Australian Water Recycling
Centre of Excellence

Project Report

Water Reuse and Communities ToolKit

Module 2: Community Understanding of Risk and Safety in relation to Recycled Water

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Australian Water Recycling Centre of Excellence

Victoria University, November 2014

Water Reuse and Communities Toolkit
Module 2: Community understanding of risk and safety in relation to recycled water

This report has been prepared as part of the National Demonstration, Education and Engagement Program (NDEEP). This Program has developed a suite of high quality, evidence-based information, tools and engagement strategies that can be used by the water industry when considering water recycling for drinking purposes. The products are fully integrated and can be used at different phases of project development commencing at 'just thinking about water recycling for drinking water purposes as an option' to 'nearly implemented'.

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About the Australian Water Recycling Centre of Excellence

The mission of the Australian Water Recycling Centre of Excellence is to enhance management and use of water recycling through industry partnerships, build capacity and capability within the recycled water industry, and promote water recycling as a socially, environmentally and economically sustainable option for future water security.

The Australian Government has provided $20 million to the Centre through its National Urban Water and Desalination Plan to support applied research and development projects which meet water recycling challenges for Australia's irrigation, urban development, food processing, heavy industry and water utility sectors. This funding has levered an additional $40 million investment from more than 80 private and public organisations, in Australia and overseas.

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Module 2: Community Understanding of Risk and Safety in Relation to Recycled Water

Executive Summary

- Clear and effective science communication with the public over future options for water supply requires understanding the ways in which people judge acceptable levels of risk and safety, both individually and collectively. The body of literature on perceptions of risk, mostly derived from empirical experiments in psychology, shows that human calculations of risk are not always rational, and not always corrected by contradictory experience.

- Judgements about the risk involved in a particular technology are often affected by the availability of information about its benefits. If information about the benefits of a technology is readily available, cognitive heuristics (rule-of-thumb shortcuts) can cause us to mistakenly infer the risk associated with that technology is low (even though this may not be the case). Any education and engagement program must place a heavy emphasis on promoting the ecological and sustainability benefits of water reuse to build a positive affective association for water reuse. Without this, reuse technologies may be unfairly judged as associated with a higher risk than is scientifically justified as inferred from a negative affect (arising from a perception of 'no benefit').

- The building of trust and transparency are critical to effective scientific communication with the public, as credibility biases impact on how information is judged. Any attempt to remove barriers to the acceptance of potable reuse must focus on making all information available and building trust relationships with the community. This could be done by co-involvement of environmental and community groups in the consultation process.

- Trust in water authorities is a key criterion to build in order to remove barriers to potable reuse. This can be developed by ensuring a high level of functioning in existing (non-recycled) water supply to develop a longer term perception of quality. Sometimes what is most important is not what is being said, but who is saying it.

- Adequate consultation and perceptions of fairness can help ameliorate community concerns, by providing a sense of identity and involvement in water planning decisions. Research on procedural justice shows us that it is not only the outcomes of decisions that are important in perceptions of fairness, but the processes and stakeholders involved in those decisions.

- Socioeconomic and cultural background has been shown in number of studies to correlate to acceptance of water reuse. However care must be taken to ensure that this correlation is not the result of some common underlying variables.

- Heuristics are used to dictate what is clean and what is contaminated and are embedded in all aspects of social and cultural life. These are primarily emotional responses, and often come into conflict with our rational knowledge of actual contamination. This is a significant and real barrier to water reuse that must be taken seriously.

- The best ways to overcome the association of recycled water with contamination are; (1) to maximize the number of steps between the water source and final output, and; (2) to provide the maximum positive association with the intermediary steps.

- Douglas and Wildavsky (1982) propose that substances that cannot easily be classified into categories of clean or dirty are considered to be ‘dangerous’. As recycled water is considered both dirty or clean depending on how far advanced it is in the treatment process, it thus comes to be considered as ambiguous and thus dangerous. In order to resolve this ambiguity, treated water should be named differently in pre-treatment and post-treatment stages to delineate between two separate entities. In the example of Singapore, “used water” and “NEWater” are used to create separation between the product before and after treatment.

Module 2: Community Understanding of Risk and Safety in Relation to Recycled Water

How does the community understand risk?

