement from livestock teams, maintenance and management.

> *Improved visibility and a completed corrective action are different outcomes. Monitoring can provide the first; named staff and managers remain responsible for deciding on and completing the second.*

This gap showed in several ways:

- Livestock team corrective actions: when goad use was elevated in a specific location on specific days, the pathway to briefing the livestock team, implementing a targeted change and checking its effect was inconsistent. The data existed but the governance structure to act on it did not.
- Infrastructure and design escalation: goad use patterns suggested that some race sections warranted a review of animal flow as well as handling practices. There was no set pathway from that finding to capital planning.
- Re-stun spikes: on several days re-stun rates rose above the normal operating range. The reason was understood by those on the slaughter floor, but there was no pathway for that information to reach those reviewing the data, or for corrective actions to be recorded for audit.

The project identified a gap between collecting data and assigning a management response. Facilities introducing continuous monitoring should check whether their existing audit and corrective action processes can accommodate the additional findings, particularly where staff time and digital systems are limited.

Engagement fell after the structured review period. The facility had no specific compliance gap to close, and additional use of the data was not being driven by an audit requirement. Risk reduction and avoided future losses did not sustain engagement against other operational priorities. This helps explain limited demand for the additional data in this setting, it does not show that the information lacked value.

7.0 Results Part B: Staff Attitudes Survey

Four staff responded to the survey. Their responses provide indicative feedback on workload, usefulness and barriers to adoption, but cannot establish how common these views are across the workforce or industry.

7.1 Perceived Value and Accuracy

Respondents saw potential value in welfare monitoring, including identifying risks and supporting training. Staff using the system daily reported more concern about detection accuracy and review time than those using its outputs for reporting and oversight. These differences are descriptive findings from four responses.

The feedback highlights a practical trade-off. Monitoring can provide better information while requiring time to verify detections. Its value should be assessed through the additional visibility and decisions it supports, alongside the review workload. A system need not eliminate a staff role to be useful, but its workload must be manageable.

7.2 Attitudes Toward Monitoring Purpose

Responses suggested differences in how staff understood the purpose of monitoring. Daily users were more concerned about workload and staff oversight, while management respondents were more positive about its role. Given the small group, these observations should be used to guide discussion rather than to characterise particular roles.

Management should explain that monitoring supports staff observation, investigation and response. Showing how findings lead to useful changes can help distinguish that purpose from a perception of individual surveillance. Staff also need time and support to use the information.

7.3 Barriers to Adoption

Respondents were asked to identify barriers to effective system use. Combined responses identified:

- False-positive detections consuming QA time (cited by 3 of 4 respondents). This was the most commonly reported barrier.
- Insufficient time during operational shifts for systematic review
- Management not prioritising system engagement as a clear expectation
- Staff turnover resulting in loss of institutional knowledge about system use
- Unclear ownership of who is responsible for responding to detections

7.4 Long-Term Sustainability

Concerns about inaccurate KPIs and time spent checking false positives suggest a risk to continued system use. Manageable review workloads and evidence that findings lead to useful changes are likely to support engagement.

Vision-based monitoring performance is sensitive to camera position, field of view, lighting, occlusion, animal variation and the number of event classes being assessed. Monitoring decisions should therefore be based on site-specific validation of accuracy, false-positive workload, coverage, computing requirements and total cost of operation. This project did not compare competing commercial platforms.

8.0 Results Part C: Welfare Footprint Framework Analysis

The WFF was included to assess the welfare impact of behaviour change. No sustained change was measured, so it could not demonstrate that impact here. This section explains its potential use qualitatively. Appendix 2 summarises the relevant harms and the data needed to assess them.

8.1 Acute and Chronic Harms

The framework considers intensity and duration separately. This helps distinguish brief events, such as goad use, restraint and ineffective stunning, from experiences that may persist during holding and lairage, such as hunger, environmental disruption and heat load. Six potential harms were considered; their relative contribution depends on facility conditions and the assumptions used.

