Smart Water Fund

Final Evaluation Report

Name:	University of NSW Centre for Water and Waste Technology
Project Description:	Creation of an Environmental Sustainability Assessment Tool (ESAT)
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Executive Summary

Providers of urban water services are being challenged by the need to cope with population pressure, aging infrastructure, climate change and an increasing need to focus on sustainable service provision. Life cycle assessment (LCA) and life cycle costing (LCC) are information tools which can assist organisations responsible for service and resource planning. Delivered by external service providers, the cost and contractual effort can be a barrier to application of LCA and LCC. Even when internal skill sets are developed, it is feasible to make these tools more efficient to use by the application of tailored software tools.

This project has delivered such a tailored software tool which works in the common Microsoft Excel environment. It enables water service providers in Melbourne to rapidly perform LCA and LCC on a range of technical service options at different scales. The development of the tool has been facilitated by continuous dialogue with the Melbourne water service providers, and represents a useful compromise between simplistic tools which constrain the field of possible options and complex tools (eg: commercial LCA software) which can take some time to use. Initial testing has confirmed its value in accelerating the rate at which quantitative environmental assessment can be performed during the early stages of the development of water servicing options.

City West Water
Melbourne Water
South East Water
Yarra Valley Water
Department of Sustainability and Environment

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1. Introduction and background

Urban water services in Australia are predominantly provided through centralised systems, involving large scale water distribution, wastewater collection and water and wastewater treatment. Through the development of such systems we can deliver reliable water and sewerage services which underpin our quality of life.

Increasing populations demanding more water and producing larger volumes of waste within a natural environment with fixed resources presents us with new challenges. The major cities of Australia need to consider many options to meet future water demand and at the same time take environmental and economic effects into account.

In order to meet future water demands, methods such as blackwater recycling, greywater reuse, rainwater tanks, stormwater harvesting, dual pipe systems and desalination need to be considered. Since each of these water servicing options have their specific energy requirements, contribute differently to climate change, release varying amounts of nutrients and come at different cost, it is important to be able to evaluate their environmental and economic impacts of the entire service provision.

Life cycle assessment (LCA), life cycle costing (LCC) and multicriteria analysis (MCA) have the advantage of allowing holistic assessment of alternatives, for example, they will consider the greenhouse emissions associated with the significant quantity of materials required by some decentralised service delivery strategies. They also have the disadvantage of being time and resource intensive as well as requiring a high degree of expert knowledge. The development of an environmental sustainability assessment tool (ESAT) allows the water industry to quickly compare alternative water and sewage servicing (infrastructure) options and be positioned to select the most environmentally sustainable approach.

2. Objectives and benefits

ESAT can help the Melbourne metropolitan water service providers with the task of comparing alternative water and sewage servicing options. Built on the common Microsoft Excel platform, ESAT represents a simple but flexible tool which allows for rapid characterisation of alternative water servicing options. It also ensures that a broad range of users can utilise the tool with relative ease. ESAT will perform quantitative life cycle assessment (LCA) and life cycle costing (LCC). Results for 5 environmental and the economic assessment category are consolidated by means of interactive multicriteria analysis (MCA) to show a final result for the preferred option.

The expected benefits of ESAT are a consequence of making sustainability assessment quicker and easier for water service providers:

- Accelerated delivery of sustainability assessments
- Support of 'sustainability thinking'
- Increased capacity to identify key variables that inform the sustainability of infrastructure solutions
- Increased capacity to innovate on the basis of insights into the relative sustainability of water and sewerage options

In order to strike the intended balance between specificity and simplicity, ESAT contains a large amount of very detailed information about each water servicing option. At the same time it is designed to be operated by a wide variety of users so the amount of data the user is required to enter is minimised allowing the rapid generation of results.

3. Project overview

Initial meetings with potential users of ESAT from each water service provider in Melbourne (Melbourne Water, City West Water, Yarra Valley Water and South East Water) assisted in defining the scope of the project. A first workshop was held shortly afterwards which involved the main stakeholders of each organisation. The outcome was a consensus on the different water servicing options to be included in ESAT and the environmental and economic evaluation criteria by which different scenarios are assessed.

The next phase of the project involved detailed data collection and analysis. A database was developed incorporating the materials, energy, financial costs, physical footprints and treatment performances associated with each water servicing option. The data was obtained from a variety of sources including our project partner organisations, literature, direct contact to system providers and results from previous LCA projects of the UNSW.

