

# Greywater Recycling Systems: Can These Systems Gain Public Support?

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The supply of clean drinking water is in short in many areas of the world. Some parts of the United States have developed regulations to allow greywater systems, where non-fecal wastewater can be recycled for toilets and irrigations systems. According to existing research, greywater systems can cut residential usage of water by up to 50%, but the installation of systems in new construction is rare. This study looks at some of the regulations on greywater recycling systems in the U.S. to understand the role of government. The authors also conducted a survey to find out the level of knowledge about greywater systems and the public acceptance of the systems that could be placed in new construction. The results of the survey showed that there was a general acceptance of such systems. The implementation of the systems is still weighted by costs, but other factors do impact the decisions.

**Key Words:** Greywater, Water Recycling, Water Conservation, Residential Recycling Systems

## Introduction

The basic necessity for human livelihood is safe and reliable water supply (Karney and Racoviceanu, 2010). Around 1% of the world's water supply is fresh water. It has been predicted that the world will have a serious water shortage problem by 2020 (Brac Systems, 2010). A water survey performed in 2003 on 47 states in the U.S. produced a conclusion that 37 of these states would expect water shortages within 10 years. Water rates have doubled the rate of inflation since 1996 (Rehfle, 2005). "It has also been recognized that underpricing and the lack of consistent regulations and policies for pursuing and promoting efficient water use has led to excessive consumption, depletion of natural resources, and increased pressure on the infrastructure" (Karney & Racoviceanu, 2010).

Greywater recycling systems could help with the potential shortage of water resources. In the United States, around 8% of the potable water produced is used in residential buildings. 20% of this demand is used for flushing toilets and 34% is used for irrigation during a peak summer period (Glick et al., 2009). The bathroom generates up to 65% of the home's water use (Brac Systems, 2010). The average breakdown of fixtures in a residential building is approximately: 25% to 35% for sinks, showers and baths; 20% to 23% for laundry room; 12% for cooling and HVAC; 5% to 10% for kitchen sink, drinking, and cleaning; and 30% to 34% for toilet flushing. (Grosskopf, 1994; & Brac Systems, 2010) Greywater is waste water from bathroom sinks, washing machines, showers, and baths which are non-fecal sources. In the Alabama Department of Public Health Administrative Code chapter 420-3-1 defines Greywater as "that portion of domestic sewage generated by a water-using fixture or appliance, excluding toilet and food preparation waste." Greywater could generate 50% of the wastewater demand for residential buildings (Glick et al., 2009). With minimal treatment greywater can be recycled (reused) for non-potable fixtures that are maintained separately from others that require potable water. Greywater recycling doesn't just reduce the demand on the water resources but it also reduces the discharge into the sewerage systems. A well designed fully functional Greywater System has the potential to save a third of water used in a household. Greywater can be used for many different types of uses from washing cars to watering gardens. The more innovation with recycled greywater could ease the pressure on the fresh water resources (Environment Agency, 2008).

Greywater recycling systems have been well developed and shown to save water, but are not used in many new homes. The primary barriers to implementation are level of information to the public, that Greywater systems are expensive to install and maintain while the cost of water is still economical (Environment Agency, 2008), and many states and municipalities do not have regulations covering greywater systems (Vassos et al., 2007).

Regulations play a huge role in the future for greywater recycling systems. Regulations need the flexibility to allow the general public to control their own systems but protect these systems from potential harm to animals, plants, humans, and the environment. The implementation of greywater recycling systems has been held up because of a lack of established approval processes and existing regulations in the U.S. Vassos has noted that “identifying and removing regulatory barriers that prohibit or unduly complicate the installation of greywater systems, and/or implementing a permitting process, are key areas for future investigation and action” (Vassos et al., 2007).

The following provides a quick look at some of the state and local regulations. The authors also performed a small survey to measure the public understanding and acceptance of greywater recycling systems. The focus of the survey was to determine whether greywater systems can gain public support. Although the group surveyed was small and localized, the survey results indicated that greywater systems may gain public support.

### **Greywater Recycling System Regulations in the U.S.**

Greywater regulations vary throughout the United States. The reason for this variation is because the regulations are made up by local authorities. Two of the most commonly used regulations are the Arizona Law and New Mexico Law. These are the best laws to date for greywater recycling (Ludwig, 2007). California regulations are similar to Arizona and New Mexico, and will be summarized and compared to the area which was used in the survey.

#### *Arizona Greywater Law*

The Arizona Greywater Law has several great aspects (Ludwig, 2007):

- Regulators use a three-tiered system to manage the greywater systems.
- Limited the applications by placing a minimum requirement for an application.
- Does not limit design but sets performance goals.
- The laws are short and easy to understand.