Harm	Type	Main driver	Data that measures it
Extended holding (hunger)	Chronic	Cumulative time off feed	Time feed was last available, plus transport, arrival and slaughter records
Lairage disruption	Chronic	Time in lairage, group mixing, stocking density	Pen entry and exit timestamps; batch mixing records
Thermal discomfort	Chronic	Heat load, shade and genotype	Black globe temperature, humidity and wind for HLI; exposure duration and panting score
Electric goad	Acute	Race design, lighting and handler practice	Goad sensor counts and durations
Handling and restraint	Acute	Race and restraint design; temperament	Race transit time, movement speed, time in the stun box
Ineffective stun	Acute	Stunner maintenance, operator accuracy, animal class	Stunner records, operator logs and footage review; checks for signs of sensibility

Table 3. Six pre-slaughter harms, their main drivers and the records that can support assessment. Full profiles are in Appendix 2.

8.2 Interpreting Cumulative Pain

Holding and lairage can expose animals to discomfort for extended periods, so duration deserves attention alongside acute handling events. The available illustrative inputs do not support a reliable numerical ranking of these harms or a facility-wide total.

A quantitative assessment would need to specify exposure durations, the proportion of animals affected, the evidence for intensity estimates and uncertainty. It would also need to state how simultaneous experiences are treated. Cumulative estimates across overlapping harms should not be read as elapsed time.

A small population-average contribution does not make a severe event unimportant. Effective stunning, checks for sensibility and prompt corrective action remain essential regardless of how much time such events contribute to an aggregate estimate.

8.3 Assessing a Reduction in Electric Goad Use

A reduction in confirmed goad use would provide a measurable handling outcome. Its welfare significance would depend on how many animals were affected, whether use was repeated, and the duration and context of exposure. Counts should be checked against footage and device performance before attributing a reduction to an intervention.

Before-and-after comparisons should distinguish total goad activations from the proportion of animals goaded and from repeated use on the same animal. Sensors can record activations and timestamps, but identifying repeated exposure may require animal tracking or footage review. Changes in race design, lighting and handling can then be assessed against comparable operating periods.

8.4 What This Means for Measurement

The practical lesson is to measure duration-driven harms as well as acute events. This assessment does not establish a percentage contribution for holding and lairage or show that one harm should take priority over all others. Priorities should reflect severity, duration, frequency and the opportunity to prevent harm.

Useful inputs include arrival, pen and slaughter timestamps, goad activations, re-stun records and heat-load measurements. These overlap with the proposed sensor set (Section 9.3). Total time off feed also requires information from before arrival; timing and event records alone do not determine welfare intensity.

9.0 Discussion

The clearest outcome was improved visibility into the operation. Continuous event records and targeted footage review helped staff recognise patterns that intermittent observation had missed. No sustained handling change was measured, so the project distinguishes better information from a demonstrated welfare improvement. The discussion considers how businesses can obtain that information now, what staff need to use it, and how to assess its value without assuming that technology replaces people.

9.1 Visibility and the Demand for Welfare Data

A business may want to understand more about its operation than its assurance activities require it to record. Monitoring can meet that need by extending coverage and making relevant events easier to find. Where assurance requirements do not call for continuous welfare data, however, the external incentive to fund that additional visibility is weaker. The business must then decide what the information is worth for its own management purposes.

In this project, there was no specific compliance gap to close, and engagement fell after structured review ended. Goad use was lower during direct senior management oversight, but monitoring alone was not associated with a sustained reduction. These observations suggest that management priorities influenced use of the information. They do not establish that data has value only when it is audited or enforced.

Audit and retailer programs can strengthen demand for useful monitoring evidence by recognising how it supports assurance. In the earlier trial, uncertainty about acceptance led staff to continue manual CCTV review alongside AI-assisted review. Clear evidence requirements could reduce duplicated review while retaining human verification and responsibility for decisions.