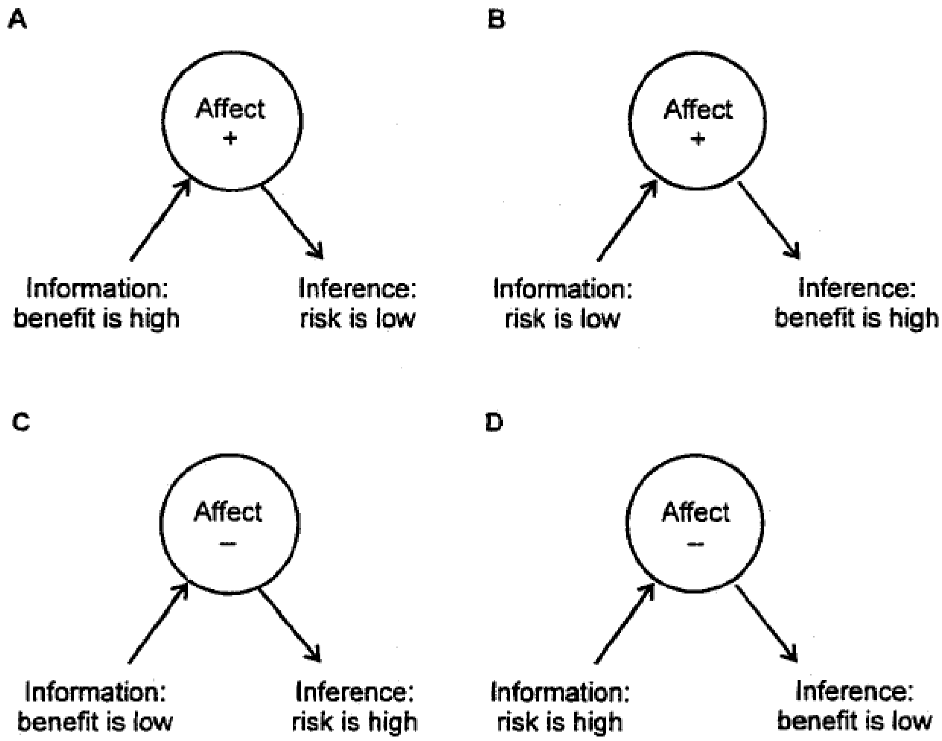
Fischhoff et al (1982) show that in general, people are not very good at accurately rating the risk in society around them. Certain types of risks are overestimated, and certain types are underestimated. The ratings around the incidence of waterborne diseases are typically overestimated, and this is a significant barrier to public acceptance of water reuse.

Why are humans not always good at judging risk? Three major schools of thought in examining the social perception of risk have emerged since over the last fifty years. The first, based on rational choice economics, looks at judgments of risk in terms of costs and benefits. The second school, emerging from social psychology and behavioural economics and often associated with Daniel Kahneman, Paul Slovic, Amos Tvesrsky, and Melissa Finucane, has come to be known as the 'psychometric approach'. These theorists tended to focus on the role of biases and heuristics in individual assessments of risk. The third school, sometimes identified as the Cultural Theory of Risk, tends to focus on the role of cultural constructed schemes of classification rather than the individual, in reinforcing 'matter out of place'. These latter two schools are often combined, in approaches such as cultural cognition theory.

Psychometric approaches to the perception of risk

Dual-process theories of human cognition (e.g. Kahneman, Slovic, & Tversky, 1982; Kahneman & Frederick, 2002) provide us with some explanation as to why risk assessment, especially for novel risks such as water reuse, are often woefully cautious, making us instinctually 'feel' danger when there is no reason to. Slovic et al (2004) argue that the human mind does not always employ formal risk analysis, and calculate cost-benefit payoffs rationally. Rather, this form of judgment operates slowly, so quick decisions are made by a more affective system that is capable of making calculations that require less time and mental energy. Thus they counter-pose an 'analytic system' that employs probability calculus and formal logic, against an 'experiential system' that is intuitive, associative, and automatic. One of the most insightful features of dual-process theories for the consideration of alternative water sources is that they help to explain why, in an affective sense, higher risk is often incorrectly inferred to associated with a lower benefit when from a rational perspective, higher risk activities are more likely to be undertaken only when there is a high benefit. To say this another way; in the real world, high risk activities that are actually undertaken are likely to yield high benefit, and low risk activities are likely to yield low benefit. Thus risk and benefit are likely to be positively correlated. In the fast-acting affective system, they are perceived as negatively correlated. The figure below is reproduced from Finucane, Slovic et al (2000) to demonstrate this point with nuclear power.

Figure 1: Inferences made from available information about benefit and risk (reproduced from Slovic et al (2000).



If water reuse risk is allowed to be seen to be high, then it assumes a negative affect, and is thus wrongly felt to result in a low level of benefit. Likewise, if benefit is thought to be low, a negative affect will become associated with water reuse, thus making the affective system believe the risk is high, even when there is no information available from which risk calculations may be made. Thus an understanding that water recycling does not carry with it significant benefits (environmental and personal) may, using the fast affective system, contribute to a false inference of risk. Finucane, Slovic et al (2000) report that experiments (n=54), Australian participants (n=54) made higher negative correlations between benefit and risk (in situations where this was unjustified) when time-pressured. These correlations are reproduced below for each time condition.

Table 1: Time pressure and risk judgements from an experiment conducted by Finucane, Slovic et al (2000).

