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Roadmap to create a knowledge centre for abattoir wastewater treatment

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Abstract

There is currently a lack of knowledge within the red meat industry regarding design and operation of Anaerobic Lagoons (ALs) and upgrading these to Covered Anaerobic Lagoons (CALs) to minimise GHG emissions from wastewater treatment operations. This project was designed to address these issues and recommend a roadmap for the establishment of an Anaerobic Lagoon Knowledge Centre (ALKC) to provide the necessary information and knowledge for the industry. The roadmap identified the eight most important knowledge gaps within the industry and recommended projects to fill these knowledge gaps. It also recommended an approach to consider for the establishment of the knowledge centre. The data generated by this knowledge centre will assist the industry to improve their environmental performance with respect to wastewater treatment and thus remain environmentally sustainable.

Executive summary

The AMPC 2010/11 Environment programme, as part of their CPRS initiative, proposed the development of a roadmap to create a knowledge centre for abattoir wastewater treatment, with a focus on Anaerobic Lagoons (AL). ALs are major GHG emitters and while the basic science involved in minimizing these emissions, via covering the lagoons is relatively well known, there are currently major technical knowledge gaps in relation to the design, operation and maintenance of Covered Anaerobic Lagoons (CALs) in the industry.

The objective of this study was thus to develop a knowledge centre that collects and collates the collective industry knowledge with respect to CALs, particularly information relating to the design, construction, operation and maintenance of CALs that offer biogas harvesting and combustion to generate renewable energy. Furthermore, it was proposed that in 3 to 5 years to construct a website that houses the collected knowledge, maybe in the form of an expert system, for use by industry members to improve the operation and environmental performance of their ALs and thus remain environmentally sustainable. The first phase of this project, for FY 2010/11, was the development of the roadmap for this anaerobic lagoon knowledge centre (ALKC).

The generic approach used to obtain the information required to develop the roadmap for the development of the ALKC was to run two workshops, the first with industry representatives and the second with external stakeholders, to obtain an understanding of the current knowledge base of the industry and more importantly to identify knowledge gaps with respect to ALs and upgrading these to CALs.

These two workshops identified thirty major technology and information knowledge gaps within the industry and these were prioritised to develop the nine top priority knowledge gaps. A listing of these top knowledge gaps within the industry are summarised in the table below.

Issue Priority	Issue Description
1	To address cost uncertainties, it was recommended that MLA, through the ALKC, develop a position paper on the costs and cost benefits of upgrading to CALs. Are there better treatment processes to consider? Is biogas reuse actually cost effective? What is the cost of reducing GHGs in \$/t CO_{2e}?
2	The industry does not have a good understanding of basic AL design principles. It was requested that MLA, through the ALKC, develop a sound and scientifically robust but yet simple spread-sheet based design manual for ALs. This manual to also include practical engineering design issues and monitoring requirements.
3	Improved grit and screening removal systems prior to use of CALs.
4	Focus on site-based planning rather than jumping straight to AL/CAL design
5	Provide wastewater treatment operator training courses, possibly via MINTRAC
6	Holistic wastewater treatment system design, with better integration of unit operations
7	Due to low application of CALs in the abattoir industry, need a literature review on what is being done elsewhere.
8	Benefits Analysis of intensified AL systems, eg adding baffles, recirculation or heating
9	Improved product recovery rather than end-of-pipe treatment

At a third and final workshop with industry representatives these projects were discussed in detail and a GANTT chart was developed to identify appropriate timelines for the implementation of projects to fill these knowledge gaps. Based on the outcomes generated by this project the following major recommendations are made:

- It is recommended that during FY 2011/12 AMPC/MLA prepare a scope of works to go to tender with the aim of contracting a vendor to conduct a study to review and assess improved processes for the removal of grit and screenings (oil and grease) from abattoir wastewaters.
- It is recommended that during FY 2011/12 AMPC/MLA prepare a scope of works to go to tender with the aim of contracting a vendor to conduct a thorough global literature review of ALs and CALs as used in the red meat industry.
- It is recommended that during FY 2011/12 AMPC/MLA prepare a scope of works to go to tender with the aim of contracting a vendor to conduct a thorough investigation of CALs and that this review include a comprehensive CBA of upgrading ALs to CALs.
- It is recommended that a scoping study for the set-up of the KC be commissioned in early 2012 with the intention of appointing a contractor to set-up and run the KC by the 3Q 2012.

Execution of the projects recommended in this roadmap will, to a large extent, “fill” the knowledge gaps identified by the industry with respect to ALs and CALs. Establishment of the and maintenance of the ALKC as recommended by this project will ensure the industry remains at the forefront of wastewater treatment and energy recovery technology developmental programmes and thus enhances the ability of members to remain environmentally sustainable.

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1 Background

The Australian Meat Processors Co-operative (AMPC) 2010/11 Environment programme, as part of their CPRS initiative, has proposed the development of a roadmap to create a knowledge centre for abattoir wastewater treatment, with a focus on Anaerobic Ponds, also known as Anaerobic Lagoons (AL). ALs are major GHG emitters and while the basic science involved in minimizing these emissions, via covering the lagoons is relatively well known, there are currently major technical knowledge gaps in relation to the design, operation and maintenance of Covered Anaerobic Lagoons (CALs) in the industry.

2 Project objectives

The main aims of this project are to:

- Develop a knowledge centre that collects and collates the collective industry knowledge with respect to CALs, particularly information relating to the design, construction, operation and maintenance of CALs that offer biogas harvesting and combustion to generate renewable energy, and,
- In 3 to 5 years to construct a website that houses the collected knowledge, maybe in the form of an expert system, for use by industry members to improve the operation and environmental performance of their ALs and thus remain environmentally sustainable.

