Centre for Integrated Biowaste Research

Greywater - Developing the Science Behind a New Zealand Guideline

Objective One:

Exploring Drivers for Greywater Reuse in New Zealand

In collaboration with

Environmental Science and Research

Prepared by

L W E
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I m p a c t

June 2012

Exploring Drivers for Greywater Reuse in New Zealand

Centre for Integrated Biowaste Research

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Job No.: 10049
Date: June 2012
Ref: CIBR Greywater Research Project

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1.0 EXECUTIVE SUMMARY

Greywater, the portion of the wastewater stream contributed from showers, basins and the laundry, has the potential to be diverted from wastewater streams and discharged separately. The extent of greywater use in New Zealand is not known and there is limited information on the methods used and impact of greywater use.

A Centre for Integrated Biowaste Research research programme, "Developing the Science Behind a New Zealand Guideline" aims to fill in information gaps and to develop a tool for assessing the appropriateness of greywater discharges based on environmental and public health implications. This programme has three key objectives, of which the research outlined in this report will contribute to Objective 1.

- Objective 1: Exploring drivers for greywater reuse in New Zealand.
- Objective 2: Sustainable greywater use.
- Objective 3: Developing a process for greywater system assessment (2013).

The purpose of this report is to identify the key drivers for greywater reuse in New Zealand and to examine how these drivers may influence research on effects of greywater reuse. This has been achieved through identification of information gaps and assessment of the interest in greywater use amongst stakeholder groups.

The procedure undertaken was:

- Make a preliminary assessment of drivers based on literature;
- Identify groups or individuals that contribute to or are affected by the drivers – the stakeholders;
- Develop a survey to address the understanding, use and acceptance of greywater amongst stakeholders;
- Interview stakeholders;
- Review the survey results; and
- Identify the key drivers and how the influence greywater reuse in New Zealand.

Five key drivers have been identified that influence the use of greywater in New Zealand. They are:

- Environmental conditions;
- Cost benefit of greywater reuse;
- Availability of information for making decisions;
- Risks involved with greywater reuse; and
- Level of interest in sustainability and greywater reuse.

The drivers identified reflect the perceptions of the stakeholders surveyed. The diversion and reuse of greywater was identified as a low priority by most stakeholders. A lack of suitable guidance regarding the safe and appropriate discharge of greywater was a common concern and seen to be a key draw back for increasing the reuse of greywater in New Zealand. It is interesting to note that public health on its own was not seen as a key driver for the management of greywater. Instead public health was frequently associated with receiving environment considerations.

There is a clear need for the development of guidelines for greywater reuse. It is expected that the primary users of a guideline document would be councils with a requirement to safeguard environmental and public health.

Information needed to support greywater reuse extends beyond the design of a sustainable greywater system. Consideration needs to be given to establishing appropriate guidance at a policy, regulatory and implementation level. This allows for the setting of direction, developing of regulatory requirements and then ultimately system design. Therefore a guideline document needs to take a holistic approach to greywater reuse which includes (but is not limited to) consideration of:

- What sources of waste can be included in greywater;
- What chemicals (detergents, personal care products etc.) can be used or should be avoided;
- Clear assessment of public health risks;
- Managing nuisance effects of greywater, especially with regard to neighbouring properties;
- Development of a site specific rate of discharge and field size; and
- When to divert the greywater to the sewer.

It is well understood that greywater impacts need to be considered differently to wastewater due to its perceived characteristics (lower pathogens, higher sodium, phosphorus and personal care products chemicals). However, there is a need to examine the impact of these components on the receiving environment, both the acute effects and cumulative effects.

In addition to a guideline document there is a need for detailed technical information for Councils to enable them to make informed decisions regarding:

- Appropriate guidelines for technical staff and for home owners;
- Consenting criteria;
- Prioritisation of water conservation measures;
- Choices available for greywater diversion from a reticulated wastewater system;
- Impacts of greywater reduction from a reticulated wastewater system; and
- Costs and benefits for greywater diversion from different wastewater systems.

Without a strong case based on cost and benefit, greywater reuse is unlikely to be incorporated into municipal systems; and therefore there may be limited uptake of greywater reuse on a larger urban scale. The greatest potential for establishment of greywater systems would appear to be in one-off applications or the incorporation into new developments rather than retrofitting into existing communities. The potential to use greywater systems to manage poorly preforming onsite wastewater systems also would seem to be an opportunity.

The research programme that was proposed for "Developing the Science Behind a New Zealand Guideline" is well conceived and has anticipated many of the issues that were identified by stakeholders particularly regarding the science required to fill information gaps for users, developers and regulators of greywater discharge systems. Based on a review of stakeholder opinion, recommendations to progress the successful adoption of greywater use in New Zealand include:

- Supporting information for regulatory and system owner decision making is limited. Further investigation is needed to identify what information is available and its relevance to New Zealand conditions.

- It is known that informal greywater discharge is practiced on and ad-hoc basis. Further information is needed to determine what alternative methodologies are being practiced but are not documented.
- Undertake a case study of greywater use in a community to identify end user understanding of greywater use and identify how it is managed outside of the regulatory framework;
- Investigate the need for region or district specific guidelines as opposed to a national document;
- Develop a frame work which supports the investigation and development of greywater reuse programmes which may include:
    - Focus on water short areas for greywater reuse developments and to establish them as leaders to guide other regions in the future.
    - Identify criteria that can predict water shortages within each district.
    - Investigate the best approach to develop data that allows accurate advice on appropriate greywater application to the receiving environments.
    - Explore options for suitable greywater reuse in urban environments.
    - Thorough cost benefit analysis for each different wastewater system, being urban reticulated, new urban homes and subdivisions, retrofitting established urban homes, retrofitting poor functioning septic tanks, to provide a realistic view of areas worth pursuing.
    - Investigate if other regions could benefit from greywater reuse for backcountry huts.
    - Provide Councils with information to ensure they can prepare promotional and educational material as well as being able to make informed decisions regarding the use of greywater by comparison to other water conservation practises.
    - Identify leaders and ensure they are informed with the latest information.
    - Respond to risks identified by the stakeholders with information or the need for research to provide suitable alleviation of concerns.

2.0 INTRODUCTION

2.1 Purpose

The purpose of this report is to identify the key drivers for greywater reuse in New Zealand and to examine how these drivers may influence research on effects of greywater reuse. This is to be achieved through identification of information gaps and assessment of the interest in greywater use amongst stakeholder groups.

2.2 Background

Greywater, the portion of the wastewater stream contributed from showers, basins and the laundry (some definitions include water from kitchen sinks, however this source is not included for this investigation), has the potential to be diverted from wastewater streams and discharged separately. The extent of greywater use in New Zealand is not known and there is limited information on the methods used and impact of greywater use.

A Centre for Integrated Biowaste Research (CIBR) research programme, "Developing the Science Behind a New Zealand Guideline" which is led by Environmental Science and Research (ESR) aims to fill in information gaps and to develop a tool for assessing the appropriateness of greywater discharges based on environmental and public health implications. This programme has three key objectives, of which the research outlined in this report will contribute to Objective 1.

- Objective 1: Exploring drivers for greywater reuse in New Zealand.
- Objective 2: Sustainable greywater use.
- Objective 3: Developing a process for greywater system assessment (2013).

In order to ensure the larger research programme meets the needs of users the first objective of the programme is to evaluate the current level of understanding and perceived value of greywater reuse. Lowe Environmental Impact (LEI) has undertaken a desktop study as part of the CIBR research project. This report details the evaluation process and outcomes for a desktop review of drivers for reuse.

There are a number of terms which are used throughout the report. In particular:

- Driver;
- Greywater;
- Greywater reuse;
- Greywater recycling;
- Greywater use;
- Stakeholder; and
- Wastewater.

Definitions for each of these terms are given in Appendix 1. While there may be some industry variation in how these terms are used, the definitions provided reflect the way they are used in the document.