Financial return should therefore be considered separately from monitoring capability. Additional visibility may help identify risks, explain incidents and target interventions, even where it produces no immediate labour saving. Limited external demand for continuous data can make those benefits harder to fund. The project did not quantify their full financial value, and the absence of demonstrated savings should not be read as evidence that improved visibility has no value.

9.2 Assessing the Value of Improved Visibility

The first question is what the business wants to understand and how staff will use the information. Technology should then be assessed on the visibility it adds, its fit with staff responsibilities and systems, its reliability and its total cost. Table 4 applies these criteria to computer vision and sensors. Reducing manual collection or footage-search time can be useful, but replacing a labour position is not the only condition of success.

Criterion	What it means	Vision-based AI	Simple sensors
Improves visibility	Reveals events and patterns staff cannot readily observe throughout the day	Can flag events across CCTV footage; coverage depends on camera views and validated event detection and model training	Records specific activations and movements and supplies timestamps for investigation
Supports people and systems	Helps staff interpret events, report findings and organise a response	Provides detections for staff review; findings need to reach the teams responsible for action	Can feed equipment events into QA and maintenance records and direct human footage review
Affordable for the purpose	Total cost is proportionate to the information and decisions supported	Include setup, computing, subscriptions, energy use, camera cleaning and maintenance, and staff review time. Usually with annual SaaS subscriptions	Provisional sensor-set estimate around AUD $10,000; include installation, integration, maintenance and review time. Low data use and subscription costs (if any)
Practical to maintain	Staff can sustain equipment checks, configuration and data availability	May need model updates after changes in camera position or conditions, and camera maintenance. Server replacement.	Requires device-function and data-transmission checks; use existing equipment records where available
Reliable for the intended use	Known coverage and error rates, with an appropriate level of human verification	Validate each event class; false positives created review workload in this project	Reviewed goad detections were mostly confirmed; device availability and event context still need checks

Table 4. Criteria for assessing the value of monitoring to staff and the business. Trial observations inform the comparison; the proposed sensor set still requires pilot validation.

A business case should identify the additional information staff will gain and the decisions it can support. It should allow for ongoing human review and response, and distinguish capability benefits from measured financial savings. The appropriate technology may be sensors, computer vision or a combination, depending on the information needed and the cost of providing it reliably.

9.3 Start with Indicative Data: A Minimum Sensor Set

Businesses do not need to wait for computer vision to handle every welfare event reliably before improving their visibility. Sensors can already record useful events such as goad activations, stunner draws and gate movements, giving staff a wider view of operations at relatively low cost. These records can direct review of existing CCTV when linked to location and timestamps. Computer vision can be added where it provides useful coverage beyond those signals, and both approaches can support timely alerts where configured for that purpose.

Table 5 sets out the proposed sensor set. The stun box is the recommended starting point.

Sensor	Location	What it tells you	Footage it points to
Gate or door sensors (induction)	Stun box entry and exit gates	Time each animal spends in the box; throughput; flow stoppages	Long holds and stoppages
Stunner fire sensor or stunner log	Stunner	Shots per animal and re-stun trends, when matched to animal cycles and operator records	Every re-stun
Operator button	Restraint box	Ineffective stuns logged by the operator, separated from precautionary re-stuns	Every logged ineffective stun (or precautionary stun)
Holder sensor	Back-up captive bolt	Each back-up stunner draw, flagging an event for review	Every draw (e.g. Backward in restraint box, difficulty stunning, down in race, disposition in pen, etc)
Goad sensors	Electric goads	Activation count and duration by device; repeated use assessed with footage or animal identification	Use and exessive use events
Ramp sensors	Receival ramp	Truck arrival and the start and finish of unloading	Unloading, where counts are disputed
Break-beam sensors	Lairage pen gates	Gate crossings; pen and mob holding times when matched to movement records	Animals held beyond set times
Speed camera or paired beams	Race	Movement speed as an indicator of temperament and handling pressure, linked to consignment	Fast-moving or baulking groups
Temperature and humidity	Lairage	Basic weather conditions; HLI assessment also requires black globe temperature and wind	Hot periods

Table 5. Proposed sensors for lairage and stunning, starting with the stun box.