In the next phase of the project a beta version of ESAT was developed. Holding a second workshop and seeking feedback and suggestions for improvement from our project partners contributed towards the finalisation of a consolidated beta version. A period of thorough testing involving the application of real life scenarios by various planning engineers in the water organisations provided additional feedback which was subsequently incorporated into ESAT. The final version of ESAT was presented to the Melbourne water industry at a workshop in August 2008.

4. Final product – ESAT_v1.1

ESAT is based on the common Microsoft Excel platform. On the input screen users can select key variables from drop-down menus for each water servicing option to describe the scenario they are considering. The main input parameters for each sections are briefly explained in the following:

4.1 Household / building water balance

In order to determine the water demand and wastewater generation for a particular development, the ESAT-user can specify the **number of households / buildings** in the development and the **number of people per household / building**. An additional **water demand for non-household use** (i.e. municipal irrigation or industrial / commercial use) can be entered. Next, the ESAT-user will be able to indicate the expected **water ratings** for different pieces of equipment installed (e.g.: washing machine). For the **location of the development region** the ESAT-user can select from 5 areas in Greater Melbourne. ESAT will use this information to allocate the respective historical rainfall record which in turn determines rainwater and stormwater yields.

4.2 Potable Supply

The following **three water supply options** are available to choose from in ESAT:

- Conventional water supply (dam à water filtration plant)
- Desalination plant (seawater reverse osmosis)
- Groundwater harvesting

4.3 Rainwater

ESAT allows for the installation of rainwater tanks of different materials and sizes. Depending on the rainfall in the area selected, the connected roof area and the intended rainwater uses chosen, ESAT calculates the improvement in the household water balance. On a second level input sheet, an experienced user can adapt additional design parameters such as coefficient of run-off, first flush depth, etc. Various graphs are available to illustrate the results from the rainwater tank modelling.

4.4 Stormwater

The stormwater section in ESAT is divided into two parts – A and B.

In part A the ESAT-user may choose between two different stormwater treatment options: a raingarden or a surface wetland. The main focus is on the nutrient removal capabilities of both systems. The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Software was utilised to estimate treatment performance in terms of the key water quality parameters of interest (TSS, TN, TP) and the capital and operating expenditures for different sizes of both stormwater treatment systems.

In part B a separate stormwater reuse option is available. This option is characterised by the collection of stormwater running off from impervious surfaces around the house. Various end-uses for the stormwater may be selected. Additional design parameters for both systems can be entered and graphs can be viewed.

4.5 Decentralised wastewater treatment

A household scale greywater system as well as eight different household and neighbourhood scale blackwater treatment systems with varying treatment technologies may be chosen in ESAT. Their environmental and economic performance can, for example, be compared to a centralised sewage treatment plant. A range of recycled water uses can be selected.

4.6 Industrial / commercial wastewater input

The ESAT-user has the option to include industrial / commercial wastewater inputs. This option may become viable if the planned development includes businesses or industries which produce wastewater or if nearby existing businesses want to connect to the wastewater treatment system of the development. ESAT also caters for modelling the reuse of treated wastewater in case there is a demand for industry in the development.

4.7 Conventional STP

ESAT will determine automatically whether the development needs to be connected to a conventional STP or whether the chosen decentralised wastewater treatment systems will treat all wastewater from the development.

4.8 Water Recycling Plant (WRP)

Connection to a WRP and the supply of recycled water via a third pipe system back to the households is also a possible option in ESAT.

4.9 Reticulation

Three different reticulation systems are available to choose from in ESAT:

- Conventional Gravity System (CGS)
- Low Pressure Sewage System (LPSS)
- Vacuum System (VS)

Further input fields in this section allow for detailed modelling of different parts of the reticulation including the use of pipes of different materials, diameters and lengths, the installation of a number of pumping stations combined with rising mains and gravity mains and the incorporation of maintenance holes. At the same time it is possible model the connection to an existing sewer network and to enter the respective energy consumption involved.

4.10 Presentation of results

After entering all the inputs and updating the model, the ESAT-user can start to view the results. Two result tables on the input page show the water balance as well as physical inputs and outputs such as electricity, materials and money associated with the scenarios chosen.

In order to know what the potential impact of the overall system is, ESAT converts the inventory into impacts in the following categories:

- Energy,
- Water use,
- Greenhouse gas emissions,
- Nutrient discharge,
- Physical footprint, and
- Life cycle cost.