The first phase of this project, for FY 2010/11, is development of the roadmap for this anaerobic lagoon knowledge centre (ALKC) and this report summarises the outcomes of this phase of the project.

3 Methodology

3.1 Generic Approach

The generic approach used to obtain the information required to develop the roadmap for the development of the ALKC was to run two workshops, the first with industry representatives and the second with external stakeholders, to obtain an understanding of the current knowledge base of the industry and more importantly to identify knowledge gaps with respect to ALs and upgrading these to CALs.

3.2 The first workshop

Attendance to the first workshop was to be limited to red-meat industry representatives only. The purpose of this closed workshop was to identify the current state-of-the-art with respect to AL design and operation within the industry and to highlight both perceived and real lack of knowledge within the industry regarding upgrading ALs to CALs. In addition the collective knowledge-base of the group with respect to research organisations, consultants, and equipment vendors who could assist in minimising these knowledge gaps was to be sought.

3.3 The second workshop

Based on the outcomes of the first workshop an agenda for the second workshop was to be prepared and a listing of suitable external stakeholders, to be involved in the workshop was to be developed. The outcomes from the second open workshop were be a better defined understanding of the current industry knowledge regarding CALs, a better definition of the knowledge gaps and suggestions regarding research and projects which should be undertaken to minimise the unknowns and uncertainties. That is, the outcome of the second workshop was designed to form the basis of the first draft of a roadmap to create an AL knowledge centre for the industry.

3.4 The third workshop

A succinct summary based on the outcomes of the two workshops, recommending a roadmap for the initial development of the ALKC was to be prepared, which was to include recommended projects for funding in 2011/12. This summary was to be presented to industry representatives at the third and final workshop, to endorse the roadmap and agree on which projects should be funded to lessen uncertainties regarding ALs and upgrading these to CALs.

4 Results and discussion

4.1 The first workshop

The first workshop was held at the Riverview Hotel in Brisbane on the 12th November, 2010. Attendees were limited to members of the AMPC Environment Committee. A brief review of major outcomes is provided below.

The attendees were requested to identify issues of concern and uncertainties/unknowns with respect to wastewater treatment with emphasis on ALs and upgrading these to CALs. In addition they were requested to identify external stakeholders (equipment suppliers/vendors, consultants and researchers) who they believed could add value to minimising these uncertainties. The areas of uncertainty were sub-divided into three groups, namely wastewater issues, AL issues and upgrading to CAL issues. The sub-group 1 issues raised by the attendees are shown in Table 4.1, the sub-group 2 issues in Table 4.2 and sub-group 3 issues in Table 4.3.

Table 4.1: Sub-group 1 issues

Subroup1: Wastewater/pre-treatment/effluent quality/licensing Issues	
1.	Should additional wastewater segregation be contemplated, eg of high COD/BOD streams for targeted treatment to reduce overall treatment costs? An example cited was high rate anaerobic treatment for stick water.
2.	Possibly look at sulphur reduction so biogas from CALs is easier to use.
3.	Is improved pre-treatment for O&G and solids removal required if upgrading to CALs?
4.	Most abattoirs had save-alls and DAFs for pre-treatment. Are there better pre-treatment systems that should be considered?

5. Nutrients in effluent the major licensing issue. Most agencies require irrigation management plans (IMP) that limit N&P loadings. Generally it is believed that many abattoirs do not meet these limits. Can the ALKC develop a rational and robust nutrient loading regime that is defensible and can be used by regulators?
6. Odours from ponds also a major issue. Can the ALKC address odour mitigation strategies?

Table 4.2: Sub-group 2 issues

Subgroup 2: AL Design and O&M Issues
1. The industry does not have a good understanding of basic AL design principles. It was requested that MLA, through the ALKC, develop a sound and scientifically robust but yet simple spread-sheet based design manual for ALs.
2. This design manual should address maintenance issues such as minimising piping elbows and allow for easy maintenance of inlet and outlet piping. Should also address pond liners, such as clay versus synthetic liners.
3. Is the presence of a crust on an AL an issue if upgrading to a CAL?
4. Can pro-biotics or enzymes be effective in reducing crust layers and sludge production? Can this be addressed in the manual?
5. What is an acceptable monitoring program for influent, lagoon and effluent to ensure good operations? Again, can this be addressed in the manual?
6. How does one measure sludge build-up in AL? Can production be estimated? Can this be included in manual?
7. What are acceptable AL desludging practises? Routine desludging or wait until full, take off-line and de-sludge?
8. Can there be a single AL or are multiple lagoons in series ALWAYS required?
9. If ALs are being upgraded or new ones built, it was recommended that ease of upgrade to CALs be included in the design premise.

Table 4.3: Sub-group 3 issues

Subgroup 3: Upgrade to CALs: Process Design, Cost and Biogas Issues
1. Costs associated with CALs seemed to be a major issue with most industry people. This should be addressed in this 2nd workshop.
2. To address 1 above it was recommended that MLA, through the ALKC, develop a position paper on the costs and cost benefits of upgrading to CALs. Are there better treatment processes to consider? Is biogas reuse actually cost effective?
3. The industry does not have a good understanding of current Australian consultants/designers/vendors of CAL systems. Can this be addressed at this workshop?

4.	Can biogas be effectively used for paunch drying, steam generation or electricity generation?
5.	The cost effectiveness of CALs in reducing GHGs was raised. What is the cost of reducing GHGs in \$/t CO_{2e}? Include this issue in the position paper identified in 2 above.
6.	There was concern re the safety and OHS issues of biogas storage, handling and reuse. Do be addressed somewhere?
7.	Is biogas corrosivity an issue in reuse applications?
8.	Due to low application of CALs in the abattoir industry, need a literature review on what is being done elsewhere.
9.	In general, it was identified that all information generated by the ALKC must be kept current, by regular updates of the information.
10.	What is the likelihood that EPAs will make CALs mandatory?

