TO CENTRALISE OR NOT? BROADENING THE DECISION MAKING PROCESS

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Abstract

This paper aims to broaden the debate for developing and choosing wastewater systems. It is argued that the current focus on on-site versus centralized wastewater systems may not identify the best wastewater solution. A new process for the evaluation of wastewater solutions is proposed based upon risk management. Life cycle thinking is also used to comprehensively identify and evaluate risks associated with the materials, construction, operation, maintenance, and end-of-life management of wastewater systems. The process was applied to wastewater treatment within Berowra Creek, New South Wales. The risk management process highlighted that an option is preferable if it requires the lowest effort to control and achieve acceptable risk. A deliberative and consultative meeting was suggested to allow stakeholders and managers to assess the information presented and to outline a conceptual design.

Keywords

decision-making process, risk management, centralised, on-site, life cycle assessment, input output analysis

1 Introduction

Currently, there does not appear to be a transparent and effective process for choosing a wastewater system that best meets the needs of a particular scenario. Consequently, the debate has tended to focus on one type of technology versus another, which reflects and gives prominence to biases from a whole range of interests and perceptions. The debate of on-site versus centralized wastewater treatment is a prime example. The poor management and resulting failure of many on-site systems in the past has led to a common perception that on-site systems are inherently less reliable. Such systems are therefore viewed by some as, at best, a temporary measure before the installation of a permanent centralised system. However, depending on the particular scenario, the best solution could be either centralised or on-site or a combination of both wastewater treatment approaches. The following quote from the USEPA highlights the potential for decentralised systems and the necessity for management.

> "Decentralised systems, where properly managed, could protect water quality over the long term and do so at a lower cost than conventional systems in many communities." (USEPA 1997)

The first step in deciding on the best solution for a particular scenario is to identify the impacts to be managed by the wastewater treatment system. In general, short and long-term security of public health is the main driver for wastewater treatment. Short-term capital and long-term operation and maintenance costs are also an important consideration. In addition, short and long term environmental impacts are a serious concern and can also link to the issue of public health. Perhaps with the exception of political interests, the issues of health, cost and environment have a common *long-term* perspective due to the relatively long lifetime of the infrastructure. A fair comparison of different types of infrastructure needs to consider the whole life cycle of a wastewater system – from materials extraction at the beginning of the life cycle, through resources and emissions associated with actual use, to resource management at the end of the infrastructure's life.

The management of the wastewater system over its life cycle will have a large affect on the possible impacts. For example, a well-constructed and well-maintained wastewater system has a reduced likelihood of failing and therefore reduced potential to cause impact. The impact associated with a particular technology in a particular scenario is a function of *both* likelihood and consequence. That is, the probability of a particular occurrence and the seriousness associated with that occurrence. This is essentially a risk management process. Consequently, the comparison of wastewater solutions becomes a consideration of the acceptable effort to control risk and the evaluation of different types of risk rather than solely an evaluation of technology.

Under the auspices of the ***Septic✓Safe*** program funded by the NSW Department of Local Government, a risk-based decision-making process for wastewater solutions was developed. The project was a collaborative venture with Hornsby Shire Council, who identified Berowra Creek as their preferred case study. Berowra Creek is located about 50km NW of Sydney, and is a major tributary to the Hawkesbury-Nepean River. It supports significant recreational activities, as well as oyster leases and commercial fishing. Approximately 200 people live along Berowra Creek. These residents all rely on on-site wastewater treatment (Webb *et al.* 2000). A major centralised sewage treatment facility discharges into the headwaters of the creek, releasing large volumes of fresh water and significant quantities of nutrients. The Creek has suffered serious algal blooms.

The Creek is fresh water in its upper reaches, brackish in its middle, where residential, recreational, and commercial activities begin, and marine in its lower reaches where it joins the Hawkesbury River approximately 25 kilometers from the ocean. The Berowra Creek catchment has an area of 310 square kilometers and approximately 70% is covered by bush land. In general, the Creek is characterized by steep slopes and shallow sandy soils that have poor water holding capacity and are highly erodable. As such, it is typical of many coastal communities in the greater Sydney basin.

There is considerable concern over the quality of the Berowra Creek waterway as highlighted by the Statement of Joint Intent regarding the issues and management of the Creek and signed by all levels of State Government and many community groups. There is also concern over public health from existing on-site sewage systems (HSC 1998). As a background to the concern about the degrading environment of Berowra Creek, the Wallis Lake incident offers a reminder of the possible consequences. The oyster industry in Berowra Creek makes the similarities to Wallis Lakes even more obvious.

2 The Process

Australian Standard 4360: 1999 Risk Management was used as the framework for the process of developing the best wastewater solution for a particular scenario. Concepts of Life Cycle Assessment provided the long-term perspective required to identify risks and to define the unit for comparing wastewater solutions. In particular, Australian Standard 14040 Environmental Management – Life Cycle Assessment – Principles and Framework provided guidance. Environmental impacts were quantified using a life cycle assessment process based on input-output analyses [Lenzen (in press), Hall (2001)].

