Smart Water Fund

A Toolkit to Minimise Water Use in Small Scale Food Processing Industry

Prepared by:
RMIT University
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City West Water
Melbourne Water
South East Water
Yarra Valley Water
Department of Sustainability and Environment

Our Water Our Future

Victoria The Place To Be

Contents

A Toolkit to Minimise Water Use in Small Scale Food Processing Industry

1.0 Background and aim

The study was undertaken in Melbourne, Australia, by RMIT University in conjunction with the Plenty Food Group, the City of Whittlesea, the City of Hume, Yarra Valley Water, and several industrial food manufacturers. The project began in March 2007 and ended in April 2008. The aim of the toolkit was to help small to medium scale food manufacturing businesses identify and prioritize water saving initiatives to maximize water savings. The main deliverables of the study was to develop an easy to use water saving toolkit applicable to other food sectors throughout Victoria and elsewhere.

1.1 Rationale

With an apparent decline in water resources, due in part to climate change, there has been an increasing concern and focus on efficient water use in Australia. Through the Pathways to Sustainability program, water authorities within metropolitan Melbourne are currently working with the top 200 industrial water users to develop plans to reduce their water use. As detailed in the *Central Region Sustainable Water Strategy* (Central Region SWS)[1] this program has been extended to businesses using in excess of 10 ML/annum (approximately 1000 businesses in Melbourne). However, there are no guidelines currently for small to medium businesses using less than 10ML/annum to develop strategies and action plans to reduce water consumption. The small companies neither have the expertise nor the finances necessary to develop water sustainability plans. For public health reasons, the food manufacturing industry has some of the strictest regulations regarding water quality used in the processing of food. This industry was selected because it uses significant volumes of water challenges researchers to identify fit for purpose water saving options in a closely regulated environment.

1.2 Significance

Food processing consumes more than 241,000 ML of water per year throughout Australia.[2] This equates to 28% of the total water used in the manufacturing sector nationwide, making it the largest water using industrial sector. Within the sector, water use (in litres per kilogram of production) ranges from 1 (for bakery products) to 18.6 (for ice cream products). The food processing sector is one of the fastest growing manufacturing sectors in the country.

The food industry is extremely conservative and is averse to risk regarding chemical and microbial contamination of food. As a result, food industries use copious amounts of water in cleaning operations. There are opportunities to save water by using targeted professional knowledge, HACCP plans, new technology and best practices (which include behavioural change regarding water use practices).

[1] Department of Sustainability and Environment 2006. *Central Region Sustainable Water Strategy*, Victorian State Government Publication, Australia. Available at: http://www.dse.vic.gov.au/DSE/wcmn202.nsf/LinkView/427BD3FAB0838556CA25709F00148870DEE554DEB21669DBCA256FFE00103BF8#COPY

[2] savewater!® Alliance, 2005. The Australian food industry and water. Available at: http://www.savewater.com.au/index.php?sectionid=60

There are several commercial and free toolkits available to industry. However these are often produced by third party providers and have only one intended customer, with unverifiable results. With respects to the Victorian water industry, this is the first collaboration between industry group representatives, local councils, water authorities, a university and manufacturers towards the development of generic, model-based, multi-sector water systems engineering. It is envisaged that the model-based approach to engineering such systems could be applied more widely, and so has significance to other sectors.

2.0 Description of the Project

2.1 Participants

The project aimed to have 15 industries audited to cover a range of food manufacturing industries. The purposes of these audits were to:

- gain enough generic information about onsite processes to construct the toolkit,
- collate information on water consumption patterns and flow rates and
- help the industries save potable water.

Initially 19 industries were approached to participate in the study. Subsequently some of the industries did not agree to participate in the study due to one or more following reasons.

1. Originally it was planned to charge $400 from each industry to participate in the study. Some small to medium scale industries were not keen to participate in the study as their water bills were less than $400 per year. As a result the $400 charge was waved in order to attract the industry to the study.
2. Small scale industries have resource constraints. Industries were concerned about the time commitments for the project.
3. Some industries were sensitive to the potential for a breach of commercial confidentiality, where competitors might gain information about manufacturing recipes and processes.

2.2 Methodology

A three-step methodology was used for the study. Step 1 was the engagement of industries to educate, step 2 was onsite auditing, and step 3 was the toolkit development. The timeline for implementation of the methodology is shown in figure 1 below.

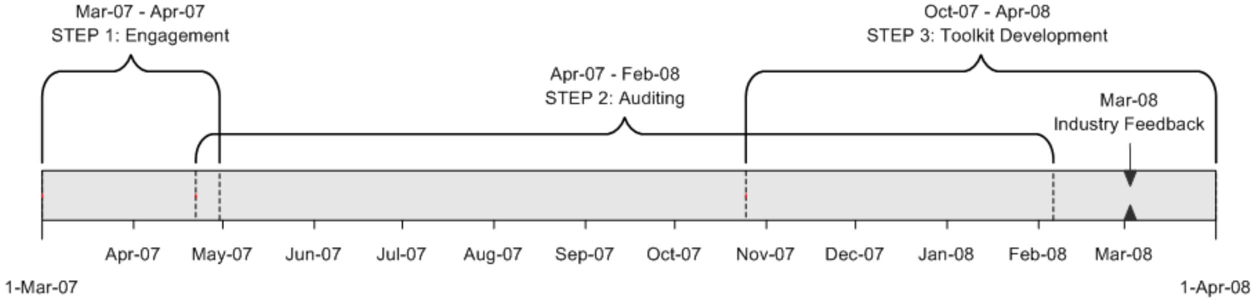

Figure 1.0 Timeline for methodology implementation

Step 1: Engagement

Engagement consisted of three aspects:

a. approaching a food manufacturer (industry) through an industry body (The Plenty Food Group) operating in conjunction with the City of Whittlesea and City of Hume;
b. signing industry on as a participant (mutually acceptable agreement); and
c. retaining the industry for the length of the study.

Step 2: Auditing

The purpose of the auditing was:

a. to assemble enough data for constructing the water balance flow charts and process mapping;
b. to gain generic information about onsite processes for mapping water use;
c. generating requirements for toolkit development; and
d. provide a baseline target for saving water.

The auditing included both initial walk through audits and detailed onsite audits. A manual audit as well as an online data logger (using the Hydroshare facility provided by the *Utility Services* corporate alliance)[3] was used to continuously monitor the water use by the participating industries and to establish a daily water consumption profile.