The attendees also provided details of the external stakeholders they used for wastewater treatment issues and a listing of these is provided in Table 4.4.

Table 4.4: Listing of external stakeholders

Consultants	Researchers/Universities	Vendors
Feedlot Services	NIAWA	Aquatec-Maxcon
EA Systems	SARDI	Contrashear (CST)
PMP Environmental	Grains RDC	FAN (Aust. Waste Engineers)
Tony Mitchell	UQ	AJM
John Marlow	USQ	Spirac
Dinmore	UNE	Darling Downs
Adan Outokumpu	UNSW CRC	PMP Enviro
Tracey Colley	Monash University	Quantum Bioenergy
Martin Haege		Geotube providers
PMT Water Engineering		
Integra		
Bill Spooner		
Mike Johns		
Ken Hartley		
GHD		

4.2 The second workshop

Based on the outcomes from the first workshop an agenda and listing of attendees for the second workshop was finalised. The second workshop was held in the MLA offices in North

Sydney on the 28th of February 2011 and was attended by 15 external stakeholders. Three represented the consulting industry, and six each from research organisations and equipment vendors/contractors. A brief review of major outcomes is provided below.

The attendees were asked to review the issues raised by Workshop 1 attendees and identify any that based on their collective expertise was NOT an issue, since they had already been resolved within the industry. They were then asked to add any additional issues that in their collective view were still regarded as uncertainties with respect to ALs and CALs. Based on this, the attendees identified and prioritised 30 issues that were regarded worthy of further consideration by AMPC/MLA. The average priority ranking for these 30 issues, again categorised by sub-group, are shown in Figures 4.5 to 4.7. Note that the highest priority ranking value was 10. The average ranking is shown by the solid blue bar and the 95 percent confidence interval for the ranking is shown as the error bar in Figures 4.5 to 4.7.