The three tier systems are as follow (Ludwig, 2007):

1. Systems for less than 400 gpd that meet a list of reasonable requirements
2. Systems that process over 400 gpd, do not meet the list of requirements, and/or commercial, multi-family, and institutional systems
3. Systems over 3,000 gpd.

Tier 1 is covered under a general permit and does not require any permits. Tier 2 requires a standard permit and the third tier will be given a permit on an individual basis. This permitting system has helped homeowners and builders to comply with the local codes. Ludwig (2007) showed all the requirements that a private residential building with flow of less than 400 gallons per day must follow for the general permit per the Arizona greywater (Ludwig, 2007).

#### *New Mexico Greywater Law*

The New Mexico Law is very similar to the Arizona Gray Water Law with the exception that the general permit is for flows up to 250 gallons per day instead of the 400 gallons per day requirement for Arizona Law.

#### *California Greywater Law*

The California Building Code (CPC) is also very similar with the New Mexico Law. The CPC allows for indoor use of greywater for flushing toilets and urinals only if it is first treated by an onsite system. Code 1612A.1 Indoor Use of Treated Greywater has four requirements (CPC, 2010):

- The treated greywater shall have a separate tank sized to minimize the length of time it is retained;
- A maintenance and operation manual for the treatment system shall be kept at the location of the system;
- Treated greywater intended for use indoors shall meet the California Department of Public Health statewide uniform criteria for disinfected tertiary recycled water as provided in California Code of Regulations.
- The treated greywater system shall be installed, inspected and tested as specified for reclaimed water systems in Sections 1618.0 and 1620.0.

The California regulation spells out the number of occupancy for each bedroom, first bedroom – two occupants and each additional bedroom – one occupant. The regulations also discuss flow rates per item like, showers, bathtubs and wash basins - 25 GPD/occupant and laundry - 15 GPD/occupant. The estimated greywater discharge shall be distributed daily (Vassos et al., 2007).

In the Light House research paper, it suggests some improvements to the California Greywater Laws. It was an important step for California to regulate Greywater recycling but it has some needed improvements. These California laws must be improved because so many states emulate their laws (Vassos et al., 2007). It discusses using the tier approach like Arizona and New Mexico to gain participation for recycling greywater.

### *Regulations of Cities Used in the Survey*

Auburn is a college town with an average household size of 2.1 people. From 2000 to 2009, Auburn had a population growth of 34.5% to 57,833. Opelika is a nearby city, which during this same timeframe has a growth of 16.8% to 27,443 (City-Data, 2010). The average household size for Opelika B is 2.5 people. 39% of Auburn and 69% of Opelika are family households. Both cities have shown an increase in building permits over the last fifteen (15) years. Auburn had 284 building permits in 2009 whereas Opelika had 119 (City-Data, 2010). According to researchers' interviews with the city officials, no known greywater recycling systems have been approved or inspected in the Opelika or Opelika area.

Table-1 shows a summary of the comparison of selected states and local area's greywater recycling system regulations.

Table 1

***Comparison of States and Local Area's Greywater Recycling System Regulations***

	<b>Arizona</b>	<b>New Mexico</b>	<b>California</b>	<b>Auburn &amp; Opelika</b>
<b>Permit Type</b>	Three tier	Three tier	Follow CPC	Follow the IBC
<b>Minimum Flow without Permit</b>	400 GPD	250 GPD	Permit Required for all systems	No Known Requirements
<b>Type of Reuse</b>	Irrigation Only	Irrigation Only	Irrigation/Toilet Flushing	No Known Requirements
<b>Code Requirement</b>	Filtering	Filtering	Filtering & Disinfection	Filtering & Disinfection
<b>Irrigation</b>	Subsurface	Subsurface	Subsurface	No Known Requirements
<b>Dye</b>	No Requirements	No Requirements	No Requirements	Dye for toilet flushing
<b>Allow Home-made Systems</b>	Yes	Yes	No	No Known Requirements
<b>Complexity of Codes</b>	Short and Easy	Short and Easy	Long and Difficult	No Known Requirements
<b>Design Criteria</b>	Sets Performance Goals	Sets Performance Goals	Limit Design	No Known Requirements