Figure 1 illustrates the stages of the process. Each step of the process is important for assessing impacts and formulating a wastewater solution. In practice, it is tempting to skip over some steps. However, doing so severely reduces the chances of finding the best solution for all concerned over the life cycle of the infrastructure. Each stage is expanded below.

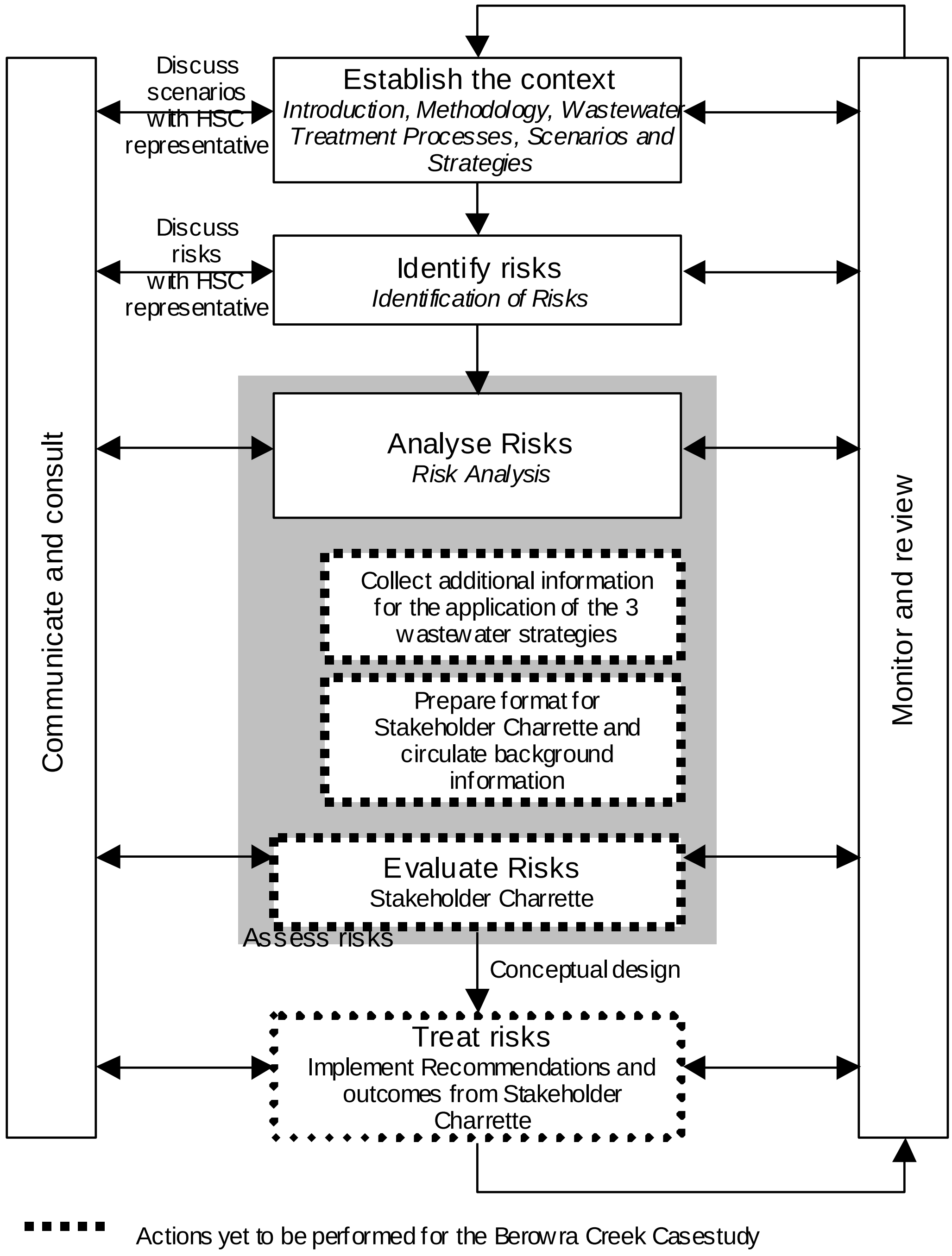

Figure 1 Risk Management Methodology

2.1 Establish the Context

A description of the social/political, financial and environmental climate introduces the context of a wastewater solution for the particular area. This is a very important stage of the process because it draws on existing information and acknowledges perceived limitations and opportunities. It also identifies the key stakeholders.