There are a number of treatment devices available which enable greywater to be recycled for non-potable uses, the most common being toilet flushing, car washing or laundry water. This pre-treatment also increases the reuse options by making the treated water safe for use in a wider range of situations (vegetable garden watering, water features, etc.).

The use of treatment devices is not examined further here. Instead this programme focuses on the reuse of untreated greywater. Levels of nutrients, trace elements, organic contaminants and pathogens are expected to be highest in untreated greywater, and so it is considered worst-case for determination of impacts.

Because untreated greywater is unsuitable for storage due to potential for microbial populations to increase and odour production, it must be used on demand i.e. as it is generated. The on demand usage limits the options available for reuse to irrigation. As a result this report focuses on the discharge of greywater to land as the reuse method

There are conflicting views on the appropriateness of unrestricted greywater application to land. Concern from some quarters, mainly Health Officers and Regulators, has been expressed with particular regard to the public health risk, but also the potential to damage the soil and plant system. Alternatively, the use of greywater is seen to be low risk, typically by property owners, either due to a belief that it is low in pathogens or that once applied to soil the greywater is largely cleaned by the percolation process and exposure to light and air. The latter being based on intuition rather than investigation.

2.3 Scope

This report presents the outcomes of Milestone 5 of the Greywater Research Programme and includes a summary of the preceding milestones (1-4). The report also presents the results of an investigation into perceived and actual drivers for greywater reuse, and discusses the implications for the research programme. The report details:

- Section 3 outlines the project objectives and progress with respect to milestones;
- Section 4 summarises the current state of knowledge of drivers for greywater use in NZ;
- Section 5 details a stakeholder survey process;
- Section 6 discusses the identified drivers for greywater reuse; and
- Section 7 gives conclusions and recommendations for incorporation into the other project objectives.

3.0 OBJECTIVE ONE MILESTONES

Objective One of the ESR lead programme is the exploration of drivers for greywater reuse in New Zealand. The relationship of the larger project to Objectives, Components and Milestones is shown below.

Greywater Research Programme	**Objective 1**	**Components**	**Desktop study**	**Milestones**	**1**
					2
					3
					4
					5
			Biophysical science	Milestones…	
			Social science	Milestones…	
	Objective 2	Components:		Milestones…	
	Objective 3	Components:…		Milestones…	

This report focuses on the desktop component of Objective 1, for which there are five specific milestones. The five milestones are listed in Table 1.

Table 1: Desk top study – exploring the drivers for greywater reuse in New Zealand

Milestone No.	Details
[1]	Develop a scoping document for the desk top study
[2]	Using the previous contacts and networks developed by Louse McCormack, and in collaboration with social science milestone [16], identify the key stakeholders in New Zealand with an interest in greywater reuse (e.g. local, regional, national government, industry public).
[3]	Undertake stakeholder interviews to explore the key drivers for greywater reuse.
[4]	Preliminary discussion document produced.
[5]	List key drivers/issues for greywater reuse in New Zealand

A scoping document (Milestone 1) was prepared at the beginning of the larger greywater research project which outlined the process to achieve the Milestones 2-5. Progress towards and outcomes from Milestones 2 and 3 are described in the following sections of this report. Milestone 4 is essentially this report, being a discussion document, while Milestone 5 being the key drivers associated with greywater use is presented later in this report.

4.0 MILESTONE 2 – IDENTIFICATION OF STAKEHOLDERS

4.1 General

Core considerations in determining the key drivers for greywater reuse are the opinions and perceptions of stakeholders. This section corresponds to Milestone 2, and details the identification of stakeholders.

4.2 Preliminary Assessment of Greywater Use Drivers

The New Zealand Land Treatment Collective (LTC) produced a technical review (Tech. Rev. 32, 2011) to provide information on the issues involved with greywater reuse. An extensive literature review was undertaken and some initial surveying of stakeholders was initiated. Significant gaps in the information available for greywater reuse were identified by the review. Outcomes of the Tech. Rev. 32 have been used to inform this desktop study component of Objective 1.

In order to determine stakeholder groups relating to greywater use, review of existing information was undertaken to:

- Define how greywater is used; and
- Understand the factors influencing greywater use (preliminary assessment of drivers).

Key drivers that emerged from Tech. Rev. 32 were:

- Water shortage/water conservation;
- Environmental risks;
- Health risks;
- Ongoing management of established systems;
- Direction of regulatory and advisory authorities; and
- Greywater information and promotion.

In addition, the consideration of greywater reuse to ease pressure on wastewater systems in areas of surplus water has been considered. A description of these drivers is given below.

4.2.1 Water Shortage as a Driver of Greywater Use

Tech. Rev 32 identified that the key driver for greywater reuse globally is a stressed water supply such that, greywater reuse is a mechanism to reduce a household's requirement for potable water. Reuse of greywater in New Zealand is increasing, in particular for the areas facing stressed water supply such as Kapiti Coast district and Gisborne region.

Kapiti Coast has serious water shortages contributed to by low rainfall and high water use per capita. This has led the Kapiti Coast District Council and community to develop a programme exploring opportunities for conservation of water. Greywater reuse is just one of a range of options that are being implemented to address water shortage. Rainwater tank installations, legislating reuse of greywater and offering interest free loans for installation of water conservation devices are just some of the approaches taken (LTC Tech. Review 32, 2011).

4.2.2 Water Surplus as a Driver of Greywater Use

The use of greywater due to water shortages only applies to limited parts of NZ as the majority of areas have water surpluses, or very occasionally need to consider water restrictions. Therefore the issue becomes the ability to manage the treatment and discharge of wastewater generated. In these situations the reduction in wastewater flow due to the removal or reduction of the greywater portion of wastewater has the potential to reduce the stress on infrastructure and the receiving environment.

The minimisation of wastewater through greywater use equally applies to reticulated areas as it does non-reticulated areas. In reticulated areas a reduction in sewer flows can lessen the need for growth and upgrading of piping infrastructure. It can also lessen the loads on the treatment plant and ultimately lessen the volume being discharged to the receiving environment.

The separation of greywater may be of particular value for households with traditional septic tank systems. Older installations were designed for daily flows substantially smaller than discharged by more modern day appliances, such as washing machines. As a result the treatment device or discharge field can be stressed or in some cases fail as a result of hydraulic overloading. Diversion of greywater contributed from these sources may be a cost effective option for addressing failing septic tanks.

4.2.3 Environmental and Health Risks

Potential for environmental or health impacts is likely to negatively affect the uptake of greywater use. The on-site discharge of greywater may carry with it a risk to environment or public health due to inadequate design or incorrect operation. Typically the risk comes from a greater volume of greywater than can be transmitted by the soil being applied. The resulting water logging and potential surface ponding has risks such as:

- Damage to the soil and plant system;
- Untreated greywater travelling to surface or groundwater; and
- Human contact with pathogens and chemicals of health concern.

Inappropriate management practises, such as vegetable garden watering, also carry a health risk.

4.2.4 Ongoing Management Requirements

In many cases the inclusion of additional systems and technology for greywater separation and discharge is required for greywater reuse. This results in the addition of plumbing infrastructure and an obligation to actively manage the system. The ongoing management requirement, whether it is by a contracted service agent (routine maintenance and repairs) or by the property owner or occupier (controlling the flow of greywater to the discharge field), may negatively impact the uptake of greywater reuse. The cost and time commitment, or perceived management difficulty has been identified as a limitation for uptake.

4.2.5 Regulatory and Advisory Authorities

The focus of the authorities involved in the control of discharges may either negatively or positively influence the uptake of greywater reuse. Greywater reuse is complex and motivated by biophysical, social, cultural and economic drivers specific to individual communities. Each

Council in NZ has their own rules, policies and guidelines to ensure greywater reuse is carried out safely for the user and for the environment. However, for the NZ context, often without the typical water shortages that motivate the uptake of greywater reuse, there are uncertainties about the best approach (Kettle, 2010).