***A Study on Local Public Support for Greywater Recycling System***

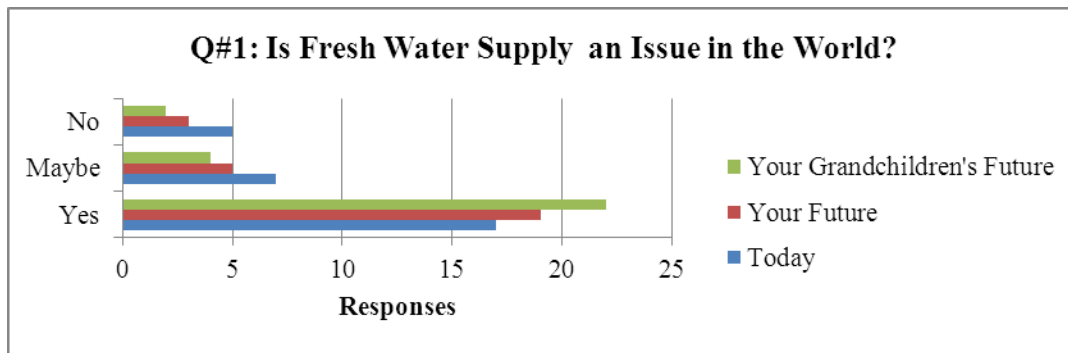
In order to determine the knowledge and support of the general public about residential greywater recycling systems, a survey was developed and conducted by the researchers. This survey was also to help determine the local public knowledge of the environmental effects on the fresh water resources. The survey was targeted to the local residents at where the research was conducted only.

170 survey invitations were sent out through e-mail. 90 out of the 170 were sent to families living in Auburn. The remaining surveys were sent to people in the surrounding areas of Auburn, including Opelika. This survey had 29 respondents which is a 17% response rate. The researchers discovered that one factor that caused the low survey response rate was the topic. Greywater is not a topic many people have knowledge of therefore most of them had ignored the survey invitation e-mail and deleted it as a junk mail.

***Survey Results and Analysis***

The result from the survey is as follows:

*Question #1: Do you feel the supply of fresh water is an issue in the World? Today, Your Future, or Your Grandchildren's Future.*



*Figure 1: Shows that the surveyed population felt Fresh Water Supply is an Issue.*

See Figure-1 for a graph of the result of this question. Out of the people who answered this question, 78.6% of them felt the fresh water supply will be an issue in the future with 58.6% considering it an issue now. This is a good indicator that the general public does understand that the supply of fresh water will be an issue if we do not try to change our ways. Over 41% of the respondents are not sure or does not feel the fresh water supply will be an issue. This could be for the lack of information they are receiving though the media and education. The trend shows that most respondents understood the water supply will become an issue in the future therefore it needs to be handled.

*Question #2: Do you know what LEED stand for?*

LEED is a way to get more knowledge out about the environment and ways to protect our environment. LEED is not a mandatory requirement. With over 62% of the respondents having knowledge of LEED, it is a good indicator why the people responded to Question #1 as they did. LEED will play a huge role in the information circulation for these environmental issues.

*Question #3: Do you know what a Greywater Recycling System is?*

It was very exciting that 67% of the respondents knew about greywater recycling systems. This was higher than anticipated since there was no known systems installed or permitted in the Auburn area.

*Question #4: Would you consider using a Greywater Recycling System in your home?*

76% of the respondents would consider using a greywater recycling systems. Similar to Question #3, this rate was higher than anticipated. This question also strengthens the need for better information and education about greywater recycling systems so the general public will not just consider the use but will actual use a system in their homes.

*Question #5: Would you consider Greywater Recycling Systems safe?*

Another question which researchers were surprised with the results since over 88% of the respondents felt greywater recycling systems were safe. This question emphasizes the need to market the costing information to help people use greywater recycling systems.

*Question #6: Of the following factors, which one would persuade you to use a Greywater Recycling System in a new home?*

This is the most important question asked to the general public because this information is how we need to market to the public. Figure-2 shows that around 39% of the people felt that cost benefits would persuade them to use a greywater recycling systems. Also 22% of the respondents would use these systems if there were tax incentives place on the use of the systems. Only 18% would wait until the government made the systems mandatory while

21% would consider the environment for their decision. This was encouraging that if the correct information can be provided to the people they may start implementing greywater recycling systems in their new homes.