Step 3: Toolkit Development

The toolkit was programmed in Visual Basic for Applications (VBA) as an MS Excel™ User Form similar to a wizard software setup. Initially the toolkit was developed concurrently with onsite auditing, and mirrored the auditing process. An initial workshop to preset the toolkit was held for industry participants as well as for non-participants. Industry feedback was incorporated into the toolkit before the stakeholders were presented with the toolkit. In the final months of the project the toolkit was developed in conjunction with workshopping and feedback.

2.3 Deliverables

The project deliverables were 5 key project outcomes consisting of milestone reports, a final report which included the delivery of the toolkit. Milestone reports were as follows:

1. Planning and organising the project
2. Information gathering from previous studies.
3. Developed process flowchart and identify inputs and outputs.
4. Audit & Assessment.
5. Evaluation and feasibility.

3.0 Key Project Outcomes

Several key project outcomes were delivered throughout the project. Some of these were novel and incidental.

MILESTONE 1: Planning and organising the project. Milestone report submitted by RMIT University 13 April 2007 and approved by the Smart Water Fund. A steering committee was formed and the first meeting was held. The scope and the benefits of the project were explained to the stakeholders. The industry participants were selected.

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[3] http://www.usus.com.au/usutility/display.asp?entityid=3208

MILESTONE 2: Information gathering from previous studies. Milestone report submitted by RMIT University, 31 May 2007 and approved by the Smart Water Fund. The report summarised national and international case studies on water conservation applicable to the food industry. This was carried out to obtain information on water saving opportunities as well as to identify fit-for purpose recycling opportunities to incorporate in to the toolkit.

MILESTONE 3: Developed process flowchart and identified inputs and outputs. Milestone report submitted by RMIT University 04 October 2007 and approved by the Smart Water Fund. The milestone reported current water use practices by the participating businesses, and prepared flowcharts after walkthrough inspections.

MILESTONE 4: Audit and assessment. Milestone report submitted by RMIT University, 8 Jan 2008 and approved by the Smart Water Fund. This involved quantitative auditing, and analysis of results. The report also presented the specifics of the toolkit and the flowchart of the processes in the toolkit.

MILESTONE 5: Evaluation and feasibility. Milestone report submitted by RMIT University, 29 February 2008 and approved by the Smart Water Fund. A review of alternative possibilities of rainwater harvesting was integrated into the toolkit together with key performance indicators (KPI) and target setting for improvement. The assumptions that were carried out in developing the Toolkit was also highlighted in the Milestone report. Two workshops were held with participating businesses and metropolitan water authorities and EPA officials.

FINAL PROJECT REPORT: Overal report on the project and delivery of the toolkit.

4.0 Results

4.1 Generic Process Model

A simplified prototype of the generic process model is illustrated diagrammatically using Generic Systems Symbols (GSS)[4] in Figure 1. GSS is currently being used by academics as a unifying medium for constructing generic models with the intention of aiding the multi-scale assessment of sustainable environmental resource use.[5]

Within the generic model presented here, the system window is a diagrammatic depiction of the system boundary. The system boundary was set using the basic steps specified in the Global

[4] For definitions see, Odum, H.T., 1994. *Ecological and General Systems*, Colorado University Press, Colorado, and Ulgiati, S., Bargigli, S. & Raugei, M., 2007. An emergy evaluation of complexity, information and technology, towards maximum power and zero emissions. *Journal of Cleaner Production*, 15(13-14), p.1359-1372.
[5] Federici, M., Ulgiati, S. & Basosi, R., 2008. A thermodynamic, environmental and material flow analysis of the Italian highway and railway transport systems. *Energy*, 33(5), p.760-775.
Gasparatos, A., El-Haram, M. & Horner, M., Assessing the sustainability of the UK society using thermodynamic concepts: Part 1. *Renewable and Sustainable Energy Reviews*, In Press, Uncorrected Proof. Available at: http://www.sciencedirect.com/science/article/B6VMY-4SBYH7R-1/1/1b00e3c44e748fab14223f8e52d24e2d.
Jiang, M. et al., 2008. Emergy-based ecological account for the Chinese economy in 2004. *Communications in Nonlinear Science and Numerical Simulation*, 13(10), p.2337-2356.

Reporting Initiative's (GRI) Boundary Protocol, thereby integrating GSS into the GRI's approach.[6] However the scope of the project was to consider the water use aspect of the system only. This included total potable water withdrawal from the mains source and water recycled and reused onsite (EN8 and EN10 respectively of the Global Reporting Initiative's Sustainability Reporting Guidelines)[7]. Due to this scope, other entities and analyses that might generate significant sustainability impacts (such as labour, energy, life cycle analysis, embodied energy, finances, marketing, brand equity and the like) were not included within the system window (boundary) of the model. Table 1 below describes the legend for the Generic Systems Symbols used in Figure 1. Table 2 below shows the symbols, formulas and units used in the prototype generic model. These were used in the identification of the water type classifications generated for the project.

It is worth noting that the toolkit produced as a part of this project, could be used to acquire data for model calibration, thereby making the generic model specific. This in turn could be used to simulate the specific process to test 'what-if' scenarios to aid management decision-making. However it was found that the scope-limited boundary of the project excluded factors from the model that are required for total system calibration and meaningful simulation.