Figure 4.5: Sub-group 1 issues ranking

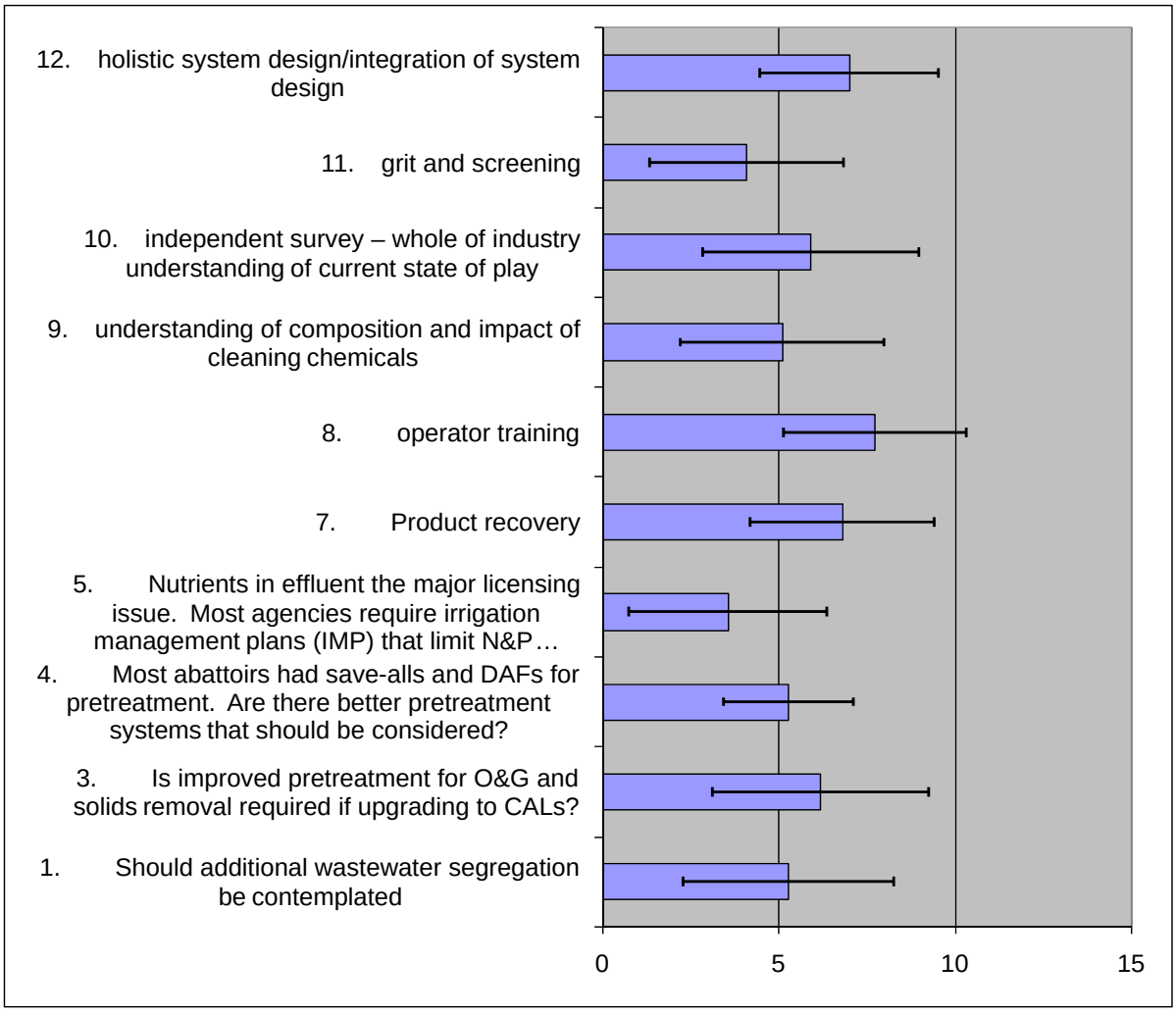


Figure 4.6: Sub-group 2 issues ranking

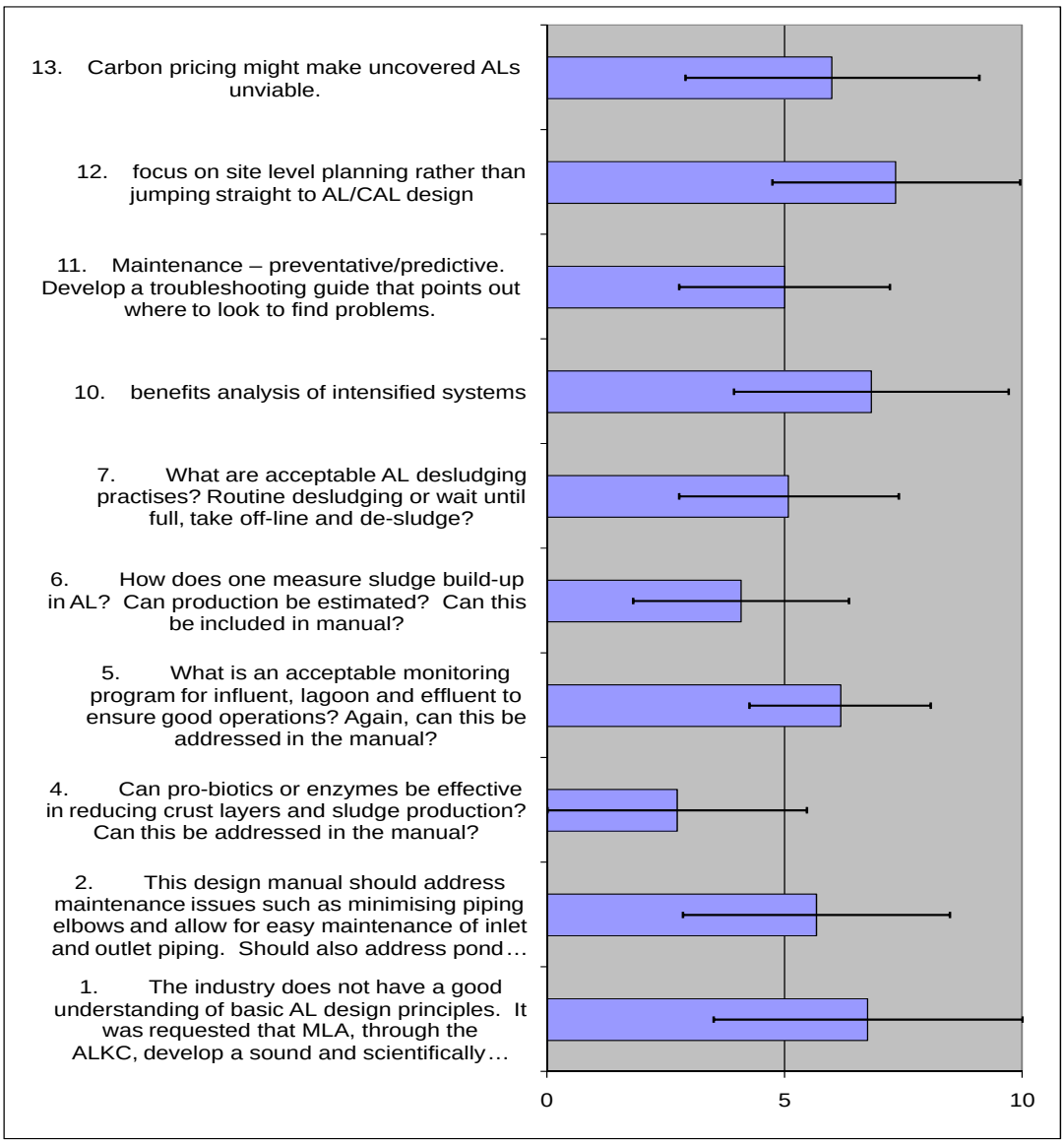
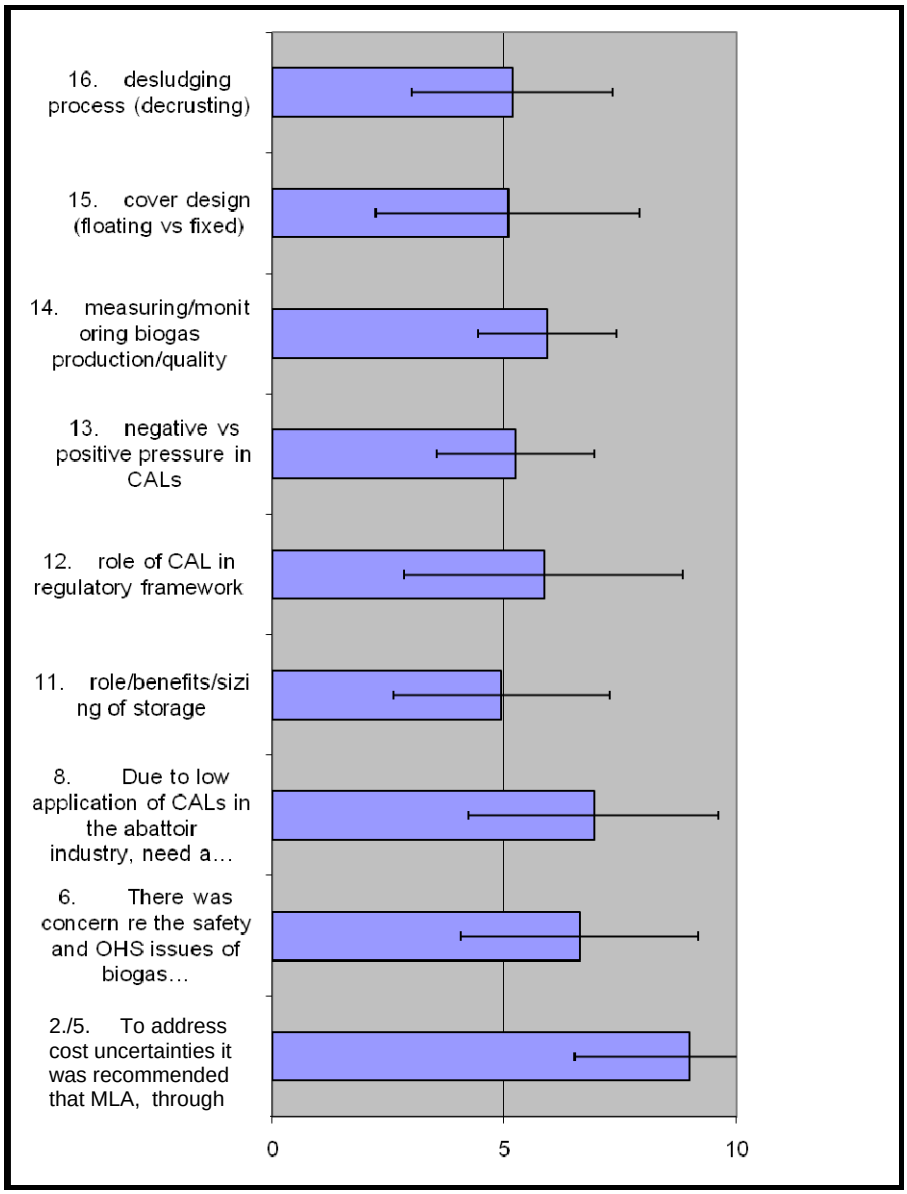