4.2.6 Information and Promotion

A driver for uptake of greywater reuse which can have either a positive or negative influence is the availability and promotion of greywater reuse information. Promotion is often needed to make stakeholders aware of the greywater reuse options. A "champion" is often a strong positive driver for greywater reuse, whether the champion is a group, authority or individual. Just as a positive champion can increase greywater awareness and use, a negative champion can curtail its use.

4.3 Stakeholder Identification

An assessment was made regarding which groups or individuals contribute to or are affected by the drivers described in Section 4.2 above. Stakeholder groups are identified in Table 2.

Table 2: Greywater Reuse Stakeholder Groups

Stakeholder Group	Involvement
Domestic households with water shortage issues connected to a reticulated sewage system.	End-user
Domestic households with water shortage issues not connected to a reticulated sewage system.	End-user
Domestic households without water shortage issues connected to a reticulated sewage system.	End-user
Domestic households without water shortage issues not connected to a reticulated sewage system.	End-user
Regional Councils	Regulation, advice and education, policy (region), environmental protection
Territorial authorities	Regulation, advice and education, policy (district)
Unitary authorities	As for regional and territorial authorities
Experts in greywater reuse	Environmental science, lobbying, system design, advice and education for authorities
Ministry of Health	Public health protection
Ministry for the Environment	Regulation, environmental protection, policy (central)
Department of Building and Housing	Regulation, advice and education
Local Government New Zealand	Extension, policy direction
Greywater suppliers, installers and maintenance	System design and installation, inspection

The stakeholder groups identified represent a varied, wide and diverse range of interests with regard to greywater reuse.

4.4 Stakeholder Selection for Survey

Due to a large number of potential stakeholders, the list given in Table 2 above was prioritised in consultation with the Greywater Research Programme project team. The stakeholders interviewed were prioritised in accordance with the following criteria:

- Broad view of issues regarding greywater reuse;
- Influence on policy development;
- Likely user of guideline document; and
- Level of contact with end users.

The councils, both regional and territorial, were determined to be the group most represented by the criteria above. Contact was attempted to all regional, local and unitary councils. A number of stakeholders involved in greywater use in advisory, design or maintenance roles were also contacted. The outcomes of the survey process (Milestone 3) may warrant additional surveys to be undertaken, however it was decided that would be reassessed following completion of initial surveys.

5.0 MILESTONE 3 – STAKEHOLDER SURVEYS

5.1 General

This section corresponds to Milestone 3, and details the development of a survey, the interview process and outcomes from the interviews.

5.2 Survey Methodology

5.2.1 Objectives

The larger greywater research programme aims to provide guidance for appropriate design, installation and on-going maintenance of greywater systems. Gaps in knowledge and uncertainties about greywater use in New Zealand were highlighted in the LTC Tech. Review 32 (2011).

More specifically, the objectives for the stakeholder survey as part of Milestone 3 are to inform and support the direction of the research with regard to the biophysical science and social science. Stakeholders are to be interviewed to obtain their views on greywater use. The survey aims to:

- Identify and describe the drivers that both positively and negatively impact decisions to use greywater.; and
- Identify research into greywater use that is relevant to stakeholders.

5.2.2 Development of Interview Questions

Interview questions were developed to address the issues identified in Section 4.2. The questions were designed to find out what drives greywater use decisions amongst the stakeholders. The following checklist summarises the key issues that were proposed to be discussed in the interviews.

- Awareness of greywater reuse (clarification of terms).
- Description of stakeholders role as regards greywater.
- Description of their own greywater reuse system or understanding of greywater reuse systems.
- Compatibility of greywater reuse for their own situation.
- Description of involvement with greywater reuse.
- Opinion of greywater reuse.
- Concerns regarding greywater reuse.
- Source of information to guide decisions
- Relationships between people involved with greywater reuse.
- Factors that have influenced their use or level of understanding in greywater reuse.
- Goals and issues associated with greywater and water use.

Appendix B contains the interview response sheets. Different response sheets were developed for an end-user, authority and a supplier. The questions were developed for each of these three types of potential interviewees using the checklist above.

5.2.3 Interview Process

The process for conducting stakeholder interviews was as follows:

- Stakeholders identified above (Section 4) were contacted;
- Arrangements for interview time made;
- Interview conducted; and
- Follow-up email to interviewee with completed interview sheet sent for confirmation or addition.

The interview approach followed the formatted questionnaire but allowed for some diversion as ideas generated from the discussion were elaborated on. Where possible a one to one phone interview was conducted in preference to having questionnaires completed by the interviewee.

The interview format and content evolved through the process to incorporate responses from previous interviewees. For example one interviewee suggested the quality of greywater systems were variable with some designs based on the lowest cost whereas others were based on effectiveness. The introduction of this idea to other interviewees enabled this to be explored further and also helped to identify where these issues had not been encountered or considered.

The questionnaires are included in Appendix C.

5.2.4 Interview Data Analysis Process

Information obtained during interviews was used to develop a list of key issues as perceived by the interviewees, and as interpreted by the interviewer. While issues that were raised most frequently are considered to be the key drivers for greywater reuse decisions in New Zealand, some ideas which arose as the interview process evolved helped to inform and confirm the key drivers.

The data analysis was based on a qualitative assessment rather than quantification of the interview responses. This was deemed to be the most appropriate assessment for the data set due to the evolution of the interview format and content, whereby additional concepts were discussed in more detail in later interviews. In addition the use of a quantitative approach was unable to account for bias due to the existing level of understanding of greywater and its reuse amongst interviewees i.e. not all interviewees had the same understanding of greywater reuse and its implications.

5.3 Survey Results

In all, 42 responses were obtained from the initial interview process. Thirty five interviews were carried out over the phone. One interview took place face to face. Six questionnaires were completed by interviewees and returned. All responses will be referred to as interviews. Of the interviewees contacted the range of roles represented is listed in Table 3.

Table 3 : Roles of Interviewees

Working Area	Number
TLA engineering (Wastewater assets, utilities and infrastructure)	26
Regional Council engineer	1
Environmental health officer	4
Information officer	1

Building consents	1
Resource consent, policy and planning	5
Consultant, advisor, architect, supplier	4
Total	**42**

5.3.1 Current Level of Greywater Reuse

The majority of interviewees indicated that the extent of greywater reuse in their area was not known but believed it to be low. Most acknowledged that this may be due to these systems not being known to councils. It is likely that not many would have been through a building consent or resource consent process. This is illustrated by a sewer survey of a small coastal community currently being undertaken by Lowe Environmental Impact, which identified a significant portion of households having a non-council approved diversions set-up for greywater reuse.

5.3.2 Identification of Factors Affecting Greywater Use

A wide range of issues contributing to greywater use were raised during the interviews. A summary of the key issues that emerged is given in Table 4 below. The points have been separated into positive and negative categories indicating whether they are likely to increase the diversion and reuse of greywater or whether they act to discourage greywater reuse respectively. The points listed are in no particular order and represent the perception of the interviewees. They have been presented as given in the interviews with no qualification or assessment added by the interviewer at this stage, except to assign a conceptual impact.

Table 4: Factors Affecting Greywater Reuse

Positive Factors	**Impacts on**
Charging for potable water (water metering)	Cost
Anticipation of future water shortages	Environment
Potential to reduce flows to sewers during high infiltration and ingress (I & I) periods	Environment/Cost
Increased public interest in sustainability	Environment/Community
Introduction of "sustainable housing credits"	Environment/Community
Concession on new builds with greywater reuse system	Cost
Garden watering during water shortage	Environment
Limitations in septic tank and discharge field size	Environment/Cost
Cost to develop new water supplies	Cost
Building in system resilience/Spreading of risk from system interruption	Cost
Desire for self-sufficiency	Community
Negative Factors	
Regional Council consent requirements	Cost/Community/Policy
Lack of information / guidance / education	Community/Policy
Microbiological contamination	Environment
Suspended solid load / settling issues	Environment
Cost of systems (particularly to retrofit)	Cost
"Flush and forget" mentality	Community
Public health concerns	Community/Environment
Lack of regulations	Policy/Community
Lack of cost/benefit analysis	Cost
Rainwater harvested favoured as a priority	Policy
Property size	Environment
Odour potential	Environment
"Doubling up" of infrastructure	Cost
Potential reduced flows in municipal sewers causing settling /insufficient	Cost

flushing On-site maintenance and operation requirement Inappropriate soils for discharge Long term P accumulation in soils Contamination of fresh water	 Cost/community Environment Environment Environment

The majority of interviewees (but not all) expressed a personal view that greywater reuse is a worthwhile practice. Often though, it was viewed as a "nice-to-have" as compared to alternative water and wastewater conservation strategies, such as rainwater harvesting and Infiltration and Ingress reduction.