Item	Time pressure	No time pressure
Alcoholic beverages	−0.71**	0.07
Water fluoridation	−0.68**	−0.33
Chemical plants	−0.62**	−0.10
Eating beef	−0.53**	−0.30
Food preservatives	−0.52**	−0.24
Cars	−0.48**	−0.36*
Cigarettes	−0.48**	−0.24
Pesticides	−0.47**	−0.07
Natural gas	−0.41*	0.13
Chemical fertilizers	−0.41*	−0.07
Explosives	−0.39*	−0.10
Cellular phones	−0.36*	−0.44*
Food irradiation	−0.35*	−0.01
Roller blades	−0.31	−0.02
Nuclear power plants	−0.30	−0.07
Surfing	−0.28	0.01
Swimming pools	−0.27	−0.28
Solar power	−0.27	−0.03
Railroads	−0.25	−0.02
Air travel	−0.22	0.21
Motorcycles	−0.20	−0.16
Microwave ovens	−0.06	−0.23
Bicycles	0.02	−0.04
Mean r	−0.37	−0.12

*$p < 0.05$ (one-tailed)
**$p < 0.01$ (one-tailed)

Most relevant to water reuse here is the judgment for the risk caused by water fluoridation. When under time pressure (as opposed to when not), participants who viewed fluoridation as of high benefit (proponents) were more likely to judge it as low risk, and those who viewed is as low benefit (opponents) were more likely to judge it as high risk, thus affectively associating their views with risk. The implications of this for removing barriers to potable reuse are that to ameliorate the perception of risk, discussion must move from the quick thinking affective system, to the slower thinking rational system. Empirical evidence does exist for the efficacy of this, as manipulating the level of benefit in a laboratory setting for three scenarios (food safety, gas safety, and nuclear power) demonstrated that being informed of higher benefit reduced perception of risk in 54% of cases (Finucane, Slovic et al, 2000). The primary benefit of potable reuse in most cases is likely to be environmental sustainability, however in the Singapore case, appeals to national pride were a significant factor. By reducing political and economic dependence on imported water piped from Malaysia, national self-sufficiency was stressed as both a desirable and necessary security goal.

The other important aspect of the work of Finucane, Slovic, et al, is their demonstration that for low risk activities, there is a natural insensitivity to probability. Loewenstein et al. (2001) give the example that one's feeling towards winning the lottery are generally the same whether the probability is one in 10,000, or one in 10 million. Thus what most drives fear of extremely rare but catastrophic events such as being contaminated by water-borne diseases is not the probability, but the possibility. Demonstrating to the public the reduction of minuscule risks in such rare events is not always effective, as the insensitivity to probability does not always change opinion.

One of the most damaging ways in which perceived risks can become amplified is stigma. Paul Slovic defines stigma as going beyond hazard awareness, but a conception in which something becomes (collectively) shunned or avoided as it is perceived as blemished. In other words, the negative affect discussed above, as an ill-considered judgement at the individual level, is amplified through media, society, and culture, to become considered negative collectively, without due consideration of actual risk and safety. He notes that the beginning of the stigmatisation process often occurs due to a "critical event, accident, or report… (which) sends a strong signal of abnormal risk". The need to raise the question of water reuse long before actual implementation is crucial here, so no perception of public hazard can develop. In their book on risk and stigma, Flynn and Slovic (2001) provide the following set of factors for coping with stigma:

Table 2: Strategies for avoiding stigma

Aim	Strategies
1. Prevent stigmatizing events	Avoid events and advertising which generate and reinforce stigma
2. Reduce perceived risk	Create and maintain trust
	Inform, educate, and desensitize the public
	Educate scientists about how the public perceive risk, and that quantitative risk assessments may actually increase fear
3. Reduce social amplification of risk	Educate media about stigma
	Educate government about stigma
4. Reduce impact of stigmatizing event	Provide Insurance
	Provide compensation

(adapted from Flynn & Slovic, 2001, page 341).

In the specific case of water reuse, authorities need a two-headed strategy. The first part is technical, in recognising how potentially damaging system failure events might be, and adequately preventing and preparing to remedy them. The second part is in community engagement, in meaningfully addressing the perceived risks and concerns of the public, as well as stopping the social amplification of risk through society and media leading to stigma.