Figure 4.7: Sub-group 3 issues ranking



The workshop 2 report identified the nine most important issues that the AMPC/MLA should consider for development of action plans/projects to resolve these uncertainties and knowledge gaps, via the ALKC. These nine issues, in order of importance, are identified in Table 4.8.

Table 4.8: Top priority issues for AMPC/MLA consideration

Issue Priority	Issue Description
1	To address cost uncertainties, it was recommended that MLA, through the ALKC, develop a position paper on the costs and cost benefits of upgrading to CALs. Are there better treatment processes to consider? Is biogas reuse actually cost effective? What is the cost of reducing GHGs in \$/t CO_{2e}?
2	The industry does not have a good understanding of basic AL design principles. It was requested that MLA, through the ALKC, develop a sound and scientifically robust but yet simple spread-sheet based design manual for ALs. This manual to also include practical engineering design issues and monitoring requirements.
3	Improved grit and screening removal systems prior to use of CALs.
4	Focus on site-based planning rather than jumping straight to AL/CAL design
5	Provide wastewater treatment operator training courses, possibly via MINTRAC
6	Holistic wastewater treatment system design, with better integration of unit operations
7	Due to low application of CALs in the abattoir industry, need a literature review on what is being done elsewhere.
8	Benefits Analysis of intensified AL systems, eg adding baffles, recirculation or heating
9	Improved product recovery rather than end-of-pipe treatment

4.3 Development of a preliminary roadmap for the ALKC

Based on the information provided by industry representatives and external stakeholders from the first two workshops, as well as MLA/AMPC information on existing or soon to be contracted projects that are relevant to the ALKC, a simple flow sheet for the proposed roadmap, for the next 2 to 3 years, is provided in Figure 4.9. As can be seen from Figure 4.9 it is recommended that the ALKC electronic information system be divided into four categories, namely:

- CAL issues,
- AL issues,
- Alternate technology issues, and,
- General issues.

As can be seen from Figure 4.9, there are already, or soon will be, 9 MLA/AMPC funded projects underway that will provide much-needed information for inclusion in the ALKC Electronic Information System. Of these, seven fall into the CAL issues category and two into the Alternative Technology issues category.