A common observation was that greywater diversion was most appropriate for rural areas. The reasons for this are:

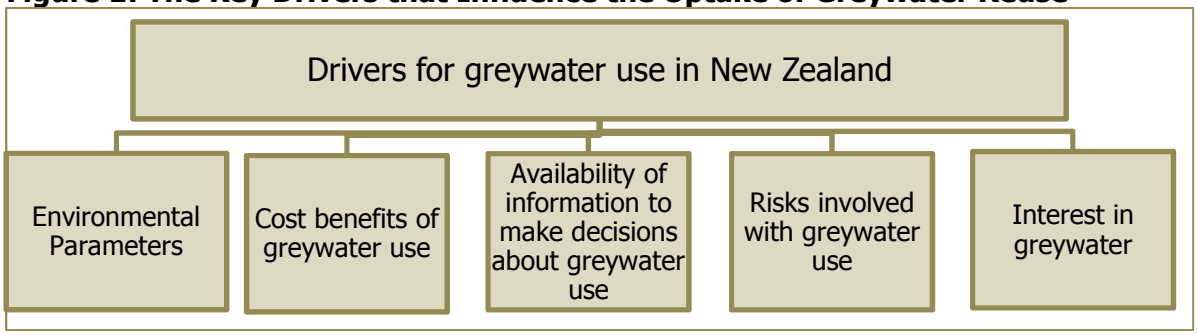
- Larger section sizes better suited to on-site discharge of greywater;
- Saving of water particularly where this was supplied by roof collection; and
- Relief for septic tank and discharge field capacity (these systems being more common in rural areas).

While the roles held by the interviewees informed their understanding of the impacts of greywater use, the perceptions expressed were typically not related to their position. For example some engineers could not see the value in separating greywater; by comparison others thought it would be a great benefit. Some stakeholders clearly had a personal interest in greywater use, yet little guidance or policy was available within their Council. Their personal interest sometimes came from having a greywater system themselves presently or in the past. Personal interest also came from a general enthusiasm for environmental conservation and they felt greywater use contributed to this.

5.4 Evaluation of Survey Results

A consistent picture emerged amongst the replies received through the interviewing process. The key issues summarised in Table 4 above have been grouped and correspond to the drivers for greywater reuse resulting from the interviews. Five key drivers (shown in Figure 1) have been identified and are described below.

Figure 1: The Key Drivers that Influence the Uptake of Greywater Reuse



Drivers influencing the uptake of greywater reuse are complex. Each location where greywater can be used has its own set of variables. This can be understood at three levels; being individual household, community and regulatory level. Each situation must take into

consideration the environmental characteristics, the variability of the greywater itself and what greywater system options can be used.

It was noted that public health was not commonly identified as a key driver, but instead was considered as part of the receiving environment. This is most likely influenced by the backgrounds of interviewees, being more engineering asset managers and policy focussed and not public health specialists.

5.4.1 Environmental Parameters

The need to consider environmental conditions emerged as a strong driver for greywater use. The perception of the environmental impact of greywater reuse was both positive and negative. Environmental drivers were broadly grouped as follows:

- Sustainability and water availability; and
- Management of effects associated with the discharge.

5.4.1.1 Sustainability and Water Availability

The availability of water was the most commonly listed driver for greywater reuse. More often than not a shortage of water was identified as a motive for using greywater, whether due to the type of water supply (roof water), seasonal deficit, utility imposed limitations (water metering) or anticipated future shortages. However, the issue of reducing excess water was also raised with regard to the potential to reduce flows to wastewater treatment systems. For reticulated systems this typically meant a reduction of the flows under high Infiltration and Ingress conditions. For on-site systems this meant a reduction in the load to older septic tank installations.

For areas that have adopted greywater reuse policies the key driver has typically been to manage water shortages. For communities in water short areas like Kapiti Coast, Central Otago and Nelson, activities to promote greywater reuse have already begun. It should be noted that water shortages are not necessarily associated with low rainfall areas. For example Hawke's Bay and Canterbury communities despite being in a low rainfall area often do not have restriction on water supplies. High or consistent rainfall areas such as Westland showed no demand for change or the consideration of greywater reuse.

In areas where greywater reuse is not actively encouraged the driver for most end-users was an interest in sustainably, where greywater was seen to be part of a holistic approach to resource use. In addition, the drive for self-sufficiency also encouraged the uptake of greywater reuse.

The demand to consider greywater in water short areas can come from a variety of places such as:

- Community demand, e.g. residents of Central Otago had experience from visits to Australia
- Council restrictions by metering water, external property washing (cars and houses) or garden irrigation restrictions

The general opinion from the surveys was that greywater use is expected to increase in the future. However some frustration was expressed by stakeholders about the lack of foresight in managing potential future water shortages. It was acknowledged that increasing demand for water may come from:

- Increasing populations

- More appliances that encourage water use such as dishwashers and washing machines
- Climate change

One stakeholder suggested greywater reuse would alleviate pressure on the wastewater system at times of storm events and flooding however, it is more likely to alleviate pressure when it is not flooding by reducing the contaminant load in the discharge from treatment plants.

5.4.1.2 Management of the Effects Associated with the Discharge

A need to correctly manage the discharge of greywater to ensure no adverse impact on the receiving environment was identified by stakeholders. Often this was considered to be a negative driver for greywater reuse due to the paucity of information available to assess the receiving environment impact (See Section 5.4.3). The receiving environment refers to the soil and plant system, groundwater and surface water, as well as the air quality. Also in this mix was the impact on public health and animals. Factors cited that can restrict the potential for greywater reuse include:

- Insufficient land area;
- Unsuitable soil type;
- Soil which readily becomes saturated;
- Slope causing runoff and contaminating adjacent areas;
- Excessive hydraulic loading causing land instability.

Some urban areas do not have enough outdoor area to provide for greywater application i.e. the section size is too small. This is exacerbated by large houses being built on small sections and infill housing. However one stakeholder suggested it would be most cost effective for homeowners with small garden areas to bucket water to the garden by hand. Close neighbours and risk of potential contamination beyond the property boundary was identified as another concern. One stakeholder described this as an area he was not prepared to consider because of potential disputes between neighbours.

Suitability of soil characteristics and the climatic conditions allow greywater to be applied to land in many areas. Taupo District Council had a risk assessment carried out for greywater use. They have chosen not to pursue greywater reuse because of their porous pumice soils with a high potential of leaching from greywater systems contaminating groundwater. The risk assessment did state the greywater could be applied but a high level of management would have to be in place.

The long term impacts of greywater application are unknown for New Zealand soils, however an interviewee identified this as one of the reasons that greywater reuse was not promoted. The interviewee cited research carried out regarding greywater applications in Australia over a 35 year period, with particular regard to phosphorus accumulation and related permeability issues most likely associated with surfactants.

5.4.2 Cost Benefits of Greywater Reuse

The perception of costs to install and maintain a greywater system compared to the benefits it would bring to an individual or a community is a strong driver affecting greywater reuse. Alternatively the paucity of this information was identified as a barrier to adoption of greywater reuse. The costs referred to are:

- Comparative cost and benefit of other water or wastewater conservation strategies;
- Financial costs for the greywater reuse system;
- Cost to maintain the greywater system over the long term;

- Financial cost of water in rates or if it is metered and how much it costs to produce clean fresh water and reticulate it to the urban area;
- Costs associated to wastewater pipe systems when blockages occur without the greywater; and
- Cost of changing management approaches to a reticulated system when there is less greywater.