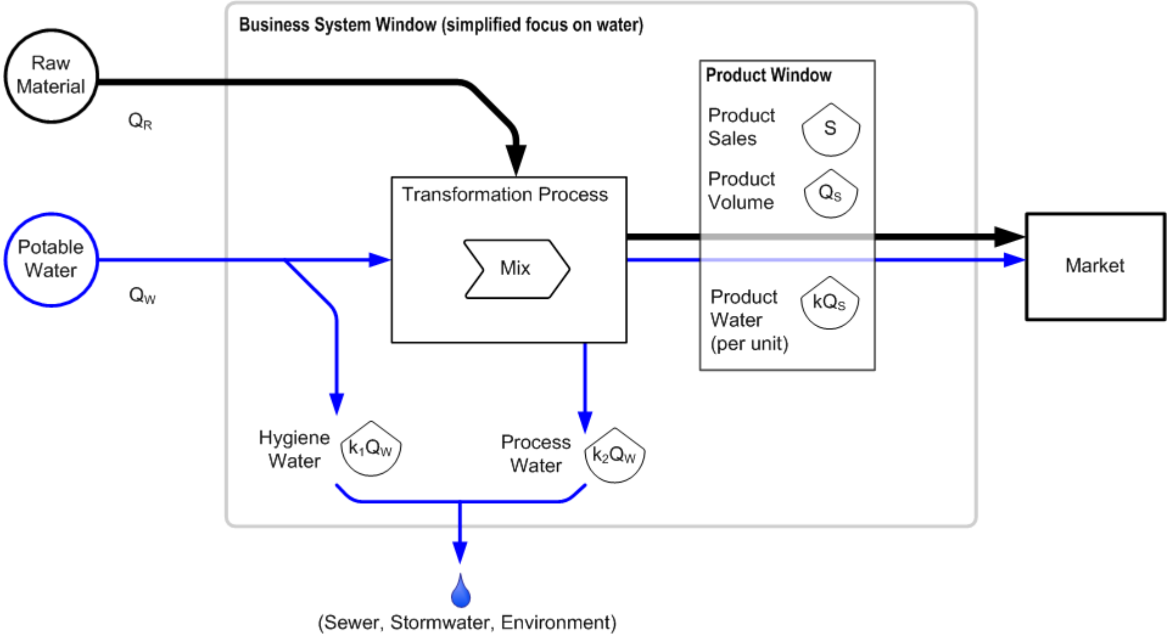


Figure 1. Prototype Generic Process Model

[6] GRI Boundary Protocol 2005 Global Reporting Initiative (GRI). Available at: http://www.globalreporting.org/NR/rdonlyres/CE510A00-5F3D-41EA-BE3F-BD89C8425EFF/0/BoundaryProtocol.pdf

[7] G3 Sustainability Reporting Guidelines 2000-2006 Global Reporting Initiative. Available at: http://www.globalreporting.org/NR/rdonlyres/ED9E9B36-AB54-4DE1-BFF2-5F735235CA44/0/G3_GuidelinesENU.pdf

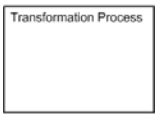
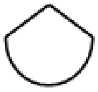
Symbol	Description
	System boundary, or also called system window. This is used to delineate inputs to and outputs from the system.
	Potable water source from mains pipeline supply
	Supply of raw materials that are transformed into the product
	Sub system generic window
	Generic Storage, or when indicated, a specific storage of water, raw materials, product.
	Transformation process by interaction between different inputs
	Potable Water Flow & top-level inputs and outputs
	Transfer of materials and product, inputs and outputs

Table 1. Legend and descriptions of Generic Systems Symbols

Description	Symbol	Formula	Units
Product water ratio	k		
Sales	S	(from financial ledger)	units/wk
Product volume per unit	Qs		kL/unit
Total volume sold	V	S*Qs	kL/wk
Product water per unit		kQs	kL/unit
Total product water		S*kQs	kL/wk
Potable water	Qw	(from meter record)	kL/wk
Process water		k2Qw (details derived from audit)	kL/wk
Hygiene water		k1Qw (details derived from audit)	kL/wk
Process & hygiene water total		k1Qw + k2Qw	kL/wk

Table 2. Nomenclature of Generic Model

4.2 Toolkit Overview

A snapshot of the toolkit is presented below through a series of screenshots. These have been presented to give a short overview of how the toolkit functions. During the course of the project, in addition to the toolkit, a novel process map flow charting method was developed and integrated with the toolkit's water wizard. A part of this method included the development of Generic Systems Icons (GSI). Each GSI is a combination of a coloured background to indicate its association – blue background indicates the icon is associated with water use, green the environment, and depicts generic water uses with a pictogram or appropriate GSS

The inspiration for the development of GSI came from multiple sources including the fishbone causation charts, HACCP flow charting methodologies, together with the suggestion by *Odum & Odum* that GSI may have a pedagogic advantage over GSS.[8] By adopting these graphic systems, the water wizard introduces the Icon-based System Definition Language (SDL) to a general audience.

Screenshot 1 is of the opening screen of the toolkit excel file. It shows that the toolkit is comprised of three data input user forms; a Water Wizard, Payback Estimator, and Net Present Value Estimator. The water wizard is a step by step user form which acquires data from the user on company water use. The payback estimator gives and estimation of the water savings over a period of five years at which point various water authorities have suggested the price of water will double. The net present value indicates what the value is when the payback period meets the investment value.

Screenshot 1. Opening page of toolkit Excel file

[8] Odum, H.T. and Odum, E.T. 2000 *Modelling For All Scales: An Introduction to System Simulation*, Academic Press, London.

Screenshot 2 shows the first page of the water wizard form which is displayed when the user clicks on the ‘start water wizard’ button from the toolkit excel file. An example of the selection of GSIs is depicted in Screenshot 2.