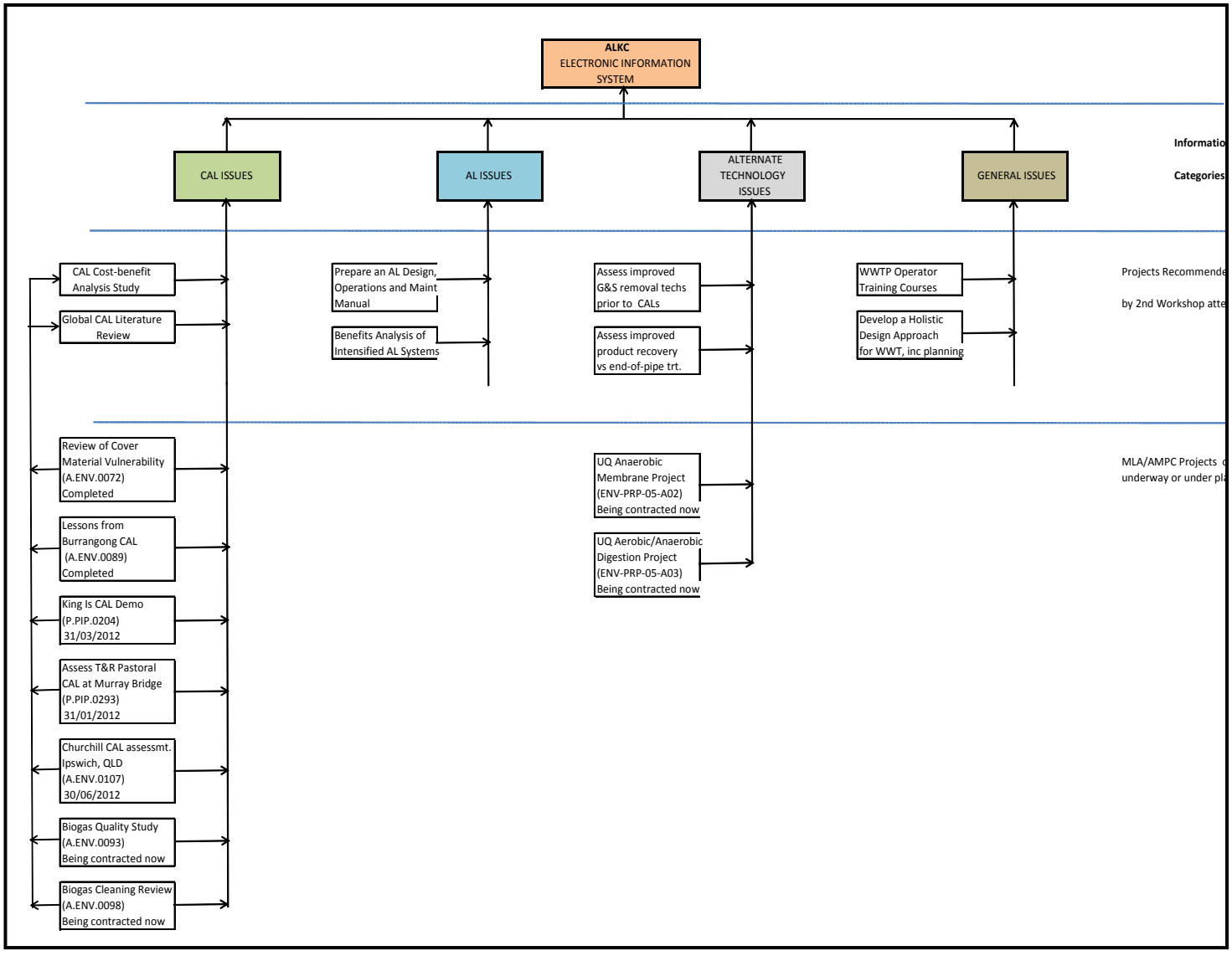
In addition to these 9 projects it is recommended that MLA/AMPC, over the next two years embark on the 8 projects identified in Figure 4.9. These are essentially the 9 highest priority issues raised by workshops 1 and 2, with priority issues 4 and 6 from Table 4.8 combined into one project.

For the 2011/12 and 2012/13 FYs it is recommended that MLA prepare detailed project specifications and costings for the following four projects:

- Project #1. Undertake a project to conduct a thorough global AL and CAL literature review with the aim of recommending AL and CAL design criteria for the red meat industry.

- Project #2. Undertake a project to prepare a cost-benefit analysis on upgrading ALs to CALs. This project is also to address alternate technologies and also review the GHG issues in converting ALs to CALs
- Project #3. Undertake a project to prepare an AL design, operations and maintenance manual for use by the industry
- Project #4. Undertake a project to review improved grit and screenings (including oil and grease) removal technologies for the industry, particularly as this applies to adoption of CAL technology.

Figure 4.9: Preliminary ALKC roadmap flow sheet (2011 to 2015)



The other four project identified in Figure 4.9 could possibly be scoped and conducted in 20013/14 or 2014/15. It should be noted that priority issue number 5, preparation of an operators WWTP training course, is not designed to limit vendor responsibility in the provision of operating manuals for treatment units supplied to the industry.

Only Project #4 identified above has no predescendants and can thus commence as soon as scopes are prepared, requests for proposal received and successful contractors appointed. Projects 1, 2, and 3 do however depend on the outcomes from the seven existing MLA/AMPC projects identified in Table 4.9 and thus their timing is dependent on a timely delivery of outcomes from these seven projects.

4.4 The third workshop

The preliminary roadmap outlined in Section 4.3 above was discussed with industry representatives at the third workshop held in Melbourne on 23th June 2011. There was unanimous consensus that the eight projects identified for funding under the auspices of the ALKC were appropriate and were endorsed. No additional major projects were identified for consideration. A preliminary GANTT chart, outlining the proposed timing for these eight projects had been prepared and was discussed with the group. The consensus was that assessment and review of Grit and Screenings removal technologies was critical to the future success of CALs as improved O&G removal was deemed to be required for successful operation of CALs. Furthermore, lower levels of O&G in the wastewater would likely impact the economics of CALs and thus this project was given the highest priority by the group. It was also agreed that projects 1 and 2 identified in Section 4.3 should be undertaken in FY 2011/12. The final GANTT chart for the ALKC roadmap is shown in Figure 4.10.