The benefits include:

- Financial cost savings;
- Reducing the demand for water; and
- Improvements to the wastewater infrastructure.

The factors which influence the cost to benefit of greywater use are:

- The capability of the existing wastewater system;
- The characteristics of the greywater system that create financial restrictions; and
- The prioritisation of water conservation options.

5.4.2.1 Capability of the Existing Wastewater System

Seven different circumstances were determined from the interviews that would allow wastewater systems to have their greywater separated from the main waste stream. They can be grouped as defined in Table 3 into urban and rural settings. Each type of wastewater system has different factors influencing the decisions to consider greywater reuse. The financial cost of changing the existing system compared to the benefits it would bring was a strong consideration amongst stakeholders.

Table 1: Wastewater Systems Identified from Interviews

Urban	Rural
Large reticulated	New wastewater systems
Small community reticulated	Old septic tanks
Individual house greywater retrofits	Back country huts
New build greywater systems	

The benefits of separating greywater from an urban reticulated wastewater system could not be quantified. Approximately half of the interviewees that talked about an urban wastewater system saw no benefits and the other half did. It is the view of the interviewer that there has not been an opportunity to evaluate precisely the cost benefits of removing greywater from an urban reticulated system and the likely cost advantages would be no more than guesses.

One engineer was clearly concerned about blockages that would occur in the pipe network as a result of reduced hydraulic flow. While blockages were still a concern expressed by others, they were more neutral. A number of the interviewees held the view that the benefits would not be sufficient to outweigh the costs associated with blockages and the changes necessary to the existing infrastructure. Potential benefits that were stated for adopting greywater diversion included reduced costs to maintain the infrastructure, less water demand, improved performance of the treatment plants.

The level of capability of existing urban reticulated wastewater systems influenced consideration of utilising the greywater. Aged and undersized reticulation infrastructure was seen as being

more compatible for the adoption of greywater reuse, when compared to communities where reticulation and treatment infrastructure had been recently upgraded.

The financial cost of a greywater system for an individual home was a significant factor in the interest in greywater reuse. Retrofitting was described as too hard and too expensive in many cases. Greywater systems for new homes was described as the most realistic and cost effective option for an individual home. As well as the mixed reaction to it being beneficial for the whole network, stakeholders were also unsure about the financial benefit from the large cost for the greywater system versus the savings made from not paying for water. Subsidies were often suggested as an option to enable the possibility of affording a greywater system particularly if retrofitting was necessary.

The level of capability of existing rural onsite wastewater systems was seen as being an influence in the interest of owners to consider greywater use. New rural wastewater systems function extremely well and manage both greywater and blackwater together. However, stakeholders involved with the design and regulation of onsite wastewater systems saw obvious benefits from separating greywater from old septic tanks that are not working well.

Back country huts provided opportunity for greywater reuse. Back country huts in the West Cost and Tasman area have recently had greater leniency on the Rules regarding greywater use. Greywater reuse is now a permitted activity in some situations. Back country huts benefit from greywater reuse as it reduces the costs associated with airlifting wastewater from the huts to urban treatment plants. The receiving environment is large and the greywater content is relatively low risk.

5.4.2.2 Financial Restrictions on Uptake

Interviewees identified three characteristics of a greywater system they considered important to encourage interest and uptake. These are:

- Simplicity of design and on-going management;
- Functionality to ensure suitable treatment of greywater; and
- Acceptable costs.

A simple system requires simplicity to manage, maintain and install. One stakeholder said guidelines for greywater use also need to be simple.

Councils are likely to support greywater systems that meet their regulatory requirements. Health risks were often identified as a critical factor, but are often stated as a caution and not as a concern that greywater units should not be installed. A good design was thought to manage these issues, but one interviewee identified that systems with poor designs were also on the market. He felt a number of designs were based on being cost effective but were poor for achieving appropriate greywater management.

An acceptable cost for greywater systems could and have been influenced by a number of factors; including:

- System cost;
- Subsidies;
- Financial incentives;
- Rates relief; and
- Consent costs.

Consents to install a greywater system have inhibited installations in some areas. A Wellington stakeholder said a home owner was required to pay $2,000 for greywater consent, not including the system. Another stakeholder indicated that Environment Canterbury charge $1,300 for a consent to discharge greywater, and this was described as a "huge barrier".

5.4.2.3 Prioritisation of Water Conservation Options

Other priorities compete with greywater reuse for uptake in a Council budget. Many examples of other matters were identified as a higher priority than allocating funds to greywater use. Some competing technology and systems to achieve water savings which were seen as a higher priority included:

- Identifying alternative water sources;
- Rain gardens;
- Use of stormwater;
- Roof collection systems;
- Reducing consumption of potable water;
- Reducing network leakages; and
- Education about water conservation.

5.4.3 Availability of Information About Greywater Use

Greywater use in NZ is low. The experience with greywater systems and promotion of greywater reuse is limited in NZ. The stakeholders interviewed were often providing their own opinion from their understanding of working with wastewater systems in general and from literature or presentations they may have read or listened to.

The availability of quality technical information impacts on decisions which influence the use of greywater systems. The extent of regulatory encouragement and public education was considered an important part of increasing greywater reuse. For a council to encourage greywater reuse, or for an individual to choose greywater reuse, they require sufficient information to be confident to install and maintain the system. One stakeholder said she will not promote greywater use because there is insufficient information available. A Banks Peninsula community pursued the use of greywater systems but did not continue partly due to insufficient information.

The types of information that stakeholders would like or felt others should know can be simply grouped into:

- greywater characteristics;
- costs involved; and
- guidelines and regulations.

Greywater quality and quantity influence how it is used. Some stakeholders described factors they felt important as being:

- What products can and can't enter the greywater system;
- Characteristics of the receiving environment that are suitable for greywater application;
- The amount of greywater that can be applied to the receiving environment; and
- How much water is produced from a household and then cumulatively in a community compared to irrigation requirements.

Accurate calculations of the costs for greywater use are likely to impact decisions. The need for several different cost analyses was identified. The particular costs that need to be identified are:

- Cost savings (or not) to the user;
- Cost of different systems, including retrofitting; and
- Financial benefits for an urban reticulated system.

Many councils use existing guidelines and regulations to inform their decisions regarding greywater use. Two distinct groups emerged from interviews; those that felt the existing guidelines or rules were sufficient and others that felt changes were necessary if they existed at all. Those who stated they had sufficient guidance used one or more of the following:

- Building Code;
- Regional Water Quality Plans;
- TP58 and 1547 (Onsite wastewater standards);
- Standards specifically for greywater;
- Guidelines from Brisbane;
- Regulations from New South Wales; and
- Regionally developed and specific guidelines (Nelson City Council greywater guidelines are included in Appendix 4).

Some stakeholders felt current Rules and plans were insufficient and often too restrictive. The suitability of each of the guidelines used to address all personal health and environmental health concerns was unclear.

5.4.4 Interest in Greywater Use

Interest in the use and management of greywater exists at three levels; Councils, community and individual. The drive to promote or use greywater can be quite different at each of these levels. Broadly expressed, an individual has an environmental interest, a community wants to address an issue such as water shortage and the Council has the responsibility to manage water supplies availability and quality.

5.4.4.1 Council Interest

Council interest exists as a number of levels, being a staff requirement to manage utilities, and at a political desire to meet the financial, sustainability and environmental desires of the community. A general theme from the interviews was the potential for greywater use to be an option in a toolbox of options for managing future water conservation measures.

One stakeholder stated their Council would choose sustainable solutions ahead of the most economic choice. Although greywater use was often a minor or non-existent conversation in Councils, it was felt their identity as a Sustainable City or a Zero Waste City meant that greywater management is an option that is likely to be discussed in the future.

It was clear from the interviews that leadership amongst councils was possibly a limitation to adoption of a position on greywater reuse. One Council interviewee suggested that while a low priority for them the uptake of greywater reuse may be enhanced by other areas developing greywater policy.