Cultural Theories of Risk and Contagion

One of the most important ideas with relation to new water sources is the idea of contagion and cleanliness. Recently, Russell and Lux (2009) have questioned the dominance of 'psychometric theories' of emotional response from social psychology in community perception of contagion in potable water. Specifically, they argue that there are no innate or instinctual tendencies to emotional response to reuse. They suggest a better approach would be to move to a more sociological and cultural explanation, that can take into account the significant shifts that have occurred in public opinion over time towards recycled water. In this section, some work from the third school of thought in understanding the perception of risk, the Cultural Theory of Risk described in Section 4 will be discussed. Dingfelder (2004) reports on experiments by Haddad & Rozin (reported in APA Monitor) that argue the importance of the emotional response to contamination, the so-called 'yuck factor'. In an article published in 1986 in the Journal of Personality and Social Psychology (Vol. 50, No. 4), Rozin et al (1986) placed a sterilized cockroach into a glass of drinking water. The result was that only one of fifty participants was willing to drink the water, but after removal of the sterilized cockroach, only twenty participants would drink the water. In another experiment, Rozin & Nemeroff (1990) served apple juice in a brand new bedpan that had been washed. The majority of participants eschewed the drink, because of cultural associations of the bedpan with contamination, even knowing that it was brand new. Such heuristics are from an evolutionary perspective, perfectly useful, and encoded in shorthand as emotional responses. However when rational responses (the understanding that the bedpan was brand new and poses no contamination threat) contradict primal emotional responses, the latter often still predominate. As a solution Rozin suggests maximizing the chain of association, by inserting as many steps as possible in between the contagion and the point of consumption. The most commonplace part of this is in indirect potable reuse, by using an aquifer or reservoir as an intermediary.

In the British Structural-Functionalist school social anthropology, the concept of sympathetic magic expresses the same idea as Rozin's contamination experiments in Psychology. The notion of sympathetic magic, as first proposed by Frazer (1922) stipulates that the Law of Contagion, that "things which have once been in contact with each other continue to act on each other at a distance after the physical contact has been severed". Generally speaking, such ideas have been found across all cultures throughout the world. This idea has had increasing currency within the sociology and psychology of water, particularly in the work of Rozin & Nemeroff, in their cockroach experiments described above.

The practical applications of such a theory for the removal of barriers to water reuse, is to increase the perceived number of steps between the input and the output in the process, such that the level of contact and contagion is diluted. This can be done in two ways: by increasing the physical number of steps between the source of contagion and the output (for example, in indirect potable reuse have two intermediary reservoirs instead of one); or by increasing the perception of the number of steps, for example in naming stages of the process. Thus in Singapore, the delivery of NEWater is a totally different and demarcated phase from recycled water.

Similar evidence exists for the effects of geographic distance reducing notions of contagion. Haddad, Rozin et al (2009) conducted scenarios with college students (n=2695) in five cities (Eugene, Philadelphia, Phoenix, San Diego, and San Jose). In one scenario, students were asked to rate their comfort with drinking the water on a scale of 0-10 in each of three conditions. In the first, water was piped directly from a wastewater treatment plant to their supply; in the second scenario water travelled for one mile down a river between the treatment plant and their supply; and in the third water travelled for one hundred miles down a river between the treatment plant and their supply. 39.7% of subjects indicated that they would be more willing to drink the water at one hundred miles separation than at a separation of one mile.

Most recently, cultural theorists of risk have looked back to the work of Mary Douglas (1922). In understanding pollution taboos, she proposes (following Claude Lévi-Strauss) that classification is an inherent part of human attempts to understand the world around them. When confronted with an array of unsorted items, humans have a natural tendency towards taxonomic activity, even at times when this is not necessarily useful for understanding. In doing so, their schemes of taxonomy create exceptions, which, as 'matter out of place' come to become regarded as sacred or profane (either marvellous, or especially dangerous). Such an analysis argues that two general heuristics we adopt are: that birds fly in the sky; while mammals walk on the land; and fish swim in the sea. Exceptions that do not conform to these rules are regarded as 'matter out of place', and thus potentially powerful (either positively, or dangerously). Thus creatures that transcend these rules are culturally attributed a significant fetish quality which we then learn. In this case, whales and dolphins (who don't conform to the heuristic) are positively totemised as being more special that fish or cows (who do conform to the heuristics), and likewise, cassowaries and bats (as vampires) are negatively totemised for not conforming to the heuristic.

In this scheme of classification, water is classified as clean by its association with nature (rivers, streams, aquifers), and defiled water by its association with humans and technology (stormwater, sewerage). Part of the problem with the way recycled water is currently conceptualized, is that it is, 'matter out of place', it is a product of human technology and activity, not nature, yet it is meant to be clean. Thus it is attributed the status of something potentially dangerous. To overcome this, the treatment process needs to either be associated with nature, or the cultural equation of 'nature = clean' and 'human activity and technology = dirty' needs to be overcome. Rozin (2006, 2008) has written extensively in Psychology about the positive associations between the natural and the perception of risk reduction, assessing preference for 'natural' foods even in cases where they bear higher risk.