Screenshot 2. Opening page of water wizard user form

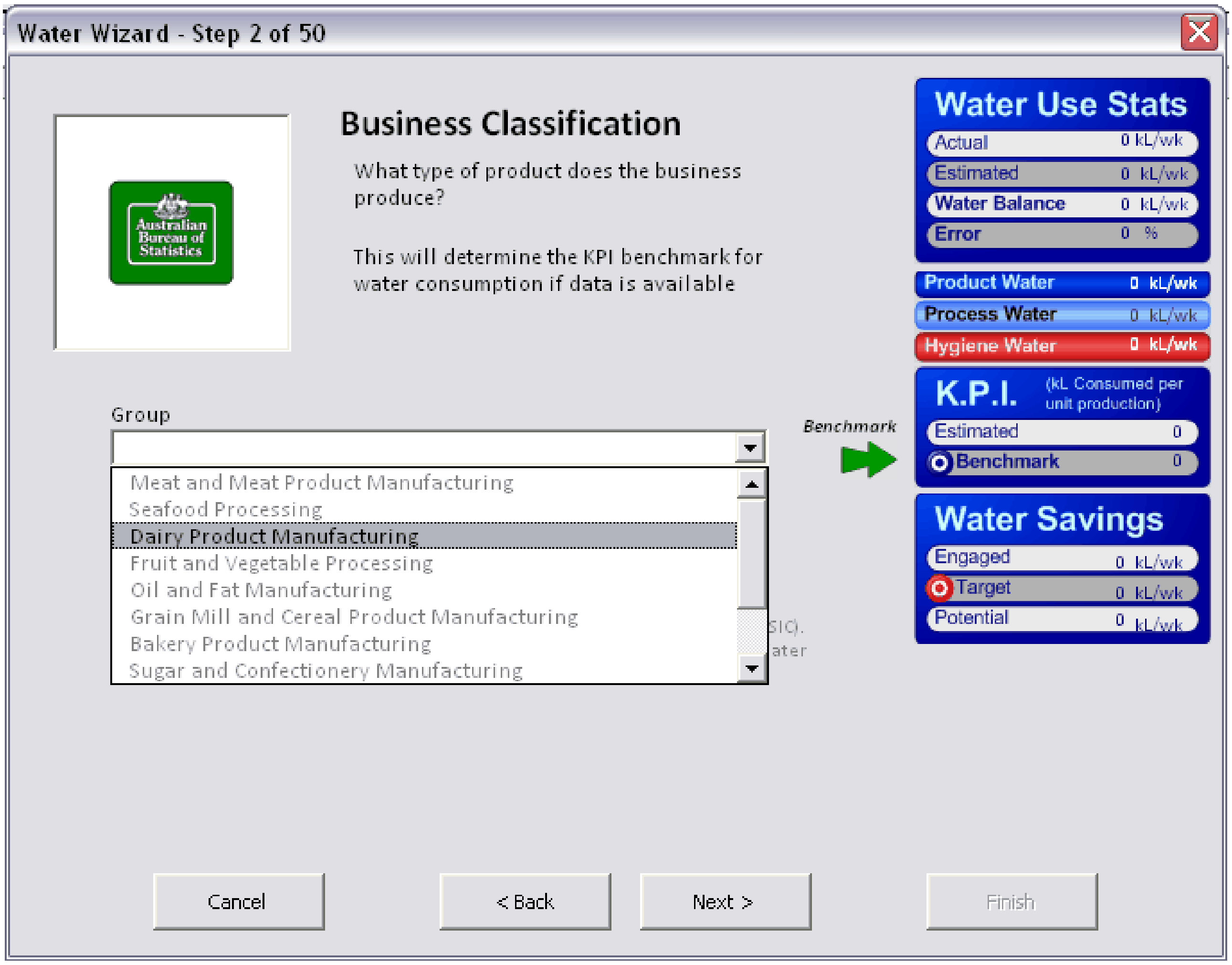
The water wizard consists of a 50-step user form. Each data entry page of the water wizard collects data from the user, and reports it to the fields on the right hand side of the screen, and ultimately stores it in the spreadsheet which the user can save.

The input data that are required to run the toolkit are listed below:

- Number of staff members
- Amount of water used in the product
- Past water billing information
- Type of appliances (number of toilets, type of flushes, number of hand washing basins)
- Roof area
- Estimates/Quotes on rainwater tank installation and retrofitting of appliances

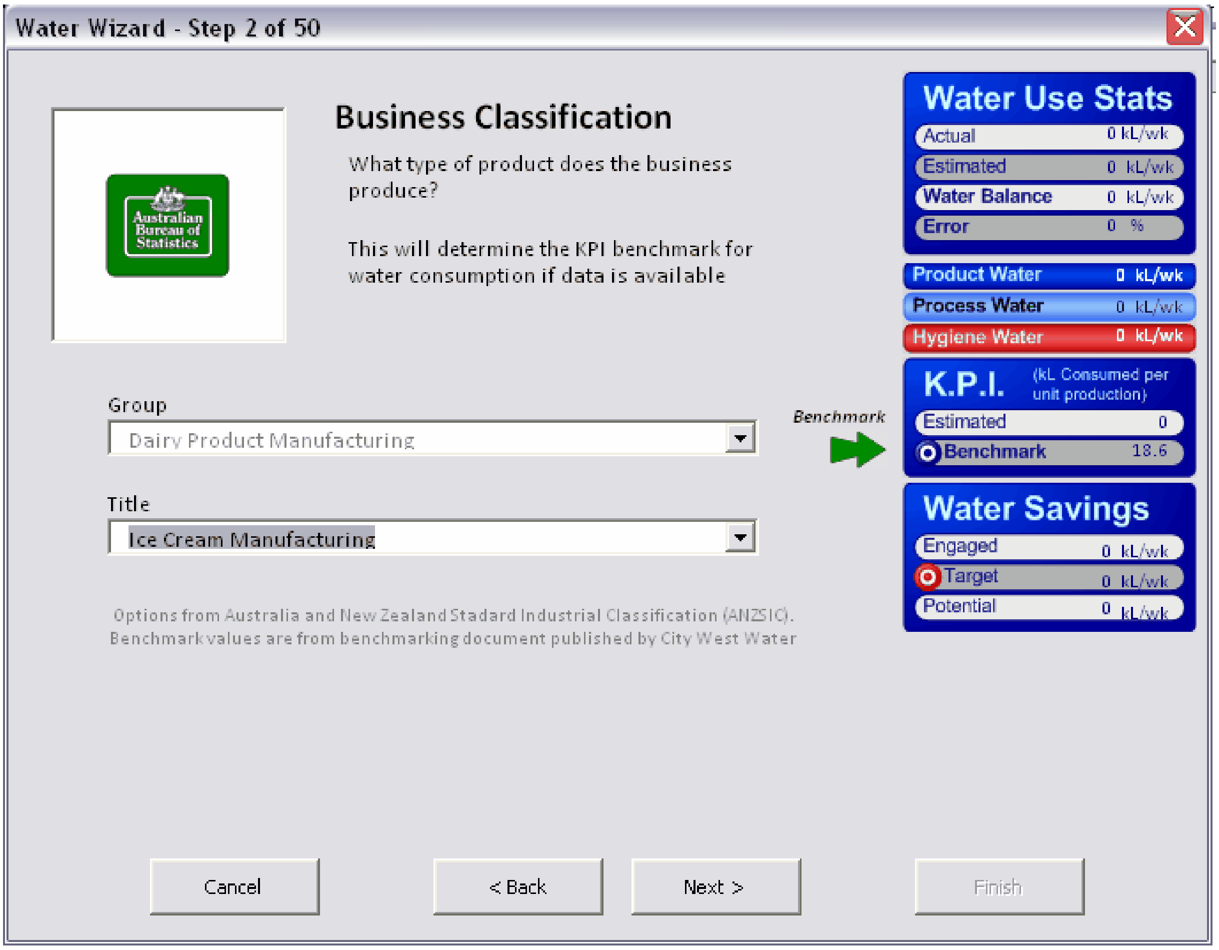
For the purpose of this report a simple example is given. Screenshot 3 takes data input from the user to select the ANZSIC (Australian and New Zealand Standard Industrial Classification) code as used by the Australian Bureau of Statistics, to determine the water use benchmark for the company code.

Once the user has selected their ANZSIC group, the water wizard displays the KPI benchmark to the right of the screen indicated by the green arrow. Screenshot 3 shows that a user has selected the dairy product manufacturing classification group.