5.4.4.2 Community Interest

Several communities have shown their interest has influenced or potentially will influence Council decisions. Banks Peninsula provides a good example of community interest influencing Council to make changes to adopt greywater use. Five years ago the Council supported the community with a comprehensive enquiry into greywater use. This did not go ahead because of insufficient information plus a number of other issues.

In another example, several people who had experience in Australia approached the Central Otago District Council wanting similar options considered for their own community.

5.4.4.3 Personal Interest

Several stakeholders identified that people with an interest in the environment and choose a sustainable lifestyle for personally or eco-tourism reasons choose to use greywater. In some cases (the Golden Bay area for example) people with low incomes were able to find the money to install a greywater system because of their commitment to an environmental lifestyle. In contrast there are people who do not want to know about greywater and prefer to pay for their water than have anything to do with its management.

Adoption of greywater use was described by stakeholders with experience of the Christchurch earthquake as an opportunity to establish resilience. One interviewee noted that greywater use can contribute to self-responsibility and independence.

5.4.5 Risks Involved With Greywater Reuse

The perceived risks of greywater reuse are a strong driver in the decision making process. The risks associated with greywater use limit potential uptake or simply create concerns. It was considered that the majority of risks can be managed with appropriate design. Risks identified include:

- Health concerns, particularly from households with a higher risk of faecal content in their greywater;
- Odour (including due to hydrogen sulphide);
- Pets bring potential contaminants into the house after being in contact with the greywater applied outside;
- Contamination of neighbouring properties and potential complaints;
- Soil contamination;
- What will happen when someone takes over a greywater system in their new home and are not interested in its management;
- Long term impacts on the soil;
- The difficulty of managing the soaps and fat content of the greywater;
- The Regional Council will make changes that will negate greywater systems that have been installed;
- NZ greywater systems require more precision than Australian systems;
- Less water in the reticulated system will cause blockages;
- The nutrients from the greywater area are an important part of the solid waste breakdown therefore inappropriate to remove it;
- Sodium will damage soils to which greywater is applied; and
- Phosphorus based detergent build up will make soils impermeable to water in the long run.

The above risks were identified by interviewers. Some can be addressed with good greywater system design. Some require education to reduce the concern and some will require further investigation.

5.5 Evaluation of Survey Process

The outcomes of the survey were strongly related to the interviewees technical background. As a result it is expected that the outcomes identified are skewed towards issues which more directly affect those interviewees. Therefore the key drivers identified from the survey were representative of the views of the stakeholder most likely to benefit from the development of a greywater reuse guideline document.

During the survey it was clear that the willingness to discuss greywater was a reflection of that person's knowledge of greywater systems. One interviewee did not provide an extensive response, saw no benefits in greywater use and was not interested to be interviewed. However, upon further questioning he showed interest when introduced to the possibility of reducing the load on the wastewater system.

A key finding of the survey was that greywater use is minimal in New Zealand. This finding is most likely due to the interviewees consideration of greywater as being managed under Regional or District Council rules using manufactured systems dedicated to greywater use (e.g. Water Lillee systems). There is a potential that a high number of uncontrolled greywater discharges are in use (bucket or hose from the laundry to the backyard). This view is supported by anecdotal information and LEI experience.

A particular example is a community serviced by septic tanks where it is common to divert greywater to the back garden. In this community there are no specialised greywater management systems and there has been no regulatory approval under the Resource Management Act or Building Act. The relevant District Council and Regional Council servicing this community were interviewed, and in both cases were unaware or unable to acknowledge the extent of greywater reuse from unauthorised discharges (or authorised discharges in their areas). This shows that there is a discrepancy between the regulatory requirements, regulator opinion and what is actually happening with respect to current greywater management.

There is scope to extend the survey to a group of end-users who are actually using greywater, rather than managing its use. This group of users are likely to have different views on the value of greywater reuse and risk than the survey interviewees.

6.0 MILESTONE 5 - EXPLORING DRIVERS FOR GREYWATER REUSE

6.1 General

The survey has identified and helped to consolidate discussion and thoughts about the main drivers for greywater use in New Zealand. The following sections summarise what are thought to be the 5 key drivers for greywater use being:

- Environmental parameters;
- Cost benefit of greywater reuse;
- Availability of information for making decisions;
- Risks involved with greywater reuse; and
- Level of interest in sustainability and greywater reuse.

The identified drivers have an influence on greywater reuse decisions at a number of scales including:

- National and regional policy (climate change strategy, land discharge environmental standards, waste management strategies, building code);
- District policy (water and wastewater strategies, long term plan objectives, sustainability goals);
- Assessment of discharges for permitting (resource consent and building consent);
- System design;
- Discharge design; and
- Community engagement.

6.2 Environmental Parameters

The drive to use greywater is often based on environmental parameters such as those outlined in Section 5.4.1. This section examines how environmental parameters drive decision making regarding greywater reuse.

6.2.1 Water Shortage

Water shortages are perceived as being the main driver that has influenced adoption of greywater use for NZ communities. If a community does not experience water shortages there currently is little coordinated activity to support greywater use.

Water shortages occur in areas for more than one reason. It is a combination of low rainfall, limited storage capacity within water supplies and high water usage. According to Figure 2 and 3 Kapiti Coast is not subject to low mean rainfall, however the area experiences water shortage due to the seasonality of rainfall and the capability of the water supply system to meet demand during low rainfall periods. Other areas such as Hawke's Bay have lower rainfall and yet do not experience the same water shortages due to management of the available water. The east coast of the South Island has low rainfall but none of the Councils contacted identified water shortages.

6.2.2 Future-Proofing

A trend identified during the surveys was that some Councils were not future oriented with their policies and were not establishing resilient foundations to avoid future water shortages. If it is accepted that:

a) the frequency and duration of water shortages were to increase; and
b) this is the primary motivation to consider greywater use,

Then an accurate prediction of future water shortage needs to be established and well understood. This would enable districts to prepare for the future with more tangible criteria on which to base their water conservation decisions including consideration of greywater reuse.

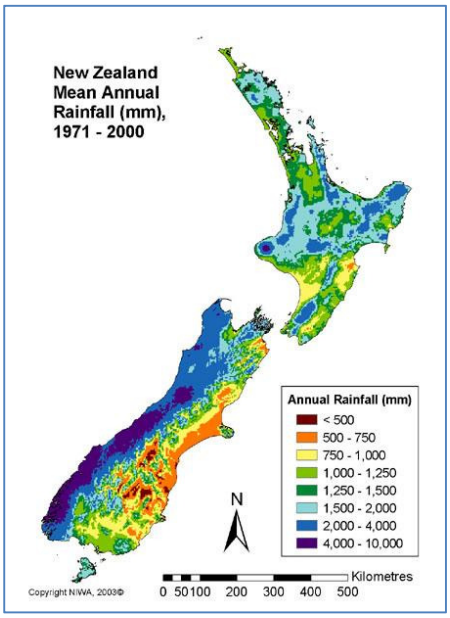


Figure 2: New Zealand Mean Annual Rainfall (J. Wilson, 2011)

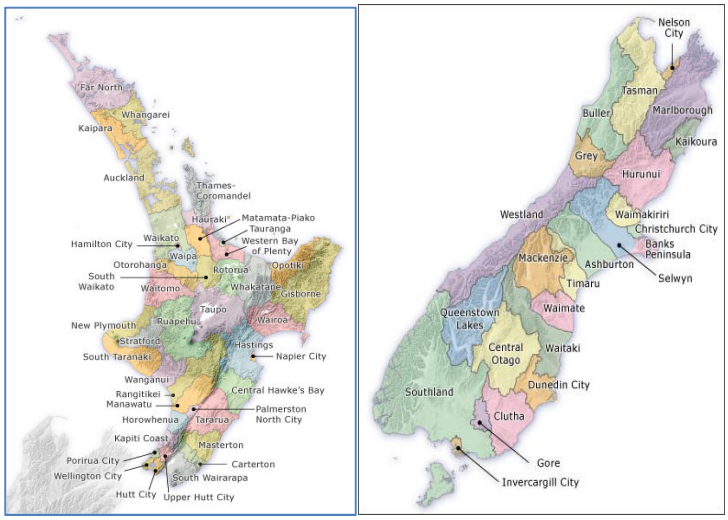


Figure 3: District Council Locations (Mullan, 2009)

6.2.3 Management of Discharge Environmental Impact

Understanding the receiving environment that the greywater is to be discharged into or diverted away from is an important aspect in assessing the potential for greywater reuse. The receiving

environment considerations are the soil and plant system, surface and groundwater, air quality and risk to receptors being humans and animals (public health). The existing or proposed infrastructure must also be considered.