Sensor timestamps help staff find relevant periods in CCTV footage. Ramp events, for example, can be matched to truck records and footage when unloading counts are disputed. Staff still establish the count and interpret what occurred. The benefit is a better-informed and more targeted investigation, rather than removal of the person doing it.

Some modern restraint boxes and stunners already record door movements and stun events, so the first step may be to connect existing equipment. Check with supplier if there are API's available for integration. Goad sensors should be checked regularly for reliable activation records and data transmission. For example, a fall in detections must not be assumed to reflect less use until device performance is confirmed.

The proposed set offers a practical starting point for better visibility. A pilot should confirm installation, integration and ongoing costs, data completeness and review workload. Businesses can start with a small number of useful signals and expand as needs become clearer. The timestamps may also support later assessment of duration-driven harms, alongside the additional evidence needed to estimate welfare impact.

9.4 From Data to Action

Better visibility gives staff a basis for deciding where to act. Making use of it requires time for review, a named owner for each response and a route from QA findings to livestock teams, maintenance or capital planning. Monitoring can automate parts of data collection and

flagging, while interpretation, decisions and corrective actions remain responsibilities of people within the business.

Data can test assumptions formed during day-to-day work. The late-week goad pattern was not previously recognised, and the staff's belief that morning use was higher was not supported by the sampled data. Review meetings should allow staff to examine such differences and agree on a response.

Location-specific goad patterns warrant review by facilities management as well as QA. Where footage confirms a constraint on cattle movement, a targeted design change should be considered alongside handling practices and its effect checked after implementation.

9.5 Where Computer Vision Fits

Computer vision can extend visibility by analysing CCTV footage and flagging events across the operating day. Where performance is suitable, it can support timely alerts as well as retrospective review. It can complement sensor records and cover events that are not captured by equipment activations. Businesses should validate performance for the events they need, including missed events and false positives, and allow for staff review, computing and maintenance costs. Reliability limitations in some applications are a reason to choose carefully, rather than a reason to delay all monitoring until computer vision improves.

There are significant training, maintenance, and running costs associated with computer vision. Efficiency of training models will improve over time, but the data requirements of vision systems mean that for the foreseeable future they will require physical servers on site which cost money to run and will need to be purchased and replaced. Commercial vision systems charge software subscriptions.

Whichever technology supplies a detection, staff remain responsible for understanding the event and responding. Footage review and operational knowledge provide context that a count or alert cannot establish on its own. The expected benefit is wider observation and more informed, timely action. Staffing plans and financial appraisals should provide for that work rather than assume that the monitoring system replaces a person.

9.6 The Welfare Footprint Framework as an Option for Measuring Impact

The WFF was included as a potential way to assess welfare impact, but the project did not demonstrate a sustained behaviour change to evaluate. Its use here illustrates the approach rather than validates a measured improvement.

The approach draws attention to duration as well as intensity and could help assess changes in holding, lairage and handling. A quantitative application would need facility-specific exposure data and documented evidence for intensity estimates, prevalence and uncertainty. The timestamps and counts from the proposed sensor set would provide some of those inputs.

The WFF is offered as one option for evaluating change, rather than as a framework the industry needs to adopt. Businesses should first establish reliable operational records and a process for acting on them.