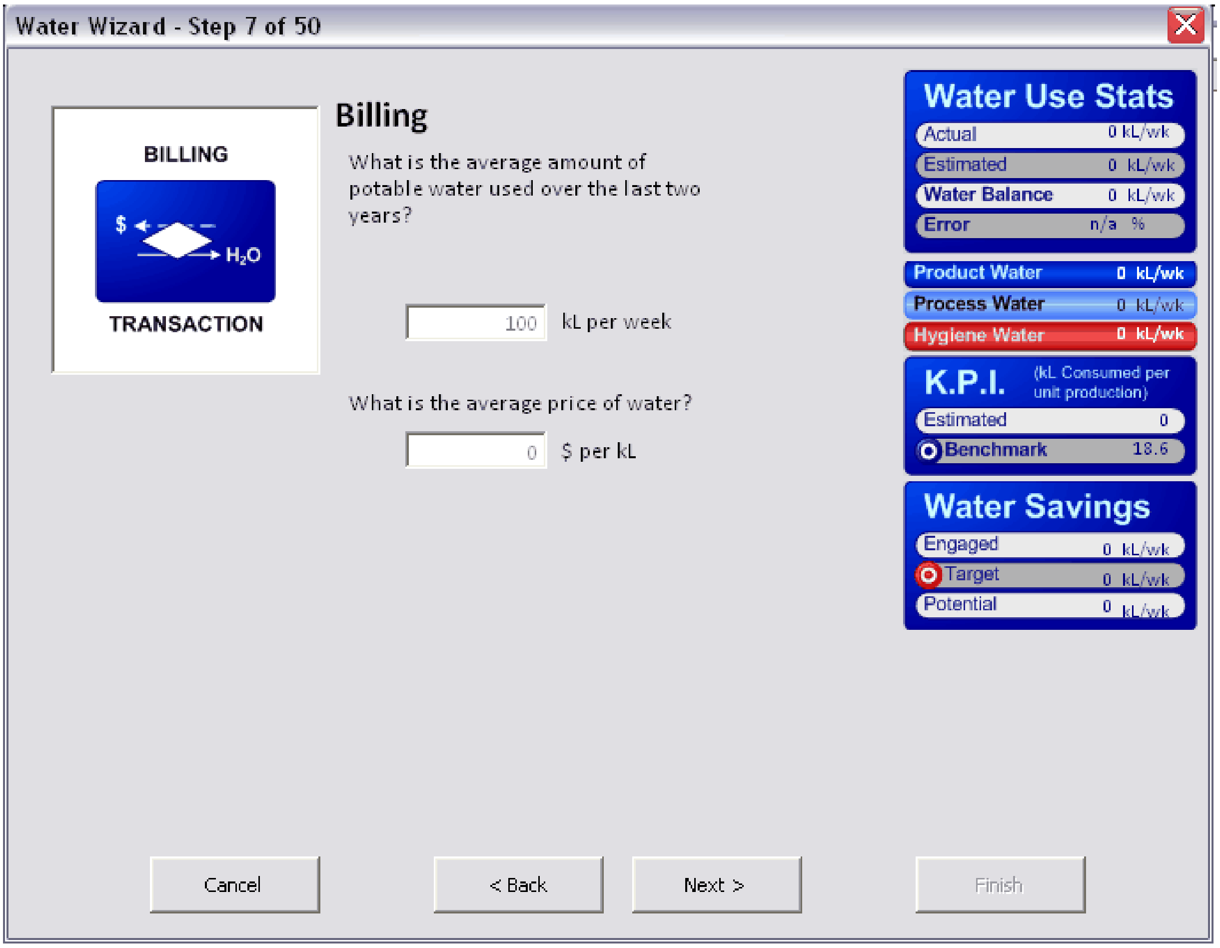
Screenshot 3. Selection of ANZSIC Group page of water wizard

After selecting this group, the user is now presented with an ANZSIC title to select from, and as shown in Screenshot 4, the user has selected an ice-cream manufacturer title. After selection of the ANZSIC group and title, the water wizard displays the benchmark to the right of the screen. In this instance the benchmark for Ice Cream Manufacturing is 18.6 kL/kL product. The user goes through nearly another 40 steps entering data for each step in response to various questions.



Screenshot 4. Selection of ANZSIC title page of water wizard

Screenshot 5 shows the average billing information input page used to acquire data on average historical water use. In this instance the user has entered 100 kL per week as their average billing water use. Notice the billing transaction icon to the left of the data entry point (GSI). This is the generic energy systems symbol for a financial transaction. When the user clicks the next button, their data is entered and stored in the wizard.



Screenshot 5. Water use page of water wizard

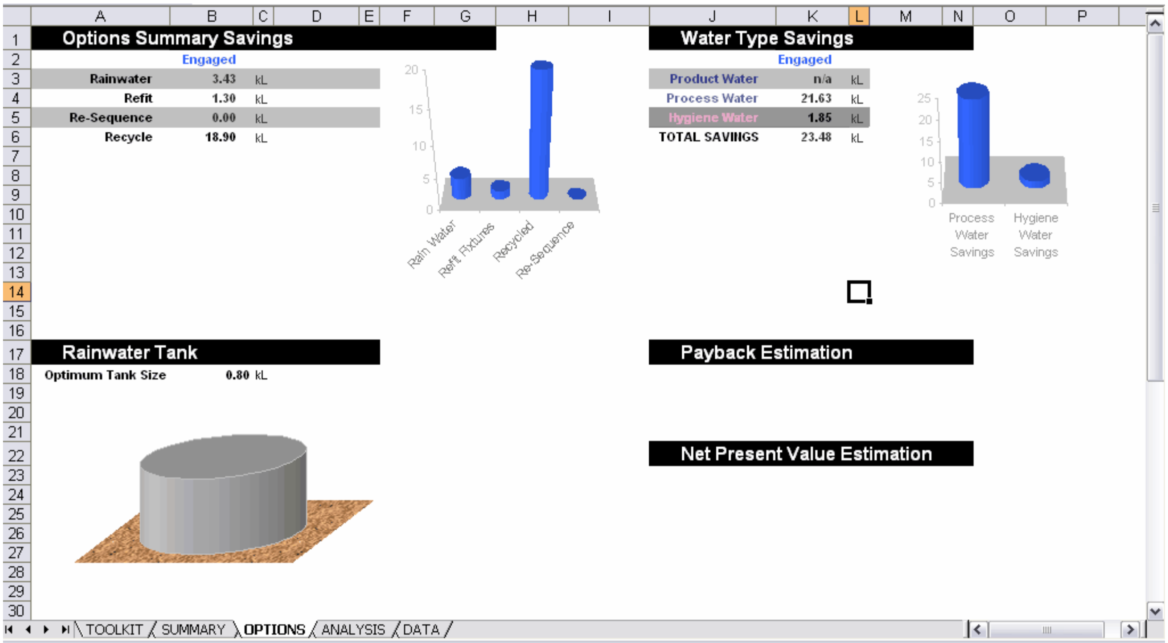
In instances where the user may have an option to save water, the wizard asks for information on water sources. For example, in Screenshot 6, the water wizard has already established how many toilets are onsite. It is now asking for the water source, and the user has replied that the source is rainwater. The user is then presented with the action option of using rainwater in the toilet as a source of water savings.