The environmental conditions impact on decisions regarding greywater at a number of scales. As described above temporal considerations, in particular climate change and population growth must be factored at policy and regulatory levels. The existing resources of water, land area, soil and geology inform districts about need for and safe implementation of greywater policies at a district wide scale.

For design of a greywater system or application for discharge (resource or building consent) site specific information must be known. In some instances local authorities have summarised key information requirements into informational pamphlets (e.g. Nelson District Council) or a step by step method for risk assessment has been produced (e.g. Taupo District Council). Commonly on-site wastewater guidelines are applied to greywater.

The production of district or region specific information is commendable, and appropriate to address specific policies and potentially some information about local conditions. It is considered however that a national guidance document is needed to ensure a consistent understanding of best practice amongst Councils and greywater users.

6.3 Cost Benefits Of Greywater Reuse

This section examines how an analysis of costs and benefits drives greywater decision making.

The drive to promote large scale and significant greywater reuse is likely to occur as part of a water or wastewater strategy implemented at a district or regional scale. It is also likely to focus on a specific community. The inclusion of greywater reuse in a water or wastewater strategy may be initiated by environmental concerns, particularly water shortage, however to drive the use of greywater there needs to be a demonstration that it can provide a benefit whose cost is equal to or better than an alternative method to achieve that benefit. An example of this is for a rural property which has an under sized septic tank and discharge field resulting in undertreated wastewater causing soil damage, public health concerns and aesthetic issues. The options for the property owner may include:

- The status quo, with no cost but an unacceptable outcome;
- The replacement of the existing system with an advanced treatment system at a cost of $10,000-20,000 and solving the existing wastewater issues; or
- The installation of a greywater diversion system alongside the existing septic tank system at a cost of $1,000-2,000 and solving the existing wastewater issues but requiring a higher management input form the property owner.

In this case the cost benefit may favour the installation of greywater diversion.

On a larger scale the evaluation of greywater reuse as part of a wider community, district or regional strategy would require consideration of a range of issues which may include:

- Assessment of options (e.g. development of bores, water metering, etc.) for dealing with water shortages including availability of other options, cost to enact options, amount of water saving or increased water capacity able to be achieved by option;

- Potential reduction in wastewater flows requiring treatment and discharge (as compared to, for instance, works to reduce inflow and ingress), and costs to enact those changes; and
- How future-proof each option is i.e. how will the ongoing costs and benefits stack up against population growth and climate extremes?

This type of analysis is complex, long ranging and therefore costly. For greywater to be considered a brief evaluation (go / no-go) would need to demonstrate that there is sufficient information and technical merit to allow a comparison with other options. At present this appears not to be the case and therefore there may be limited uptake of greywater reuse on a larger scale.

At present the most likely case for demonstrating a favourable cost and benefit analysis for greywater reuse is for new developments, both rural and urban. New homes and subdivisions provide an opportunity for new ideas and new designs. Clear benefits can be identified and costed including:

- Simplicity for design, installation and maintenance;
- Low cost;
- Suitable environmental land allocations;
- Low risk to humans and the environment; and
- Supportive local rules and consenting.

Retrofitting into existing homes is likely to be less favourable and too expensive to implement on a community wide basis. As for the new homes, simple costs effective solutions will be required if large scale adoption of the technology is to be embraced. At present this appears to be unrealistic but further evaluation could provide solutions.

New on-site wastewater systems that manage both blackwater and greywater work well and the treated water can be used for irrigation. Therefore the use of greywater systems in rural environments, especially when new houses are built would seem unlikely. This is an area that would be unlikely to benefit greatly from further consideration.

Back country huts are a good example of how clear financial, operational and environmental benefits can be achieved by greywater diversion. Benefits include:

- Cheaper waste removal;
- Suitable environmental conditions;
- Low environmental risks; and
- Supportive Regional Plan standards.

This is working well for Tasman District Council and West Coast Regional Council at present. Further enquiries to other regions would determine if the situation in Tasman and the West Coast would be valuable for other areas. The enquiry would identify if a similar approach is already in place and if there is value in transferring an apparently successful approach.

6.4 Availability of Information To Make Decisions About Greywater Use

Education is an important part of the promotion for greywater use. The low priority of greywater use for most regions in NZ suggests a lot of time has not been put into developing

educational and promotional material for greywater use. Such material could be generic for most regions of NZ and could be shared rather than starting from the beginning for each region.

Information about the impact of greywater use or diversion on the environment is not readily available. The onus is on the interested party to obtain, collate and interpret data from a range of sources. The interested party also has to justify the system and its effects to the regulatory agencies. This takes time and money and is likely to be an obstacle to a greater uptake of greywater systems.

More detailed technical information is required for Councils to ensure they have the resources to make informed decisions regarding:

- Appropriate guidelines for technical staff and for home owners;
- Appropriate receiving environment characteristics for greywater systems;
- Management of greywater systems;
- Consenting criteria;
- Prioritisation of water conservation measures;
- Choices available for greywater diversion from a wastewater reticulated system;
- Impacts of greywater reduction from a wastewater reticulated system; and
- Costs and benefits for greywater diversion from different wastewater systems.

6.5 Level of Interest in Greywater Reuse

Greywater reuse is more likely to be adopted where it is seen as a solution for an environmental issue. For stakeholders concern for the environment is a key driver for consideration of greywater reuse. That concern may be driven by individuals or by an organisation. However, to encourage the use of greywater to levels that warrant development of a resource pamphlet or guideline there is a need for a "champion".

It will take leadership to move the inspiration of individuals, communities and Councils to adopt greywater systems. The leaders will need to be well informed to ensure the recipients of their leadership are inspired and confident to proceed. It is important to reiterate that greywater use is a relatively new technology and it is important to provide resources that will best inform the interested parties. This information needs to be balanced and factually based.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Five key drivers have been identified that influence the use of greywater in New Zealand. They are:

- Environmental conditions;
- Cost benefit of greywater reuse;
- Availability of information for making decisions;
- Risks involved with greywater reuse; and
- Level of interest in sustainability and greywater reuse.

The drivers identified reflect the perceptions of the stakeholders surveyed. The diversion and reuse of greywater was identified as a low priority by most stakeholders. A lack of suitable guidance regarding the safe and appropriate discharge of greywater was a common concern and seen to be a key draw back for increasing the reuse of greywater in New Zealand. It is interesting to note that public health on its own was not seen as a key driver for the management of greywater.

There is a clear need for the development of guidelines for greywater reuse. It is expected that the primary users of a guideline document would be councils with a requirement to safeguard environmental and public health.

Information needed to support greywater reuse extends beyond the design of a sustainable greywater system. Consideration needs to be given to establishing appropriate guidance at a policy, regulatory and implementation level. This allows for the setting of direction, developing of regulatory requirements and then ultimately system design. Therefore a guideline document needs to take a holistic approach to greywater reuse which includes (but is not limited to) consideration of:

- What sources of waste can be included in greywater;
- What chemicals (detergents, personal care products etc.) can be used or should be avoided;
- Clear assessment of public health risks;
- Managing nuisance effects of greywater, especially with regard to neighbouring properties;
- Development of a site specific rate of discharge and field size; and
- When to divert the greywater to the sewer.