The importance of culture and peer expectation in shaping risk assessment is best exemplified in the cultural theory of risk proposed by Douglas and Wildavsky (1982). They proposed that the predominant factor in shaping risk is the cultural context in which debates about risk are taking place. In their eyes, the perception of risk is very much dependent on what the peer group-at-large think. Furthermore, this perception is shaped by the political and social milieu associated with it, for example partisan politics shape perceptions of risk with regards to nuclear politics. In the case of water recycling, the logical application of this analysis would be that the perceived risk that proponents and opponents declare, are not so much a result of probability analysis, but rather, politics.

It has been suggested by McGuinness and Van Buynder (2004) that emotional responses of disgust towards recycled water are reduced as the source is drawn closer to home, and thus a higher level of control is exercised over the input. Thus the idea of water reuse is more appealing when that the 'yuk factor' is reduced if the source is closer to home, i.e. recycled greywater. This gives the user a higher perceived level of control over the quality of the wastewater then they would have over combined treated wastewater from secondary sources. Empirical evidence which supports this theory is a survey of attitudes to in-house water recycling by householders in England and Wales (n=324) (Jeffrey, 2002). In the study, 88% of respondents were happy to use recycled water if it came from their own household, 56% for effluent from their own house and that of their neighbour, while only 49% were willing to use wastewater treated from effluent from their whole street.

Bias correction and education

Besharov (2004) asks the important question: why don't individuals correct their biases, even when doing so results in advantage to themselves by allowing them to more accurately calculate the costs of hazards? He notes two important circumstances under which biases are corrected. Firstly, because people lack awareness of the systems of their interacting biases, a favourable result is not easily to correctly recognise that is it is the underlying bias that is causing the error. Secondly, for biases to be corrected there must be some advantage for the rational dominance required to overcome the bias. In the context of potable reuse, this involves in the first instance highlighting the irrationality of people's fear of potable reuse, and secondly, highlighting the negative consequences of non-adoption of reuse (water shortages, environmental strain).

There are several examples highlighting that positive experiences with recycled water itself does increase the willingness to accept, however this would not necessarily be the case in all circumstances. In the case of the introduction of NEWater in Singapore, the process of the introduction was neither gradual, not contingent upon building community acceptance beforehand. However in that case, specific social conditions existed that allowed the Public Utilities Board (PUB) to gain acceptance in conditions where public discourse around reuse were able to be regulated, through a strong schooling system and tight control of the media.

In conclusion, the body of literature on perceptions of risk, derived predominantly from empirical experiments in Psychology, shows that human calculations of risk are not always rational, and not always corrected by contradictory experience. They demonstrate:

- The potential importance of perceived individual and community environmental benefits. Any education and engagement program may need to include arguments about promoting the ecological and sustainability benefits of water reuse to build a positive affective association for water reuse, thus reducing the perception of risk.

- The importance of trust and transparency. Any attempt to remove barriers to the acceptance of potable reuse must focus on making all information available and building trust relationships with the community. This could be done by co-involvement of environmental and community groups in the consultation process.

Biases in the perception of water quality

Key to the consideration of water reuse as an alternative by the public is the idea of maintaining water quality. This includes not only safety, but taste and odour. Customers may evaluate water quality by a number of unrelated, and often only partially rational parameters, and may attribute both actual difference and perceived difference to a change in water source from catchment water to recycled water. For example, de França Doria (2010) summarises the following factors as important to the evaluation of water quality; sensorial information; risk perception; water chemicals and microbiological parameters; prior experience; media and interpersonal information; trust in water companies; and perceived control. Customer concerns about water quality may stem from doubts about safety, or from dissatisfaction with aesthetic qualities such as taste and odour. Jardine *et al* (1999) note that even though high standards of water treatment in large cities mean there is little link between the taste and odour of drinking water and health risk, taste and odour are vitally important to consumer evaluation of water safety. This is true regardless of assurances by water authorities that such concerns are merely aesthetic. One important feature of the introduction of water recycling is that even if water quality remains constant, residential customers do not perceive there to be differences. Anecdotal reporting by water authorities we are working with suggest that in a number of cases, customer complaints were reported changes to the taste of water (putatively) after the introduction of desalination, even before the plants started operation.

Dupont (2005) describes the erosion of consumer confidence in consumer tap water in Canada, with a large number of consumers choosing to install home filtration units or drink only bottled water. Amongst her work she reviews surveys from Canada and the United Kingdom between 1990 and 2005. Significantly, a drop in satisfaction with water quality in both those countries was associated with a media panic resulting from the reporting of a single incident in 2000, when E.coli O157:H7 contaminated the water supply of the town of Walkerton, Ontario, leading to seven deaths and numerous cases of illness.