Screenshot 6. Water use page of water wizard

After the user has entered all of their information they arrive at the final page and can click the finish button, and data is entered onto the spreadsheet as shown in Screenshot 7. The results shown are hypothetical data. The summary output of the water wizard is shown in Screenshot 7. This summary reveals that the user of the water wizard has underestimated their water balance by nearly 20kL. The water wizard has a water balance validation step built in so that the user is warned when they have over estimated by more than 10%. If the user has underestimated their water balance by more than 10% a warning pseudo-validation form appears when they finish the wizard. The user can override the validation and proceed to the summary and options pages if they so choose. The values reported on the summary page are water balance, KPI benchmark and wizard estimate, and the water use breakdown, and best case estimates under the water type classification.

Screenshot 7. Summary output of water wizard

Screenshot 8 is of the options tag produced by the water wizard. The options tag reports on the water savings engaged from the options presented in the water wizard. Savings are broken down into four types of savings identified as rainwater substitution, fixture retrofit, re-sequencing of the process production order, and water recycling. In this instance, the water wizard presented the option of installing a water bottle rinse recycling unit, and it was estimated that this unit would save in the order of 19kL/wk of water. Engaged water savings are also reported under water type. The user has selected some rainwater substitution and the wizard has calculated the optimal rainwater tank size given the demand, and roof area input from the user. Payback and Net Present Value Estimations are not yet presented because the user has not yet started these parts of the toolkit. It was assumed no water savings could be achieved from the water embedded in the product.



Screenshot 8. Options output of water wizard

The wizard also presents an analysis of the data acquired from the user (Screenshot 9). This analysis reports on the potable water use estimate of each element in the wizard, together with estimates for engaged savings, potential savings, rainwater demand, refit savings, and the recycled water potential. The engaged and potential savings will be the same in some cases. This is because the toolkit makes no assumptions about the potential to save water, but rather takes the users estimate of potential savings as the best case scenario.

The toolkit user can cut and paste the analysis to their WaterMAP or Environment and Resource Efficiency Plans (EREPs) where appropriate.

	A	B	C	D	E	F	G	H
1	water type	Element	Potable Water	Engaged Savings	Potential Savings	Rainwater	Refit savin	Recycled water
2	hygiene	toilets	1.93	1.14	1.93	1.93	1.14	
3	hygiene	urinals	0.55	0.55	0.55	0.55	0.00	
4	hygiene	toilet taps	0.00	0.00	0.00	0.00	0.00	
5	hygiene	toilet cleaning	0.02	0.00	0.00	0.00	0.00	
6	hygiene	canteen cleaning	0.00	0.00	0.00	0.00	0.00	
7	hygiene	warehouse cleaning	0.00	0.00	0.00	0.00	0.00	
8	hygiene	office cleaning	0.00	0.00	0.00	0.00	0.00	
9	hygiene	freezer cleanin	0.00	0.00	0.00	0.00	0.00	
10	hygiene	industrial washing machine	1.00	0.00	0.00	0.00	0.00	
11	hygiene	cooling tower	0.00	0.00	0.00	0.00	0.00	
12	hygiene	garden	0.00	0.00	0.00	0.96	0.00	
13	hygiene	pavings	0.00	0.00	0.00	0.00	0.00	
14	hygiene	chiller	0.00	0.00	0.00	0.00	0.00	
15	hygiene	truck wash	0.00	0.00	0.00	0.00	0.00	
16	hygiene	process hand wash taps	0.27	0.16	0.16	0.00	0.16	
17	process	process line cleaning open end hose	0.00	0.00	0.00	0.00	0.00	
18	process	process line cleaning high pressure hose	0.00	0.00	0.00	0.00	0.00	
19	process	process line cleaning trigger nozzle	0.40	0.33	0.33	0.00	0.00	
20	process	process line clean in place	0.00	0.00	0.00	0.00	0.00	
21	process	process line clean straight through rinse	0.00	0.00	0.00	0.00	0.00	
22	process	bottle rinse	21.00	18.90	18.90	0.00	0.00	18.90
23	process	process floors cleaning	2.50	2.40	n/a	0.00	0.00	
24	process	process walls cleaning	0.00	0.00	n/a	0.00	0.00	
25	process	other	0.00	0.00	n/a	0.00	0.00	

TOOLKIT / SUMMARY / OPTIONS / ANALYSIS / DATA

Screenshot 9. Analysis output of water wizard

5.0 Observations

5.1. Participation & Retention

Through the Plenty Food Group, 19 industries were invited to participate. 12 expressed an interest in the study. Several industries needed to pull out due to production demands, and possibly also because the industries perceived the study costing them money and time.

5.2 Capacity to gather data

The study found that the capacity to gather accurate data in an industrial setting was limited by a number of factors which were outside the control of the researchers. The study found nearly all potential participants initially expressed good will towards the project. However it was also found that the study needed to balance the need to gather accurate data with the need to retain industry participation. That is, the researcher needs to be conscious of time-demand (& associated industry cost) and inconvenience whilst onsite.

5.3 Industry ethics thresholds

For those industries which had an overt community ethic and good will towards the project, the study found an apparent time-demand and inconvenience threshold. Passing the threshold appeared to transform the management attitude towards the study: from an attitude of good will, to an attitude seeking a Return On Investment (ROI). When the industry became focused on the ROI, the likelihood of industry retention in the study became reduced, which in turn reduced the capacity for data acquisition.

5.4 Toolkit Deployment

There are several draw-backs in deploying the toolkit as a one-shot system. For instance, various stakeholders such as government agencies are not able to acquire information on various Key Performance Indicators in order to establish benchmarks and best and worst practice. The one-shot system is also difficult to update with a static options database. Hence the toolkit is prone to being outdated, and the process performance profile not tracked. In addition, bugs cannot not be easily fixed, nor updates distributed once the toolkit file has been downloaded by industry.