It is well understood that greywater impacts need to be considered differently to wastewater due to its perceived characteristics (lower pathogens, higher sodium, phosphorus and personal care products chemicals). However there is a need to examine the impact of these components on the receiving environment, both the acute effects and cumulative effects.

In addition to a guideline document there is a need for detailed technical information for Councils to enable them to make informed decisions regarding:

- Appropriate guidelines for technical staff and for home owners;
- Consenting criteria;
- Prioritisation of water conservation measures;
- Choices available for greywater diversion from a reticulated wastewater system;
- Impacts of greywater reduction from a reticulated wastewater system;

- Costs and benefits for greywater diversion from different wastewater systems;

Without a strong case based on cost and benefit, greywater reuse is unlikely to be incorporated into municipal systems; and therefore there may be limited uptake of greywater reuse on a larger urban scale. The greatest potential for establishment of greywater systems would appear to be in one-off applications or the incorporation into new developments rather than retrofitting into existing communities. The potential to use greywater systems to manage poorly preforming onsite wastewater systems also would seem to be an opportunity.

7.1 Recommendations for Further Work

The research programme that was proposed for "Developing the Science Behind a New Zealand Guideline" is well conceived and has anticipated many of the issues that were identified by stakeholders particularly regarding the science required to fill information gaps for users, developers and regulators of greywater discharge systems. Based on a review of stakeholder opinion, recommendations to progress the successful adoption of greywater use in New Zealand include:

- Supporting information for regulatory and system owner decision making is limited. Further investigation is needed to identify what information is available and its relevance to New Zealand conditions.
- It is known that informal greywater discharge is practiced on and ad-hoc basis. Further information is needed to determine what alternative methodologies are being practiced but are not documented.
- Undertake a case study of greywater use in a community to identify end user understanding of greywater use and identify how it is managed outside of the regulatory framework;
- Investigate the need for region or district specific guidelines;
- Develop a frame work which supports the investigation and development of greywater reuse programmes which may include:
    - Focus on water short areas for greywater reuse developments to establish them as leaders to guide other regions in the future.
    - Identify criteria that can predict water shortages within each district.
    - Investigate the best approach to develop data that allows accurate advice on appropriate greywater application to the receiving environments.
    - Explore options for suitable greywater reuse in urban environments.
    - Thorough cost benefit analysis for each different wastewater system, being urban reticulated, new urban homes and subdivisions, retrofitting established urban homes, retrofitting poor functioning septic tanks, to provide a realistic view of areas worth pursuing.
    - Investigate if other regions could benefit from greywater reuse for backcountry huts.
    - Provide Councils with information to ensure they can prepare promotional and educational material as well as being able to make informed decisions regarding the use of greywater by comparison to other water conservation practises.
    - Identify leaders and ensure they are informed with the latest information.
    - Respond to risks identified by the stakeholders with information or the need for research to provide suitable alleviation of concerns.

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9.0 APPENDICES

Appendix A Definitions
Appendix B Interview response sheets
Appendix C Reference to Interviewees
Appendix D Nelson City Council Greywater Guidelines

APPENDIX A

Definitions

Driver: Factor(s) that influence a decision. In this research the decision being explored is the use greywater.

Greywater: Untreated wastewater from a household excluding toilet water (blackwater) (Leonard & Kikkert, 2006). Greywater will often exclude discharges from the kitchen due to high levels of organic matter such as fats grease and oils which can cause fouling and result in blockages and odour issues (Fewtrell & Kay, 2008)..

Greywater reuse: Additional use of the water after simple treatment (adequate for the task). Taking laundry water and watering the lawn without any treatment is re-use. Treating water by filtration so that is can be pumped and distributed by subsurface pressure irrigation is still 're-use', even though it replaces potable water for that purpose (Patterson, 2009).

Greywater recycling: The water that is treated (reclaimed) is then used back in the home or industry instead of potable water. As an example, water that is used by the home is treated to a sufficient standard that it can be used for toilet flushing, rather than having the toilet cistern connected to potable water supply is an example of recycling. Wastewater that is treated by a municipal authority and then distributed in a separate pipe for toilet flushing, garden watering, washing the car or laundry use is 'recycling'(Patterson, 2009).

Greywater use: For this research the term 'greywater use' is suggested to encompass both greywater reuse and recycling. The purpose for this decision is to allow the research to be broad enough to capture and understand potential drivers to all forms of utilising greywater.

Stakeholder: individuals and organisations with a direct interest in a particular issue. For this research the issue is in greywater reuse

APPENDIX B

Interview Response Sheets

INTERVIEW RESPONSE SHEET – end user

Describe your understanding of what greywater reuse is. (How to guide a clear understanding of greywater reuse)
Explain your involvement with greywater reuse.
How well is the greywater reuse system working?
Do you see it operating for you into the future or are there changes you would make?
What benefits and what encourages you to utilise a greywater reuse system?
What concerns do you have related to greywater or greywater reuse systems?
Where do you get your information and guidance from? Who is providing information?
What understanding do you have of the legal requirements for greywater reuse?
Do you see greywater reuse a valuable asset for the future? What benefits/ what difficulties do you envisage?
Any other matters that you consider important to developing greywater systems.

INTERVIEW RESPONSE SHEET – authorities

First, can you describe your understanding of what greywater reuse is? (How to guide a clear understanding of greywater reuse). What level of use and interest is there in your region?
Explain your involvement with greywater reuse.
What benefits and what encourages utilisation of greywater reuse systems?
What concerns do you have related to greywater or greywater reuse systems?
Where do you get your information and guidance from? Who is providing information?
What legal requirements are in place or are being developed for greywater reuse?
Do you see it operating into the future or are there changes you would make?
Do you see greywater reuse a valuable asset for the future? What benefits/ what difficulties do you envisage?
Any other matters that you consider important to developing greywater systems.
Do you know of users of greywater or interest groups that could be contacted

INTERVIEW RESPONSE SHEET – suppliers

First, can you describe your understanding of greywater reuse? (How to guide a clear understanding of greywater reuse). What level of uptake are you getting for greywater systems?
Explain your involvement with greywater reuse. How did you get involved?
How well are the greywater reuse systems working?
Do you see it operating into the future or are there changes that need to be made?
What benefits and what encourages you to utilise a greywater reuse system?
What concerns do you have related to greywater or greywater reuse systems?
Where do you get your information and guidance from? Who is providing information?
What understanding do you have of the legal requirements for greywater reuse?
Do you see greywater reuse a valuable asset for the future? What benefits/ what difficulties do you envisage?
Any other matters that you consider important to developing greywater systems.
Do you know of users of greywater or interest groups that could be contacted

APPENDIX C

Reference to Interviewees

APPENDIX D

Nelson City Council Greywater Guidelines

GUIDELINES

- The Council has to respond to nuisances – we don't want to endorse anything that might impact on the health or cause a nuisance.
- Out of grey water sources, concentrate on bath, shower and hand basins.
- Reuse may not be suitable for small properties (300 – 400 m3), because the volumes can be quite high.
- Grey water should not be poured anywhere near boundaries and not adjacent to your house because of the potential for nuisance and undermining of foundations.
- If property is on a hill, only small volumes of water are okay.
- In winter, need to discontinue using grey water, because there is not enough bacterial activity to break down the fats etc. (and more rain, would cause more ground saturation).
- It is best to spread the water around, to spread the loading. Don't let it all run to the same place because fats would accumulate.
- Be aware of the effect on plants of specific shampoos and soaps.
- Don't use the water on the vegetable garden, as chemicals in shampoos/soaps could have adverse effects.
- A moderate approach is best.
- Discharging the water under bark or mulch can avoid the problem of flies and smell.
- Promote simple techniques such as bucketing out bathwater and using on the garden, and for washing machine, put hose in the tub for the rinse cycle, and put plug in. Bucket out that water.
- Don't encourage costly or high tech cut off systems or storage systems. Not going to save a lot of money, and piping or storage of grey water will cause a buildup of fats.
- It would be helpful to decide if the purpose is reducing use of water from the central system, or promoting alternative and additional watering of gardens.