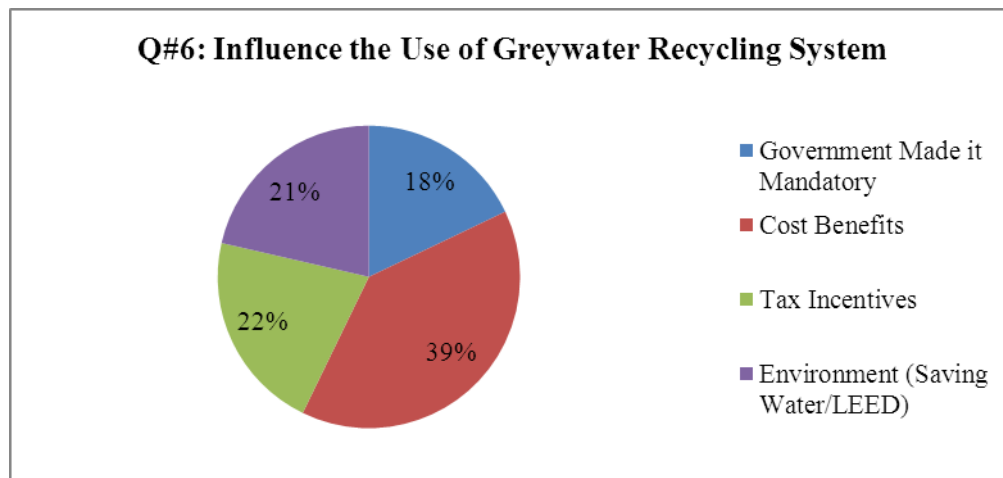


Figure 2: Shows What Influence the Use of Greywater Recycling System.

*Question #7: Rank the important of the following factors from (1) most important to (6) least important to influence your use of a Greywater Recycling System in a new home?*

The rankings from Question #7 are in line with the result of the first six questions. It supports Question #6 that cost benefits were extremely important. The surveyed population felt that mandatory requirements are not an important influence factor to choose a greywater recycling systems. The remaining influence factors had very similar important to the general public for the use of these systems. This question also revealed a need to explore the cost benefits of the greywater systems to help influence people to start using greywater recycling systems. See Figure-3 for the graph of the result of this question.

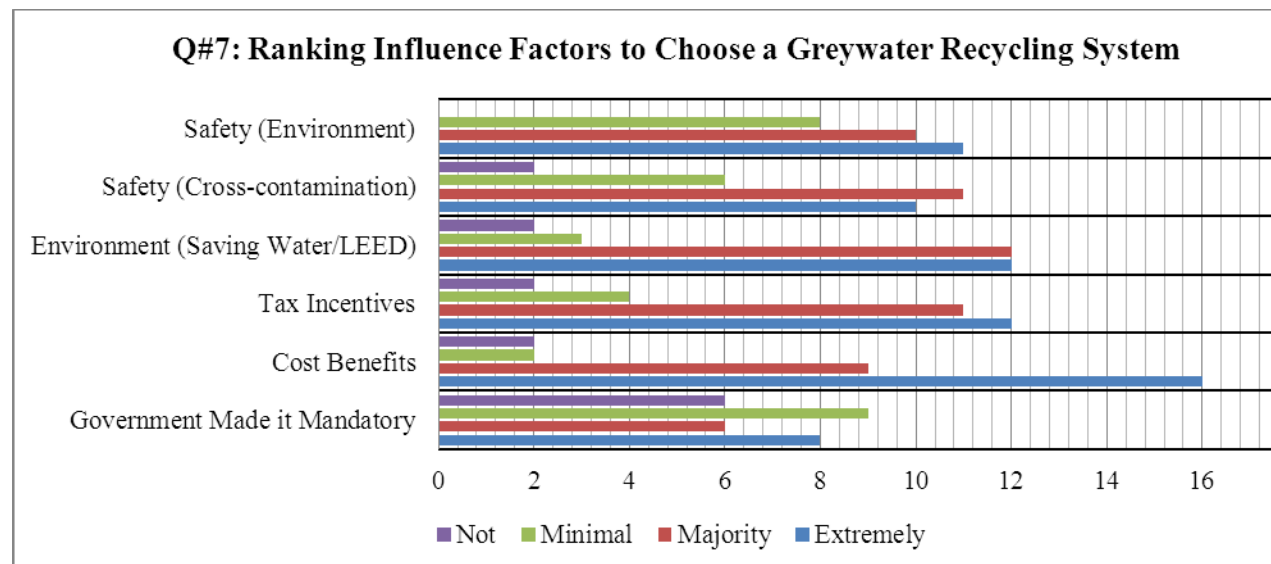
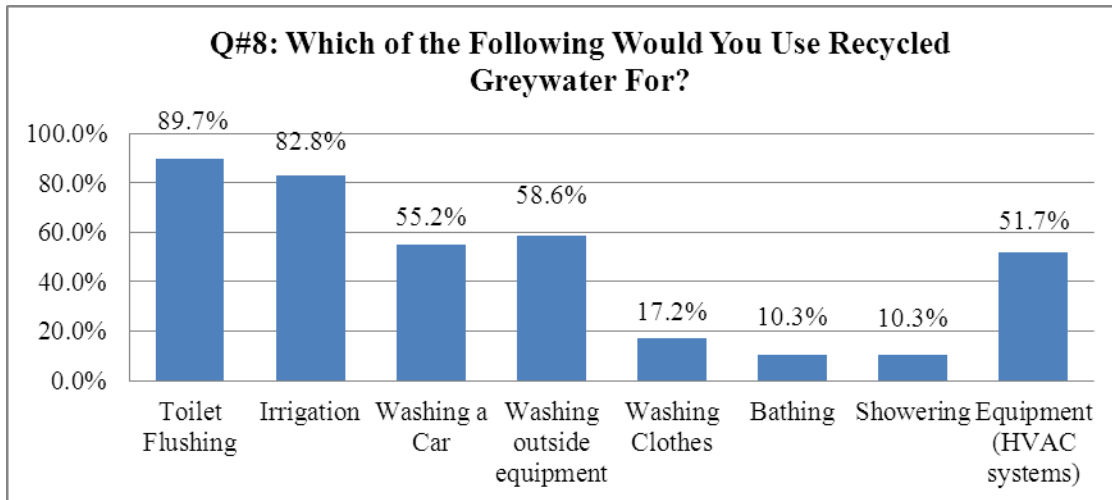