5.5 Reliability of Assumptions

Various assumptions have been made for the simplification of the toolkit. Most of the assumptions were based on the information collected from auditing food industry or from published results. The assumptions made were reported in detail in Milestone Report 5.

The reliability and accuracy of the assumptions could be improved with further development of the toolkit. For example the toolkit could integrate an up-to-date fixture and utilities database which would provide specific details of the water use associated with the specific fixtures and utilities onsite. This would also increase the validity of the estimations made from the toolkit.

5.6 Validation and Verification

This phase of the Smart Water funded research was not specifically concerned with the validation and verification of water saved using the Toolkit. Hydroshare could be used for verification purposes. In an ideal environment, both verification and validation must be attended to. This is to ensure that the options provided do, in the final analysis, produce the estimated water savings, paybacks and net present value as a result of the toolkit’s calculations. However, this requires a long-standing commitment of the participating industry, funding body, and data analysis body such as a University, and would be best carried out by the industry voluntarily.

6.0 Conclusions

6.1 Industry Participation

Small industries could not see the benefit of participating in the study as there was no regulatory pressure to save water from the water authorities. The cost of water as it stands in 2008 is only a small component of the full production cost. However, this could change in the future.

6.2 Water Types

In the context of a ‘water-saving’ motivation, the data acquired from auditing an industrial setting needs to take into account the amount of water used in the product itself in order to provide a meaningful analysis. Hence the study separated water into product, process and hygiene categories.

The distinction between water types provided a first step towards establishing fit for purpose water balance saving opportunities to substitute potable water with alternative water sources where possible.

6.3 Incidental Novel Results

The research has produced some novel results in areas not anticipated prior to the research. For some of these results the details were not able to be fully reported in Milestone or Monthly Reports. For example, through the research we have explored some of the beginnings of a total information system for SME not previously available. We have also found some of the limitations of data acquisition in the absence of total systems analysis together with novel research in systems simulation and verification. Further consideration is given to some of these in the opportunities for further work section below.

6.4 Information Quality

The quality of the audit results varied according to the resources available during auditing, the capacity for the industry to provide accurate information, and the size of the food manufacturing process. Larger manufacturing processes were difficult to obtain accurate information on, because of the scale of the facilities, the large variety in products produced and different percentages of water in the product, and the variety of water using tasks associated with different processes. This level of complexity resulted in several general estimations and assumptions.

On the technology side, the research has highlighted the absence of inexpensive digital data acquisition equipment relevant to SME setting in the market, and has raised important methodological questions about the importance of such technology to sustainable water management. It is concluded that if a simple technology was available which could provide point specific data cheaply, and without massive labour costs, then not only would the data acquisition process be more viable and accurate, but it would also provide a strong business case for installation of such technology on a more permanent basis.

6.5 Water Savings Targets

The total water savings target was set at 10%. The toolkit will provide the water savings that could be achieved from each fixture (or appliance) or by using rainwater. It can be concluded that this would deliver a more accurate total water savings target than the total estimation. This would give water authorities a better indication of the potential and scope for the food industry sector to save water.

Water recycling options are not recommended in the toolkit. In some industries water could be recycled for fit-for purpose use. However, each company has to comply with the HACCP requirements before reusing the water. As such the toolkit reminds the industry to comply with the HACCP requirements before the recycling options are considered.

6.6 Industry Ethic

The study found that costs to industry associated with onsite auditing were more likely to be accepted by the industry when the management of the industry openly expressed a community ethic or philosophy. This was the case no matter what the industry size. In addition, those industries which did not have an expressed “community-oriented” or “good corporate citizien” ethic were more likely to participate when they could see direct benefit to themselves. While it was difficult to communicate the benefits of the toolkit, several managers could see the benefit of dynamic total systems information. Hence, we conclude that it could be useful in the future to develop a business case for this feature and to make the toolkit generally useful no matter what the industry ethic. This is included in the recommendations below.

6.7 Toolkit Development

The toolkit development took place at the same time as auditing. The toolkit was also developed as a "one-shot" evaluation system rather than a on-going, dynamic management system. A benefit of the "one-shot" system is that it has a lower level of complexity which makes development a relatively achievable task for one programmer. The comments from the industry and workshop participants were included in the toolkit if within the scope of the project. All participants at both workshops were very positive of the outcomes that could be obtained from the toolkit. It was recommended by the water authority officials that the Toolkit could be used as a tool to assist with water saving options prior to large companies (greater than 10ML/annum) preparing their Water Map.

7.0 A Vision of the Future

At the end of this year's research we have been exposed to, and participated in the development and use of many emerging technologies in the areas of reporting, data acquisition, process mapping and web-based services. From the viewpoint of the researchers, the experience of pioneering the toolkit has given us a glimpse of an exciting future in water management, water use analysis, the generation of water savings options for potential deployment, and the environmental services and resource management sector generally. Stepping back from the technical issues of auditing, coding, development and deployment, our experience has furnished a vision for the toolkit which was beyond the scope of the year-long project. The toolkit can provide a useful launching pad for ideas about the future development and deployment of what can be referred to as a massively scalable generic system (from local to global industrial & regulatory systems) that integrates cutting edge technologies and best practices from around the world.

We envisage that the generic model-based nature of such a system provides the potential for total system information on the local, regional and global sustainability of essential environmental resources. Furthermore, if deployed utilising web-based technologies such as XBRL (Extensible Business Reporting Language), this system may provide a nexus for the delivery of a system of sustainable water management and reporting.

8. Recommendations

At the industry workshop several major comments on development features were suggested. Many of the ideas were anticipated by the researchers and the researchers also too several concepts for further development. However integration of many of these good ideas were beyond the scope of this one year project. It is recommended that the various stakeholders and participants review the importance of future developments and recommendations documented in Appendix A, and act on them if appropriate.

8.1 Reliability of assumptions

The reliability and accuracy of the assumptions could be improved with further development of the toolkit. For example the toolkit could integrate an up-to-date fixture and utilities database which would provide specific details of the water use associated with the specific fixtures and utilities onsite. This would also increase the validity of the estimations made from the toolkit.

The toolkit currently accounts for average use of water in the product even if there is more than one product type manufactured in the industry. It is recommended to expand the Toolkit to incorporate more than one value for the percentage of potable water in the manufactured product so that multiple products can be entered.