10.0 Conclusions

- Monitoring improved visibility into the facility's handling practices and revealed patterns that intermittent observation had missed. This was a useful outcome even though no sustained change in handling behaviour was measured. Achieving welfare improvements requires people to interpret the findings and implement a response.
- Computer vision, sensors and operator records enable that visibility in different ways and can be combined. The relevant question is what staff need to see and understand, followed by which tools can provide that information reliably and affordably.
- Businesses can begin improving visibility now. Simple sensors can provide useful event counts and timestamps at relatively low cost, without waiting for computer vision to become more reliable across all event types. Computer vision remains a complementary option where its coverage and performance meet the business's needs.
- Sensors and operator records supplied the most reliable event streams in this project.
- Monitoring should be expected to extend staff capability, rather than eliminate a labour position. It can widen observation, reduce time spent finding relevant footage and help staff investigate and respond. People remain necessary for interpretation, decisions and corrective action, and time for that work belongs in the business case.
- Where continuous welfare data is not required for assurance, external demand for that additional visibility is weaker. This can limit the financial incentive to invest even when the information is useful. The value of better visibility should therefore be distinguished from demonstrated labour savings and from the requirements of existing welfare assurance.
- Electric goad patterns suggested that training alone may be insufficient where race design constrains cattle movement.
- The WFF offers one option for assessing the intensity and duration of harms. Its application here remained illustrative and did not establish a measured change in welfare burden.

11.0 Recommendations

For Processing Businesses

- Identify the questions the business wants monitoring to answer, then start with a small set of useful records. The stun box is a practical starting point, using gate movements, stunner records, an operator button and back-up stunner draws, followed by goad and lairage records where useful.
- Use timestamps and alerts to direct staff attention. Review relevant footage for back-up stunner draws, logged ineffective stuns, excessive goad events and disputed unloading counts, and include checks for events the chosen monitoring system may miss.
- Assess investments against the criteria in Section 9.2. Ask what additional visibility they provide, which decisions they support, how staff will use them and what they cost to install, operate and maintain. Do not assume that a labour position will be removed.

- Allocate staff time for verification, interpretation and response. Link findings to a corrective action register, name who owns each response, and provide an escalation route from QA to livestock teams, maintenance and capital planning.
- Explain that monitoring supports staff in seeing and managing the operation. Involve users in selecting useful signals, reviewing findings and assessing the workload, and show how their use of the information leads to changes.
- Where race design drives goad use, treat it as an infrastructure issue rather than a training issue.

For Further Research and Development

- Welfare monitoring and visibility technology requires prototyping and testing in commercial environments, however the relative small scale of the industry limits investment from technology companies. Rather than relying on full research projects to validate each technology, an open innovation type program has been successful in other sectors in agriculture to commercially prototype bespoke technologies and solutions (e.g. in grains and live export).

  For example, electric goad sensor enabled devices, HLI monitoring, stun data, temperament monitoring (eg speed), induction sensors on gates, use of generative AI to interpret findings.
- Perform a scoping study to understand the most used and useful monitoring and record keeping technologies used in the industry and their capability for integration. Develop guidance on combining sensor records, computer vision and human review within existing QA, maintenance and corrective action processes, including timestamping issues.

12.0 Project outputs

Output	Description
Retrospective baseline data analysis	Event data (August to November 2025) analysed and documented; summary provided to AMPC and the participating facility, December 2025
Staff perception survey	Structured survey developed and administered; n = 4 responses analysed for adoption themes and perception gaps
Illustrative WFF assessment	Qualitative account of acute and duration-driven harms and the data needed to assess change (Section 8 and Appendix 2)
Baseline criteria summary	Retrospective baseline criteria document provided to AMPC and the participating facility; held as a confidential annex and not included in the public report
Milestone Report (Milestone 1)	Inception and baseline report submitted to and approved by AMPC (December 2025)
Final Report (Milestone 2)	This document

Table 6. Project outputs.

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15.0 Appendices

15.1 Appendix 1 – Data Summary

Not included in the public report. The facility-level event data summary that supported the analysis in Section 6 has been provided to AMPC and to the participating facility as a confidential annex. It is excluded here because it consists of site-specific event counts, device-level and location-level detail, and internal review commentary that are not required in order to interpret or apply the industry findings in this report.

15.2 Appendix 2 Welfare Footprint Framework Harm Profiles

These qualitative profiles support Section 8. They describe potential harms, factors affecting exposure and records needed for assessment. They do not assign validated intensity distributions or numerical welfare burdens to animals at the participating facility.