The results can be seen via graphs illustrating the potential environmental impacts of the specified water service scenario, expressed in relative terms as a percentage of the highest impact (=100%) in each impact category. In the example shown in Figure 1, scenario (SCEN) 1 has a larger impact on energy use, but SCEN 2 has a larger impact on water use.

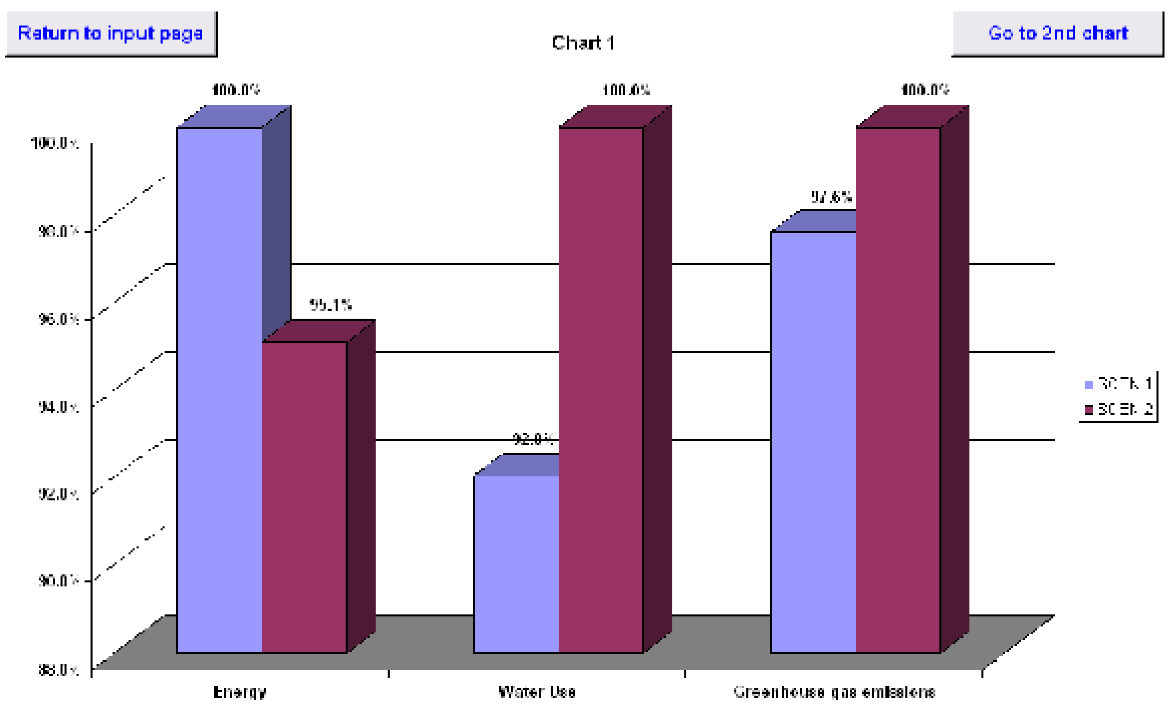

Figure 1: Environmental impacts for energy use, water use and greenhouse gas emissions

An impact table providing a detailed breakdown of the impacts of each scenario for each impact category serves as a basis for further analysis.

An aggregated result which combines the individual scores in each impact category by means of multicriteria analysis can also be obtained in ESAT. Based on weighting factors which can be entered for each impact category, a final result indicating the most favourable scenario will be presented.

In the example shown in Figure 2, SCEN 2 represents the preferred water servicing option.