2.2 Identify Risks

Risk identification is "the process of determining what can happen, why and how" (Standards Australia AS 4360:1999). The Standard goes on to state:

> "Comprehensive identification using a well-structured process is critical, because a potential risk not identified at this stage is excluded from further analysis. Identification should include all risks whether or not they are under the control of the organization." (Standards Australia AS 4360:1999)

We addressed this notion of comprehensive identification by using life cycle thinking. That is, the risks of wastewater treatment were identified over the whole life cycle of the infrastructure, incorporating extraction of materials, manufacture, installation, use, and final reuse and/or disposal. This aspect of our approach is significantly broader than other risk management frameworks that have been suggested for on-site systems (Brown & Root, 2001).

Risks were broadly categorised as either socio-economic or environmental. This broad characterization allows all risks to be identified whether or not they fit neatly into existing methods of analysis. A range of indicators was selected to provide quantitative data where possible of social and environmental risks over the life cycle of the wastewater system.

2.3 Analyse Risks

A number of wastewater technologies were chosen in discussion with Hornsby Shire Council and various on-site experts. The use of each technology was described and linked to an appropriate risk management control. Risk management controls can link into decision-making mechanisms such as "existing management, technical systems and procedures to control risk" (Standards Australia, 1999).

The risk management standard (Standards Australia, 1999) advises separating minor or acceptable risks from major risks. This requires data to assist in the evaluation and treatment of risks. This data was generated from calculations using life cycle costing, input/output analysis and process analysis over the whole life cycle of each wastewater solution. Not all the risks and impacts identified in stage 2 are quantifiable. Thus, our input-output life cycle model (Lenzen 1999) for quantification was restricted to the environmental impacts of global warming, water use, and land degradation, and the socio-economic impacts of life cycle cost and employment.

2.4 Evaluate and Treat Risks

Risk evaluation is the interpretation of different perceptions of the likelihood and consequences of an event. The likelihood is dependent on the ability to implement risk controls and the severity of the consequences is dependent on people's values. Therefore risk evaluation and treatment must be conducted with the input of those responsible for managing the risk and those stakeholders affected by the risk. This necessitates a consultative and deliberative approach. It is important that the approach is consultative to allow a range of values to be expressed regarding the consequences of an event. It is also important that the approach is deliberative to allow the exchange of information between experts and stakeholders about the likelihood of risks and the options for managing risks.

We proposed just such a process to develop a conceptual design for the wastewater solution. We used the term 'charrette' to describe this process, since it is similar to a format already widely used and advocated by the American Institute of Architects (AIA 1998). The advantage of a charrette over other processes is the additional outcome of a conceptual design or suite of designs to steer the rest of the decision process.

3 Applying the Process

Risk management highlights that an option is preferable if it requires the lowest effort to control to achieve acceptable risk. Risk management can only confidently identify a solution that is preferable to the stakeholders if the stakeholders are part of the risk evaluation and treatment process. The application of the risk process to Berowra Creek demonstrated that the presentation of a set of data or a recommendation from an "expert" may not deliver the option that requires the lowest effort to achieve acceptable risk.

The following information is presented to illustrate the scope of issues that need to be considered in the evaluation and treatment of risk. It does not use a stakeholder group to evaluate and treat the risks and so cannot identify the preferable option for the stakeholders.

Following discussion with Hornsby Shire Council, suites of wastewater technologies were assembled into nine options for wastewater treatment within Berowra Creek. The list of technologies (see Table 1) is not intended to be exhaustive. Rather, it combines common on-site wastewater technologies with common-sense strategies. Each option was investigated in terms of the materials, construction, operation and demolition of the wastewater systems on a site-by-site basis. In the first stage of the investigation, risks and likely control mechanisms were identified. In the second stage, the risks and impacts amenable to quantification were assessed using our input-output life cycle model (Lenzen in press).

Table 1 Wastewater Options for Berowra Creek

OPTION	PROCESSES
1	Water efficiency retrofit, compost toilet, upgraded septic tank, subsurface wetland, leachfield
2	Water efficiency retrofit, compost toilet, upgraded septic tank, subsurface wetland, sand filter, leachfield
3	Water efficiency retrofit, compost toilet, upgraded septic tank, pump-out, package treatment plant
4	Water efficiency retrofit, compost toilet, upgraded septic tank, pump-out, truck and treat at STP
5	Water efficiency retrofit, upgraded septic tank, subsurface wetland, leachfield
6	Water efficiency retrofit, septic tank, subsurface wetland, sandfilter, leachfield
7	Water efficiency retrofit, AWTS, leachfield
8	Water efficiency retrofit, upgraded septic tank, pump-out, package treatment plant
9	Water efficiency retrofit, upgraded septic tank, pump-out, truck and treat at STP

Table 1 shows that all options begin with a water efficiency retrofit. The efficacy of this step was highlighted by the risk management process. Other work carried out by the Institute for Sustainable Futures (Carew *et al.* (1999) has demonstrated that both the likelihood and the severity of the consequences of failure are reduced by decreasing the volume of water entering the wastewater treatment system.