In a survey of 1259 Albertans conducted in 1999 (before the Walkerton incident in Canada), 8.5% of respondents ranked tap water as a high health risk, with another 28.3% rating the risk as moderate. This was compared with only 14.6% of respondents reporting bacteria in food as a risk and 17.6% reporting moulds in food as a risk. In another study, Jardine et al (1999) report that when asked about where respondents obtained their information about health risks, 77.6% cited newspapers and magazines, while 72.9% cited TV and radio (p. 93). In light of these statistics, the ability of one statistically isolated incident of contamination to generalise into a widely known health scare is a key consideration that needs to be monitored through complaints data.

Turgeon et al (2004) surveyed residential water consumers in Quebec City, on measures of overall satisfaction with drinking water quality, as well as taste satisfaction and risk perception. Their study found that variations in water quality and geographic location resulted in significant differences in consumer satisfaction. Moreover, they found that those living in close proximity to the water treatment plant resulted in higher risk perception of water quality (55.6%, against 47.2% at the extremities of the distribution system). This was not a result of higher residual chlorine levels for those closest to the treatment plants, as their rating on the taste satisfaction test remained constant regardless of distance to the nearest water treatment plant.

Individuals acclimatize to their local water quality - whether treated tap water or bottled water (Dietrich, 2006), and can notice changes relatively robustly. If there are even minute changes in the dissolved minerals in the introduction of recycled water, complaints may result. Thus a large part of what individual consumers label adequate water quality is water to whose taste they have become habituated. Visibility and overall profile and reputation of water retailers may play a factor in complaint levels. For example, Jones (1996) and Lawrence & Statton (1999) have suggested that customer complaints increase at times when consumers have a heightened awareness of the water company.'

Carr et al (2011) conducted semi-structured interviews with Jordanian farmers to assess their acceptance of reclaimed water, and partitioned them into two groups according to their proximity to wastewater treatment plants. Those near treatment plants had control of which areas of their holdings were to be administered reclaimed water directly (n=11), while those living further away from treatment plants, for whom reclaimed water was transported via the river system mixed with fresh water, did not have a choice over which parts of the holdings could use reclaimed water and which parts could use non-reclaimed water (n=39). They found that perceptions of water quality were much lower in the case of those who had no choice about where to use the reclaimed water, indicating the important of personal control over water safety.

From this body of work on the links between perceived water quality and safety, it can be concluded:

- Trust in water authorities is a key criterion to build to remove barriers to potable reuse. This can be developed by ensuring a high level of functioning in existing (non-recycled) water supply to develop a longer term perception of quality.

- Adequate consultation and perceptions of fairness can help ameliorate community concerns, by providing a sense of identity and involvement in water planning decisions.

- Socioeconomic and cultural background has been shown in number of studies to correlate to acceptance of water reuse. However care must be taken to ensure that this correlation is not the result of some common underlying variable.

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APPENDIX: Considering the Importance of Safety Assurance, Need, and Benefit in Public Willingness to Consider Water Reuse

Executive Summary

- A pilot study was conducted by Victoria University on a sample of 75 participants testing attitudes to water recycling before and after presentation of various types of information about recycled water. The pre-test, presentation of information, and post-test were all done on separate days, via the internet.

- Participants were divided into four groups. The first group received no information (a control group), the second group received information regarding the safety of the treatment process. A third group received no information about the treatment process, but were told of some of the overall potential benefits of water recycling in terms of water security and sustainability. A fourth group were given both sets of information, regarding safety of the treatment process, and the overall benefits.

- Group distributions were compared, and it was found that the effect of both the information about benefits (Group 3), and both sets of information (Group 4) were statistically significant, with participants in these groups displaying a more favourable attitude to recycled water after presentation of information than the control group. Those who solely received information about the safety of the treatment process (Group 2) were not significantly different after presentation of this material from those who received no information (the control group).

- For the three groups which received information, analyses were conducted on the relationship between the changes in attitude, and the delay between information presentation and post-testing. No statistically significant relationship was found, but this may be due to the short delay (between one and nine days), or the small sample size.

- Additionally, participants were asked whether they considered themselves early adopters of new technology. Unexpectedly, no correlation was found between this factor and participants' attitudes to water recycling.

APPENDIX: Considering the Importance of Safety Assurance, Need, and Benefit in Public Willingness to Consider Water Reuse

Rationale

Work by Slovic and Kahneman cited in Module 2, and the WRRF-09-01 report, has demonstrated the importance of information in changing attitudes towards water recycling. In particular, the availability of information about the benefits of a new technology can have positive impacts on a person's perception of the risk associated with its introduction. In reality, the level of risk associated with water recycling is independent of the benefits. These two are linked because, in making quick judgements, people may utilise heuristics affectively, attributing positive or negative attachment rather than making lengthy formal cost-benefit analyses. The implications for the NDEEP have been the need to understand how information about benefits contributes to safety assurances about risk. This leads to the necessity of testing the following experimental questions:

- How important is it to provide information about the benefits of recycled water, as well as safety assurances about risk, in order to remove barriers to water recycling?
- What are the medium-term and longer-term effects of this information? How long lasting is its impact on forming long term attitudes towards recycled water?
- Are there correlations between early adopters of technology and attitudes to water recycling?