Extended holding (Hunger)

Extended time off feed can contribute to hunger; its welfare impact depends on cumulative exposure and the animals' condition.

An assessment should include the period before arrival as well as time in lairage. Behavioural and physiological evidence can inform interpretation, but an absence of marked physiological change does not establish an absence of hunger. Estimating time in each WFF intensity category requires evidence specific to the exposure being assessed.

Factors that materially affect it: cumulative time off feed (the dominant lever), transport duration and on-farm curfew before arrival, and the point at which lairage feed is provided.

Records needed: when feed was last available, transport and on-farm curfew information, arrival and slaughter timestamps, and any feeding during lairage. Arrival-to-slaughter time alone does not measure total time off feed.

Lairage (social and environmental disruption)

Unfamiliar surroundings, disturbance and restricted opportunities to rest may affect animals during lairage.

Exposure depends on handling, mixing, pen conditions and holding duration. Familiar groups may provide social buffering, but the size and duration of any benefit depend on context. Resting behaviour and pen observations can help assess conditions (Cockram, 1991). No fixed recovery time or intensity profile is assumed here.

Factors affecting exposure: group mixing, stocking density, flooring and lying comfort, disturbance, and total lairage time.

Data that measures it: lairage arrival-to-exit timestamps, batch mixing records, and pen stocking density.

Thermal discomfort (HLI)

Heat exposure can cause discomfort and, under adverse conditions, severe distress. Duration, weather, genotype, animal condition and access to shade affect risk.

The Heat Load Index (HLI) uses black globe temperature, humidity and wind to assess environmental heat load (Gaughan et al., 2008). Panting and other animal-based observations help interpret the response. These measures can support an assessment, but they do not directly establish time in each WFF intensity category.

Factors affecting exposure: weather and its duration, genotype, acclimatisation, shade, ventilation, stocking density and water access. Shade can reduce heat load, but its effect should be assessed under the conditions at the facility (Sullivan et al., 2011; Schuck-Paim et al., 2026).

Records needed: black globe temperature, humidity, wind, exposure duration, shade access, genotype and animal-based observations such as panting score.

Ineffective stun (return to sensibility)

Failure to render an animal unconscious, or a return to sensibility before death, requires immediate corrective action. Precautionary re-stuns must be distinguished from events with signs of sensibility (Grandin, 2002). A low event frequency does not reduce the severity for an affected animal. No prevalence or duration estimate is assigned here, and ineffective stunning is not assumed to be the only possible source of severe suffering.

Factors affecting risk: stunner condition, operator accuracy, animal class, checks for sensibility, prompt corrective stunning and stun-to-stick interval.

Records needed: operator logs, precautionary and corrective re-stuns recorded separately, footage review, stun-to-stick timing and checks for signs of sensibility through to death.

Electric goad

Electric goads are aversive, and repeated use needs particular attention (Pajor et al., 2000; Warner et al., 2007). The effect depends on the application and context, so each activation should not be assigned a fixed pain duration or intensity without supporting evidence. Sensor records should distinguish activations from confirmed animal contact where possible, with footage used to identify repeated use on the same animal.

Factors affecting exposure: frequency and repetition of use, race geometry, lighting, flooring, animal flow and handling practices.

Records needed: goad activations, durations and device identifiers, matched with footage or animal tracking to assess contact and repeated exposure. These records can support before-and-after comparisons.

Handling and restraint

Moving cattle through the crowd pen and race and restraining them for stunning can cause fear or distress. Facility design, handling, temperament and the fit and operation of restraint equipment affect the response (Grandin & Shivley, 2015; Ewbank et al., 1992). Transit and restraint duration and animal-based observations can inform assessment, but do not establish a fixed WFF intensity profile.

Factors that materially affect it: race and crowd-pen design (curved race, lighting, non-slip floor, low-stress handling), restraint type and adjustment, and temperament and prior handling.