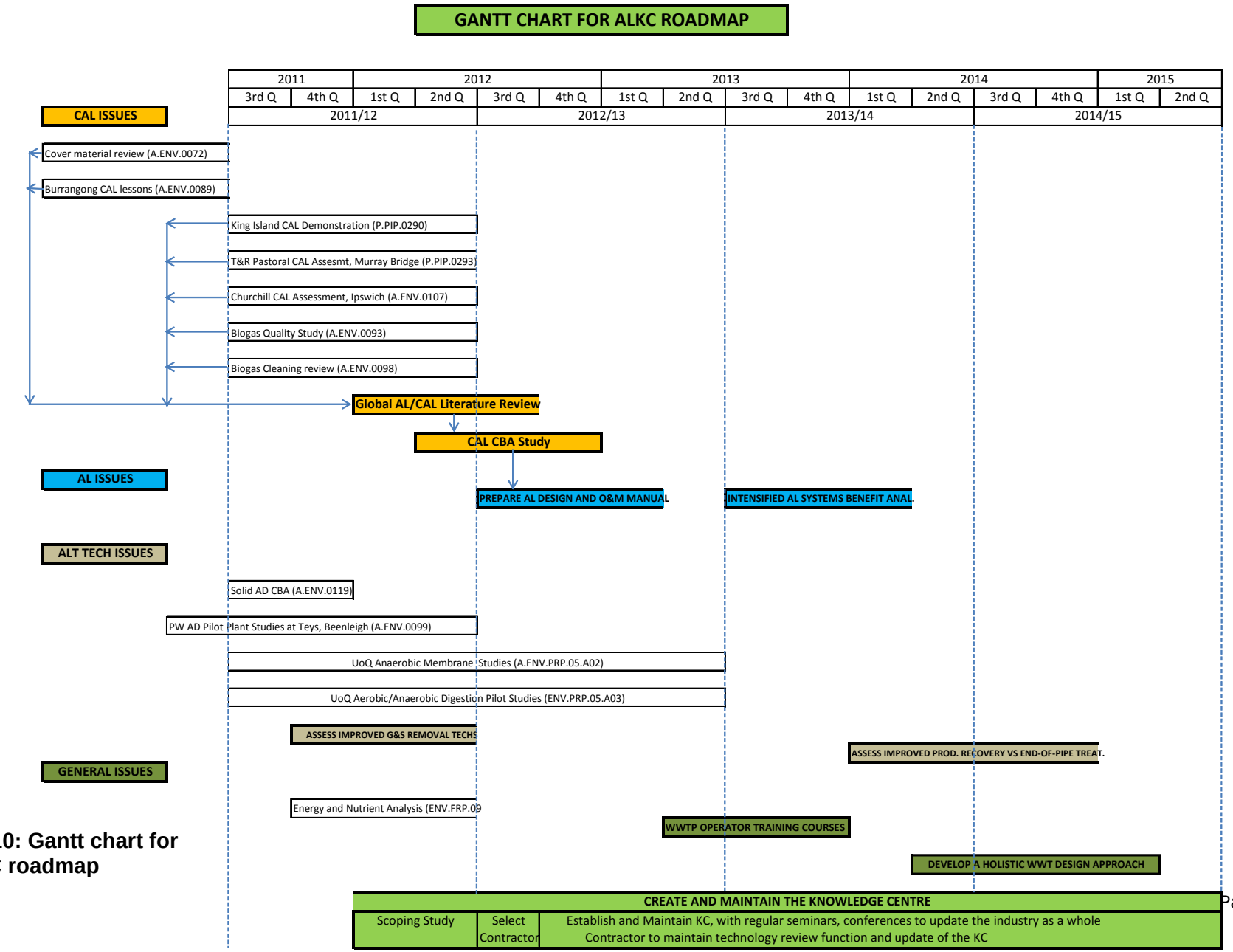


Figure 4.10: Gantt chart for ALKC roadmap

4.4.1 Description of projects to be considered for FY2011/12 funding

A brief description of the three projects to be considered for funding in FY2011/12 follows.

- It is recommended that AMPC/MLA contract a consultant or a consortium of suppliers such as consultants, research organisations and vendors to conduct a study to review and assess improved processes for the removal of grit and screenings (oil and grease) from abattoir wastewaters. This project addresses Priority Issue number 3 Table 4.8. It is firmly believed that improved screening for grit, oil and grease removal is required to ensure stable and good CAL operations and this is thus a valuable project to maximise benefits to be gained from upgrading ALs to CALs. The main question to be answered (although this project will be just a first step), is whether there is value in removing as much fat, oil & grease from the effluent as possible, before it enters an anaerobic lagoon (to be processed and sold as tallow, for instance), or whether it is preferred to be left in to maximise the production of methane, assuming this is captured and used as renewable fuel. With that in mind, the scope of this project should include the following:
    a. Review, assessment and comparison of methods to screen and remove grit, oil & grease.
    b. Definition of the scope of a future project to study and assess the efficiency of the overall anaerobic system in breaking down organic matter and generating methane, when oils and greases are removed prior to the effluent entering a CAL. This scope will be defined in the context of the CAL projects currently underway in Australian processors, and its purpose will be to define an experiment to be undertaken at one or more of the CALs to be finished in the near future, in order to test the impact, both technical and economical, of reducing the content of O&G before the wastewater enters a CAL.
    c. This review is also to include information on sound operating and maintenance procedures to be used on solids and O&G removal facilities.
    d. The project is also to provide the draft of simple CBA based on improved O&G removal, particularly as it relates to increased revenues from tallow sales and lower revenues for gas production in CALs. This CBA will only be a very preliminary first draft based on a set of assumptions, which will need to be developed further and tested in the continuation project, for which the scope is mentioned in point b) above.

  It is recommended that AMPC/MLA allocate $80,000 for this project, and the provider selected through tender process.

- It is recommended that AMPC/MLA contract a consultant or a consortium of suppliers such as consultants, research organisations and vendors to conduct a thorough global literature review of ALs and CALs as used in the red meat industry. This project addresses Priority Issue number 7 in Table 4.8. This literature review is to include all the relevant information generated by the 7 existing AMPC/MLA funded projects that relate to CALs (see Gantt chart for a listing of these projects), and should be extended to red meat processing practices outside Australia, particularly the ones common in developed countries and regions, namely North America and Europe, with a focus on areas where weather conditions are not to dissimilar from Australia. This literature review must have a reasonable level of detail and

rigour to become another input to the recommended criteria for the design, operation and maintenance of ALs and CALs.
It is recommended that AMPC/MLA allocate $75,000 for this project, and the provider selected through tender process.