Answering these questions will be critical to the development of appropriate NDEEP material, as shown in Table 1.

Table 1: Implications for NDEEP and research questions

Research question	Implication for NDEEP
Benefit vs. Risk	Determine balance of information about benefits of water recycling against information focusing on risk amelioration (safety assurance)
Decay of information	Determine the best ways to educate about water recycling
Early adoption of technology	Determine if early adopters of technology react to information about water recycling differently

Additionally, this pilot testing being conducted by Sub-stream 2.1 aims to determine whether there is a correlation between early adopters of technology and the impact of information. This associational relationship may be a key factor in understanding the social dynamics of building acceptance, by determining if the concept of the 'early adopter' (for either technological or environmental reasons) is empirically justified with regard to water recycling.

Aims

The aim of this pilot experiment is to compare how attitudes to water recycling are affected by exposure to educational information about risk and benefit, in order test and refine the balance of information provided in the NDEEP based on local audiences. This testing will: (a) compare experimental groups to determine the magnitude, direction, and significance of the differences between conditions; (b) measure three dependent variables; these being attitude to water recycling, perception of risk in water recycling, and perception of benefit in recycling; and see how each is affected by the educational material; and (c) test if there is a significant correlation between early adopters of technology and acceptance of water recycling.

Methodology

75 participants were assigned to one of four groups. These were a control group, a group only exposed to information about the benefits of water recycling, a group only exposed to information about safety assurance of water recycling, and a group exposed to both sets of information. Participants were involved in the experiment for three sessions of approximately 15 minutes, and participants were sent links via email for the next phase of

the experiment the day after completion of the previous session. Each was provided with a unique log-in for access to the Qualtrics online survey program, to allow repeated scores to be tracked. On the first day, all participants completed a 20 question survey measuring overall attitude to water recycling, perceptions of the risks and benefits, and attitude towards technology, as well as masking questions. On the second day, each group was provided with a different set of educational materials online, consisting of text, pictures, and explanatory diagrams. On the third day, participants were sent a parallel form of the pre-test, to determine the effects of the educational information provided on attitudinal change; however participants were allowed to complete this at their leisure, resulting in a distribution of delay periods between the information and retest. Additional analysis was undertaking to determine the impact of time (information decay) on attitudinal change.

Table 2: Experimental group structure for groups 1 to 4

	Control group	**Benefits group**	**Risk Amelioration group**	**Combined group**
Day 1	Pre-test (15 mins)	Pre-test (15 mins)	Pre-test (15 mins)	Pre-test (15 mins)
Day 2	Control information	Benefits information	Safety assurance Information	Both sets of information
Day 3+	Re-test (15 mins)	Re-test (15 mins)	Re-test (15 mins)	Re-test (15 mins)

Testing instrument

Participant attitudes towards water recycling were measured using a 20 question online evaluation on a five-point scale. Within the item set were the following measures comprising 10 questions, the remainder of the items were masking questions about water, the environment, and new technology. The key variables of interest and questions are shown below in Table 3.

Table 3: Key variables of interest and selected items.

Variable Measured	# of questions	Questions
Overall attitude to water recycling	3	• I would be happy to drink recycled water • I would be comfortable using recycled water • After proper treatment, I would be happy to use recycled water for cooking
Perception of risk of water recycling	3	• Recycled water poses little threat to the health of humans • For the most part, decisions made by politicians about planning are in the best interests of the people • Recycled water is safe to use
Perception of benefit of water recycling	3	• Water recycling is an important strategy to mitigate water scarcity in Australia • Water recycling is a key part of ensuring water security in Australia • Water recycling is a valuable solution to water scarcity in Australia
Early adaptation of technology	1	• I am an early adopter of technology, that is to say I embrace new technology before other people do

In order to validate the test instrument, a small pilot of 30 participants were recruited to ensure test-retest reliability within the survey. Where validation coefficients were below 0.8, questions were altered to improve reliability. Chronbach's Alpha coefficients were calculated for items sets, with the critical limit for co-familiarity set at 0.8. The coefficients for all three constructs were above this limit.

Educational information

The educational information was selected from factsheets already in use by the water industry, and permission was granted for use. The information used to inform participants about potential benefits was an excerpt from a Barwon Water factsheet titled *The Benefits of Recycled Water*. The information used to inform participants about the safety and robustness of the recycled water treatment process was an excerpt from a Water Secure factsheet entitled *Purified Recycled Water*. The information given to the control group was unrelated to water recycling.