The collection of data for the risk factors showed that centralized systems are not necessarily the best wastewater strategy for Berowra Creek. In particular the data showed:

- Sewage decomposition dominated the release of greenhouse gases over the life cycle of the wastewater systems, creating a bigger Climate Change Potential than emissions from fuels consumed to produce and operate the infrastructure. Treatment processes using anaerobic decomposition have a much greater Climate Change Potential than aerobic processes. This highlights the risk management aspect of particular technologies. For example, systems which are designed to operate aerobically may operate anaerobically if inappropriately maintained. This difference in management severely affects the environmental risk associated with a particular option.
- Water used to operate the wastewater system dominated the use of water over the life cycle of the wastewater systems and was much greater for communities with reticulated water than for those with tank water. Some processes such as composting toilets further reduce the water used. Water reduction facilities for the household control risk by reducing water use by up to 40%; either reducing the size of the treatment system required and/or improving the effluent quality through better treatment capacity; and reducing the volume of effluent released to the environment.
- Impact on land and employment was dominated by the production of materials. This was due to the multiplier effect throughout the economy and because the production of infrastructure requires the extraction and harvesting of materials from various ecosystems. The specification of materials from ecosystems that are known to have

acceptable environmental and social impacts can control the impact on land. The land used for the location of treatment systems is relatively small compared to the land impact to produce the system. However, the land that the system occupies will be of obvious importance to residents, especially for on-site treatment systems. This highlights the need for a consultative and deliberative process that takes heed of various perspectives for particular scenarios.

- The lowest cost options over a 20-year time period were on-site systems. This partly reflects the high annual cost estimate of pump-out of effluent, which becomes a large cost over a 20 year time period. The annual financial cost for effluent pump-out requires further investigation.
- The life cycle cost of a number of on-site options was dominated by high capital costs. These systems require financing mechanisms to spread the cost of the system across the lifetime and reduce the impact of upfront capital costs.

Whilst these results are enlightening, they are also confusing. Different options perform best in different impact categories. Not all impact categories are quantifiable. Hence, the decision on which impact/s have priority, and what level of quantification has meaning, and therefore which option/s provide the best outcome, is one that needs to be made by all those who are responsible for managing and evaluating the risks.

4 The Next Steps

The above analysis takes a site-by-site approach. The management authority for a particular region (eg the local government authority) may choose to consider these issues on a broader basis, such as community-wide, ecosystem-wide, or catchment-wide. When all sites within Berowra Creek are considered, some *strategic* wastewater issues arise. These were dealt with by grouping the options investigated above into three strategies for further risk evaluation of wastewater treatment for Berowra Creek:

- Strategy 1: On-site effluent disposal
- Strategy 2: Off-site effluent disposal
- Strategy 3: Off-site and on-site effluent disposal

The deliberative and consultative process proposed for risk evaluation and treatment could focus first on the strategy level, then go into further detail once a strategy has been agreed. Thus, the outcome of the charrette could be a preference for one of the three wastewater strategies and a conceptual design for wastewater treatment within Berowra Creek. The details of the charrette are still being developed and are yet to be trialed.

Regardless of the wastewater options adopted, a number of short term controls were recommended to reduce current risk. For example, failing septic tanks adjacent to oyster leases are a severe risk to human health and require immediate action. It was also suggested that a program be developed for desludging septic tanks as the lack of desludging has been identified as one of the major causes of failure (HSC 1998). In addition, water efficiency upgrades were also suggested as a way of minimizing the human health and environmental risk of current on-site systems. The payback period for a water efficiency upgrade is reported as approximately 2 years (EPA 1997), which offers low financial risk. The water efficiency upgrade also reduces the risk for new infrastructure by reducing the size of the infrastructure required as well as both the volume of water consumed and effluent produced.

5 Conclusion

In summary, our intention was to devise a process that would enable broader discussion about the various options available for wastewater treatment. We do not advocate that either on-site or centralised is necessarily better, but rather that through this decision making process, the debate might be broadened, so that a broader range of technology suites might be considered, and evaluated over a broader base of impacts by a broader base of people. We also sought to highlight the impact of management practices, and the idea that risk has both probability and consequence elements, both of which are critically dependent on management decisions.

We took two established processes (Risk Management and Life Cycle Assessment) and weaved them together. The resulting process we advocate here grew out of trying to find an answer to the wastewater treatment question for a sensitive (both ecologically and politically) creek within the greater Sydney basin. Using life cycle thinking and input-output analysis, we have quantified the pros and cons of various technology suites, but have shied away from providing them here because we believe that the inevitable weighting process of these factors should be undertaken by all those involved, and this is yet to occur.

We offer this process as one means of moving beyond the on-site versus centralised divide.

Acknowledgments

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