- It is recommended that AMPC/MLA contract a consultant or a consortium of suppliers such as consultants, research organisations and vendors to conduct a thorough investigation of CALs and that this review include a comprehensive CBA of upgrading ALs to CALs. This project addresses Priority Issue number 1 in Table 4.8. This project is to include all the relevant information generated by the 7 existing AMPC/MLA funded projects that relate to CALs (see Gantt chart for a listing of these projects) as well as relevant information generated by the literature review. This investigation is also to review alternate technologies to confirm if better treatment options are available or are near to commercialisation. The CBA is specifically to address the benefits of GHG reductions and develop cost protocols to assess the cost of these GHG reductions in $/tonne of CO2e effected. It is recommended that AMPC/MLA allocate $100,000 for this project, and it should only start when enough relevant information is available from the CAL installations currently underway (not earlier than 2012, and probably in the 12/13 financial year).

4.4.2 Establishment of the knowledge centre

Possible approaches to consider for establishment of the knowledge centre were discussed and it was generally accepted that contracting one of the relevant Australian water treatment research organisations to provide this overall service was worthy of further consideration. Organisations such as CSIRO or the Advanced Water Management Centre (AWMC) at the University of Queensland would be ideal candidates to provide this service. Both these organisations have enviable international track records in the management and treatment of wastewaters and are at the forefront of research in this area. Furthermore CSIRO and AWMC have long histories of research collaboration with AMPC/MLA in the water management arena. A cost–effective approach to consider would be for AMPC/MLA to provide scholarships to CSIRO or AWMC to provide post-graduates to set-up, manage and maintain the KC and provide regular seminars, workshops or conferences for the industry to continually disseminate the information gathered within the KC. This approach ensures that a highly motivated individual(s) will be responsible for the set-up, management and updating of the KC. Furthermore such water research academics would be well placed to ensure that the KC is kept abreast of current wastewater treatment research and technological developments to ensure the currency of the information in the KC.

It is recommended that a scoping study for the set-up of the KC be commissioned in mid 2012 with the intention of appointing a contractor to set-up and run the KC in 2012/2013.

4.4.3 Other recommendations

The following issues were raised at the workshop and recommended for follow-up by MLA/AMPC:

- The need for a bench-marking exercise of the wastewater characteristics for the red meat industry was raised and discussed. Mike Johns indicated there was a wealth of information on wastewater characteristics within the MLA/AMPC data-bases and someone should be tasked with collating this information into a useful package for the industry. Of critical importance in collating this information into a useful package is to fully understand the sources of wastewater and also the processes used by the abattoirs in generating the wastewater. This issue needs further discussion within MLA/AMPC prior to being actioned.

- It was recommended that all the current CAL demonstration/assessment projects underway be vetted to ensure that information on O&G removal via the pre-treatment systems is monitored and recorded as part of the assessment programme. The types of pre-treatment systems used for O&G removal at each demonstration site is also to be recorded. This information will significantly assist the outcome of the new project to assess improved O&G removal technologies.

- That MLA/AMPC considers a demonstration project of the best technology identified for improved O&G removal at one of the new CAL demonstration sites.

- While it was generally acknowledged that no additional new technologies are likely to become commercial in the next few years, it is recommended that MLA/AMPC maintains a watching brief on the use of privatised and centralised organic waste management facilities for contract treatment of abattoir semi-solid waste streams. Such systems are currently under development in Victoria and Tasmania.

5 Success in achieving objectives

The first phase of this project, namely the development of a roadmap for the establishment of an ALKC has been successfully achieved. The industry has endorsed the proposed roadmap developed by this project.

6 Impact on meat and livestock industry – Now and in five years time

Execution of the projects recommended in this roadmap will, to a large extent, “fill” the knowledge gaps identified by the industry with respect to ALs and CALs. Establishment of the and maintenance of the ALKC as recommended by this project will ensure the industry remains at the forefront of wastewater treatment and energy recovery technology developmental programmes and thus enhances the ability of members to remain environmentally sustainable.

7 Conclusions and recommendations

Based on the outcomes generated by this project the following major recommendations are made:

- Although the original focus of the ALKC is to help the industry grow its knowledge related to anaerobic lagoons in order to be better prepared for the challenges ahead this knowledge centre may be extended to other anaerobic technologies (like digesters) as

well as pre and post-treatment, like screening and aerobic treatment. In the roadmap, projects and initiatives looking at other technologies and treatments have been included to help make better decisions. Although it is yet to be decided (see last paragraph below), in the meantime it is recommended the KC will be extended to those other areas, and all the relevant information generated from other projects will be integrated accordingly.

- It is recommended that during FY 2011/12 AMPC/MLA prepare a scope of works to go to tender with the aim of contracting a vendor to conduct a study to review and assess improved processes for the removal of grit and screenings (oil and grease) from abattoir wastewaters.
- It is recommended that during FY 2011/12 AMPC/MLA prepare a scope of works to go to tender with the aim of contracting a vendor to conduct a thorough global literature review of ALs and CALs as used in the red meat industry.
- It is recommended that during FY 2011/12 AMPC/MLA prepare a scope of works to go to tender with the aim of contracting a vendor to conduct a thorough investigation of CALs and that this review include a comprehensive CBA of upgrading ALs to CALs.
- It is recommended that a scoping study for the set-up of the KC be commissioned in 2012 with the intention of appointing a contractor to set-up and run the KC in 2012/2013. This scoping study should resolve the question whether the KC will be extended outside anaerobic lagoons, although the initial assumption is that it will.