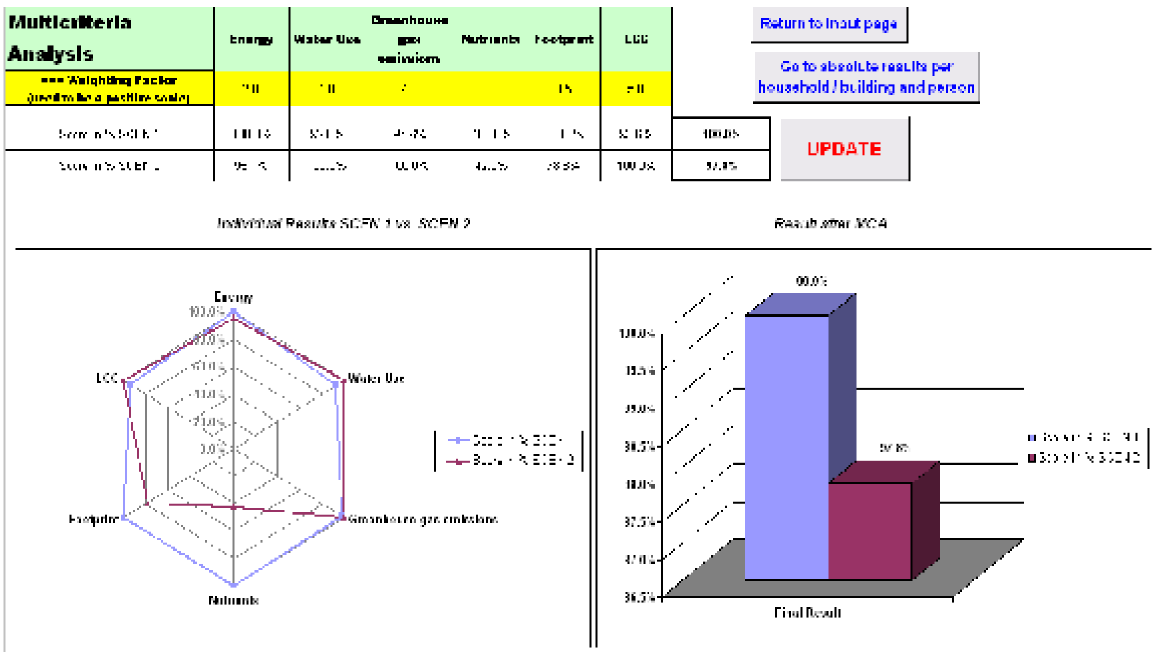

Figure 2: Individual results for both scenarios and final result after multicriteria analysis

Furthermore, the absolute results for each impact category are also available in tabular and graphical form on a per household / building and per person basis.

ESAT is a relatively intuitive tool and is basically self-explanatory. Extra built-in features such as greying of cells when inputs are not necessary for particular cases, prompts and message boxes, interactive comments as well as plenty of illustrations in form of graphs and tables make ESAT an easy to use tool and provide quick results on the environmental sustainability of particular water service scenarios.

ESAT comes together with a detailed manual describing the use of the tool and its capabilities. The user manual also provides some background information to help interpret the detailed database for each option and the methodology, conceptual framework, algorithms and assumptions used to develop the ESAT tool. For a detailed summary of the raw data incorporated in ESAT a separate spreadsheet is available.

5. Discussion and Recommendations

ESAT enables water service providers to quickly and inexpensively assess alternative water and sewage servicing options. Hiring consultants and developing models from scratch can be slow and expensive. Standard LCA software can be inefficient for simple projects. One of the maxims during the development of ESAT was to strike a balance between specificity and generality. ESAT is specific because it limits the number of variables and factors which have to be considered and hence can be adopted by a wide range of different users. At the same time it is general enough to be applied to a wide range of decision situations and still not too complex for new users to master.

ESAT has been tested in various real life scenarios by the project partners. It may develop further when applied in the everyday work examples of a wide range of planning engineers.

We estimate that the current version of ESAT will produce sensible results for approximately 3 years. After that a data update is considered appropriate.

6. Outlook and further activities

In order to ensure that a broad range of users in the Victorian water industry are aware of ESAT and know how to use it, the work will be published in industry relevant journals. ESAT will also be presented at the next Australian Life Cycle Assessment Society (ALCAS) Conference in Melbourne in February 2009. Furthermore, summarising paragraphs on ESAT will be released in the weekly AWA e-newsletter and the VicWater Sustainability group newsletter. This final project report will be available on the Smart Water Fund webpage.

7. Acknowledgements

The most important acknowledgement goes to the inventor of the idea and the founder of the project, Francis Pamminger from Yarra Valley Water, whose vision and initiative made this project possible.

We'd also like to thank our main partners in the other three water service organisations for their ongoing support and feedback over the course of the project namely Gordon Logan (South East Water), Owen Phillis (City West Water) and Erik Ligtermoet (Melbourne Water). At the same time we wish to express our appreciation for everybody in our project partner organisation who tested ESAT and provided feedback to us.

Further thanks goes to the Smart Water Fund and their staff involved for setting up and administrating this project, namely Simon Lees and Dale Alsford.