Records needed: vocalisations, baulking and escape attempts, race transit and restraint times, and relevant footage. Movement speed should be interpreted with information on handling and animal temperament.

Assessing lairage shade

Compare heat-load measurements and animal responses before and after shade provision under comparable weather and operating conditions. Record exposure duration, shade access and panting observations. A reduction in heat load should not be described as eliminating severe distress without supporting observations.

A WFF assessment could use these observations alongside documented intensity assumptions to estimate change. Effects measured in a feedlot should not be transferred directly to short-term lairage without considering differences in exposure and conditions.

Assessing handling and restraint changes

Compare similar groups before and after changes to race design, handling or restraint. Record transit and restraint times, baulking, vocalisations, escape attempts and goad use, and review footage to understand the context. Account for differences in animal class and temperament.

These records can show whether handling became smoother and exposure to adverse events declined. Quantifying welfare impact would require additional evidence for intensity and duration; a physiological change alone does not establish a proportional change in suffering.

15.3 Appendix 3 – Staff Perception Survey Instrument

Use of Livestock Monitoring AI

This survey aims to understand how livestock AI monitoring systems are being used in practice and identify what would make it easier or more valuable for staff to use.

The goal is not to evaluate individual performance, but to improve the system and how it supports the operation.

Estimated time: 10–12 minutes

Section 1 — Role and Exposure to the System

1. What is your primary role? (Select one)

- QA / Animal Welfare

- Livestock handling

- Production supervisor

- Management

- Maintenance / technical

- Other: _____

2. Which system have you had more contact with? (Select one)

- [Monitoring system A]

- [Monitoring system B]

- Other: _____

3. How often do/did you interact with the monitoring system or its results? (Select one)

- Daily

- Weekly

- Occasionally

- Rarely

- Never

4. Which of the following have you personally done? (Select all that apply)

- Reviewed alerts or detections

- Watched video footage to confirm an event

- Used the data in reporting or KPIs

- Investigated a flagged issue

- Used findings for training or corrective action

- Helped troubleshoot or train the system

- Have not interacted with the system

Section 2 — Perceived Value of the System

5. How useful do you believe the monitoring system could be for the business? (Scale 1–5)

6. What value do you believe the system could provide? (Select up to three)

- Identifying animal welfare risks
- Identifying operational issues
- Internal efficiency (e.g. counting livestock)
- Supporting reporting to customers/regulators
- Supporting staff training
- Improving consistency in procedures
- Reducing disputes about incidents
- I do not see clear value

7. In your experience so far, how accurate are the system detections? (Select one)

- Very inaccurate
- Still training
- Correct enough for use
- Accurate enough for reporting confidently
- Unsure

Section 3 — Practical Barriers to Use

8. How easy is it to find time to review dashboards, alerts, or footage? (Select one)

- Very difficult
- Difficult
- Neutral
- Easy
- Very easy

9. What makes it difficult to use the system? (Select all that apply)

- Not enough time during shifts
- Not seen as a priority by management
- Too many alerts
- Alerts are often false
- Hard to navigate or log into software
- Hard to find relevant footage
- System reliability issues
- Lack of training
- Lack of clear responsibility

Section 4 — Trust and Perception

10. What best describes how you feel about the system? (Select one)

- Useful tool
- Neutral
- Unsure

- Causes unnecessary work

- Concerned about how it may be used

Section 5 — Capability and Training

11. How confident are you in using the system? (Scale 1–5)

12. What training have you received? (Select one)

- Formal training

- Informal explanation

- Learned by trying

- No training

Section 6 — Workflow Fit

13. How well does the system fit into normal work routines? (Scale 1–5)

Section 7 — Organisational Factors

14. How strongly does management support the system? (Scale 1–5)

Section 8 — Improving Adoption

15. What would make the biggest difference? (Select up to three)

- Fewer false detections

- Faster review process

- Clear responsibilities

- Better training

- Stronger management support

Section 9 — Final Reflection

16. If the system disappeared tomorrow, would the operation lose something valuable? (Yes/No)