Participant Group Details

Participants were recruited from the Victoria University community (university students, TAFE students, staff, and surrounding community). This community is significantly more diverse in age and ethnicity than other university populations). There were 75 participants in total, all adults. The mode of recruitment was via convenience sampling and snowball sampling. No sensitive or special clinical groups were used. Participants represented the general population to the broadest extent possible, and were not paid for their participation.

Data collection

The data was collected from either online from appropriate sources or in person through the use of surveys/questionnaires with the target area of Victoria University. Data was only be available to the researchers and will be confidentially kept at Victoria University. Participants were subject to the standard ethical conditions determined by the Victoria University ethics committee.

Reliability testing

In order to validate the test instrument, a small pilot of 30 participants were recruited to ensure test-retest reliability within the survey. Where correlation co-efficients between parallel items were below 0.8, questions were altered to improve reliability.

Results

After tabulation of survey results, aggregate scores for the selected variables of interest (overall attitude to recycling, perception risk, and perception of benefit) were calculated, with reverse scored items adjusted accordingly. Group distributions were compared, and the questions below asked.

Are there differences between the groups?

The distribution of responses within some groups was found to be non-parametric, with the z statistic for skewness and kurtosis values exceeding +/- 1.96. Therefore, the non-parametric Kruskal-Wallis analysis of variance was used to determine if there were significant differences between groups, based on the gain scores of participants. A Kruskal-Wallis test revealed a significant effect of Group on Attitude to Water Recycling ((3)=8.34, $p < 0.05$). A post-hoc Mann-Whitney test showed the significant differences between Group A and B ($p < 0.05$, $r = 0.56$) and between Group A and C ($p < 0.01$, $r = 0.70$).

In overall attitude to recycling, the material that produced the most favourable attitudinal changes towards recycled water contained both the safety and benefits information, with an average change of 1.2, with positive numbers representing a more favourable attitude to water recycling. These differences are shown below, with statistically significant changes at the 0.05 level marked with an asterisk.

Table 4: Differences in overall attitude to water recycling after presentation of information

Variable	Rank	Group	Average change
Overall attitude to Recycling	1	Both safety and benefits information (Group 4)	1.20*
		Benefits information (Group 2)	0.25*
	2	Safety assurance information (Group 3)	-0.14
		No information (Group 1)	-0.23

When the individual constructs of ‘perception of risk of water recycling’ and ‘perception of benefit of water recycling’ were analysed for group differences, the differences between groups was found to be non-significant. This is shown in Table 5 below.

Table 5: Differences in perception of risk associated with water recycling and perception of benefit associated with water recycling

Variable	Rank	Group	Average change
Perception of risk of water recycling	Differences not statistically significant	Both safety and benefits information	1.08
		Benefits information	0.31
		Safety assurance information	0.29
		No information	-0.03

Variable	Rank	Group	Average change
Perception of benefit of water recycling	Differences not statistically significant	Both safety and benefits information	0.46
		Benefits information	0.44
		No information	-0.16
		Safety assurance information	-0.5

The impact of delay on information efficacy

The impact of delay on information efficacy was evaluated by calculating Spearman's rho co-efficient between the gain scores (the difference in favourability between the pre-test and post-test), and the time between the information presentation and the post-test. This was found to be non-significant.

Correlations				
			Delay	Gain
Spearman's rho	Delay	Correlation Coefficient	1.000	-.234
		Sig. (2-tailed)	.	.382

There is a small but negligible negative correlation in this case between the gain scores and the delay. This was with a range of delay scores between 1 day and 9 days. The correlation measures the linearity of the relationship between variables, but as the attitudinal variables were measures on a discrete change and the changes small, the weak correlation may be partly due to measurement limitations.

Correlations with technological adoption

			Overall Attitude Before	Overall Attitude After	Risk Perception Before	Risk Perception After	Benefits Perception Before	Benefits Perception After
Spearman's rho	I feel am an early adopter of technology	Correlation Coefficient	.011	-.083	-.004	.015	.031	.037
		Sig. (2-tailed)	.918	.483	.975	.901	.781	.757
		N	82	74	82	74	82	74

Unexpectedly, the measured attitudes, either before presentation of information, or after, did not display any notable correlation with whether participants considered themselves and early adopter of technology.

Summary

- When the effect of the presentation of information was compared between groups, it was found that the effect of both the information about benefits (Group 3), and both sets of information (Group 4) were statistically significant, with participants in these groups displaying a more favourable attitude to recycled water. Those who solely received information about the safety of the treatment process (Group 2) were not significantly different after presentation of this material from those who received no information (the control group).

- For the three groups which received information, analyses were conducted on the relationship between the changes in attitude, and the delay between information presentation and post-testing. No statistically significant relationship was found, but this may be due to the short delay (between one and nine days), or the small sample size.

- Additionally, it was asked whether participants considered themselves early adopters of new technology. Unexpectedly, no correlation was found between this and attitude to water recycling.