8.2 Validation and Verification

The developed Toolkit did not validate and verify the amount of water saved as a result of recommended water saving options. In an ideal environment, both verification and validation must be attended to in order to ensure that the options provided do, in the final analysis produce the savings, paybacks and net present value estimated as a result of the toolkit's calculations. However, this is a long term commitment and best carried out by the participating industry itself.

8.3 Toolkit development

The Toolkit does not recommend fit for purpose recycling options. This is because of the strict guidelines with the water quality in the food manufacturing industry and the compliance with the HACCP and OH&S plans. It is recommended to integrate the current Toolkit with HACCP and OH&S plans in the future.

All the participating industries considered as a time consuming exercise for proving the past water use information from the water bills. It is recommended to integrate the toolkit with the Water Authority Accounts as presently provided by Yarra Valley Water WaterMap service.

The toolkit development took place at the same time as auditing. The toolkit was also developed as a "one-shot" evaluation system rather than on-going, dynamic management system providing real-time feedback. A benefit of the "one-shot" system is that it has a lower level of complexity which makes development a relatively achievable task for one programmer. This type of development has benefits and burdens, including delays in development due to the discovery of previously unspecified global variables. From a coding point of view it is easier to develop a software system which has requirements fully specified prior to the commencement of the study. However this kind of development does not necessarily have the flexibility needed to incorporate requirement novelty – that is, new requirements which are discovered during and after the course of study, development and use. The future development and specification of requirements may need to employ a flexible development methodology which has the capacity to incorporate requirement novelty

8.4 Corporate Alliance

The more recommendations incorporated, the more sophisticated the toolkit and software will become. With greater sophistication it is suggested that an appropriate structure of the body which administrates, maintains and develops the toolkit would be an alliance, similar to the Utilities Services Alliance, between a software provider, a water authority, various industry bodies, and a University to maintain independence of the options suggested. It is envisaged that the resulting toolkit would integrate already existing technical services and could be deployed in two versions, a free online version, and a licensed desktop version, which would attract a licence fee, but would contain sophisticated process mapping, HACCP and OH&S compliance alarms, and digital process monitoring technologies. This too could considered as the next state of Toolkit development.

8.5 Specify Value Proposition

In this study it has been found that the participation, retention of industries and capacity to gather data are all related. These in turn can be related to a Return On Investment (ROI) in research for industries through the concept of 'value proposition'. A value proposition is a common way a commercial entity to communicate benefits to the market in terms of the value that is returned due to an initial investment. At the beginning of the project the value of the study was communicated to the industry, in terms of the production of a toolkit to save water. What needs to be communicated is how the toolkit provides value to industry not only in terms of saving water and meeting sustainability objectives, but also in terms of saving the time and costs associated with managers, administrators and reporting on and monitoring water using process, and in the quality of the information provided in reports.

Appendix A: Issues for further consideration (next stage Toolkit development)

No.	Title	Recommended by	Recommendation Description	Issues Addressed
1	Value Proposition	RMIT	The value proposition for industries should be clarified in terms of comparative cost involved for administering WaterMAPs, and EREPs with and without the toolkit. That the toolkit will save time and costs.	5.4
2	Industry Based Testing	Industry	It would be useful for evaluation of the toolkit beta version to be industry based with the capacity for industries to provide development feedback and error reports.	5.5, 5.6
3	Process Metering	Industry	It would be useful for the toolkit to indicate the most appropriate locations for point spot check inspection meters.	6.5, 5.2
4	Process Data Acquisition	Industry	Ability to log data from either analog spot check meters or digital data acquisition devices and port data into toolkit for reporting purposes.	6.5, 5.2, 5.4
5	Dynamic Process Mapping	RMIT	Integrate the toolkit with the Hydroshare technology provided by Utility Services to provide dynamic process mapping from telemetry systems. This will address the need for *verification* of the water savings options.	6.5, 5.2, 5.4
6	Web-Based	Water Authority	Step by step setup format would be best available as a webpage	6.5, 5.4, 5.6
7	K.W.I. Data Acquisition	Water Authority	Ability for water authority to capture data on Key Water Indicators	6.5, 5.2, 5.4, 5.6
8	Dynamic Assumptions	Smart Water	Ability to change the assumptions made about fixture usage and volumes	6.5, 5.4, 5.5, 5.6

9	Restrictions Validation	Smart Water	Ability to implement different validation limitations on Water Action Options under different stages of water restrictions	5.5, 5.6
10	Compliance Validation	RMIT	Automatic notification to water authority if the toolkit uncovers an instance of non-compliance	5.5, 5.6
11	More Products	Industry	Ability for industry to enter more than one value for the percentage of potable water in the manufactured product so that multiple products can be entered.	6.5, 5.2, 5.5, 5.6
12	Dynamic Process Analysis	Industry & RMIT	Ability to track the performance profile of a process over time so that the toolkit is not "one-shot"(i.e. one use only).	6.5, 5.2, 5.5, 5.6
13	HACCP & OHS functionality	Industry & RMIT	The capacity to integrate with HACCP and OH&S plans	6.5, 5.2, 5.5, 5.6
14	Asset management	RMIT & Industry	Capacity to integrate with MYOB to automatically gather data on production and asset acquisition	6.5, 5.2, 5.5, 5.6
15	Integrate water accounts	Water Authority & RMIT	Capacity to integrate with a Water Authority Accounts as presently provided by Yarra Valley Water WaterMAP service	6.5, 5.2, 5.5, 5.6
16	Water Quality Analysis	Industry & RMIT	Capacity to integrate water quality analysis	5.6
17	Dynamic Options Database	RMIT	The options and fixtures database expanded to include all the options & tips produced in the Deloitte Draft Final Report to Nigel Corby, and databases such as the WELS database and Sustainability Victoria Database. This would also involve the construction of a validated, verifiable and therefore transparent fixture database with data on the water use of all fixtures available on the market – these would be available for the user to select.	5.4, 5.5, 5.6, 5.7.

18	Total Systems Analysis & Reporting	RMIT, EPA & Water Authority Water	Full-cost of water approach incorporated into the toolkit.	6.5, 5.2, 5.4, 5.5, 5.6
19	Water Performance Indicator	RMIT	Benchmarking against non-product water.	5.4, 5.6
20	Greater Specificity	RMIT & Industry	On-going dynamic management of the production process. Hence the interface would be a holistic management interface incorporating the parameters water inputs/outputs.	5.2
21	Data Transfer & Reporting	RMIT	Subsequent toolkits and projects should use XBRL and integrate the G3 Guidelines established by the Global Reporting Initiative (GRI).	