Figure 3: Shows the Ranking of the Influence Factors to choose a Greywater Recycling System.

*Question #8: Which of the following would you use Recycled Greywater for?*

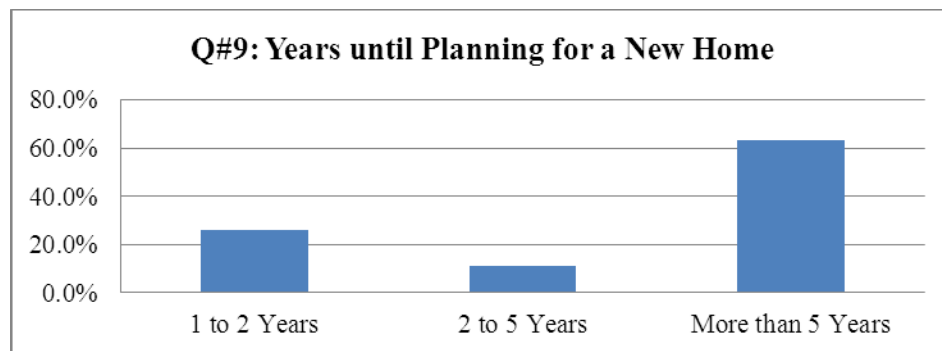
All the respondent answered this question with 89.7% stating they would use recycled greywater for toilet flushing, 82.8% for irrigation, Over 52% for washing a car, washing outside equipment, or equipment make-up, and minimal would use it for bathing, showering, and/or washing clothes. This question had a very positive result since so many people would use the recycled greywater for other uses than irrigation or toilet flushing. It appears the use of greywater for outside use would be acceptable for this area. The results does show that people still does not want the recycled greywater touching them by bathing or wearing clothes washed with recycled greywater. These are important factors when deciding which regulations would be best for this area.



*Figure 4: Shows what the surveyed population would use Recycled Greywater for.*

*Question #9: Would you be looking for a new home?*

This question helped determine the time frame that more information would be needed to get to the general public. Over 60% of the respondents would be looking for a new home in more than five year which should allow time to generate this information and to educate the public about the benefit of greywater recycling. However 26% of the people were looking for a new home in the next two years. It will be important to get as much of the information out as soon as possible to help influence these people.



*Figure 5: Shows the surveyed plans for a new home.*

*Question #10: What is your age group?*

The surveyed population was representative by all age group which help get a greater understand from each of these age groups. More than 69% of the surveyed population was over the age of 40. Only 14% of the respondents were

under the age of 29 years old which would suggest that they may not have the time, own a home, or the desire to learn more about greywater recycling.

This survey helped gain knowledge of the general public about residential greywater recycling systems and the effects of the environment on the fresh water resources. The results were somewhat surprising but positive. Most people surveyed had knowledge of greywater recycling and understood how essential our water resources will be for the future of the world. Better information will help people start implementing the use of greywater recycling.

## Conclusion

The study has shown several aspects that impact the implementation of greywater systems. One is the cost of the systems in relation to the benefit. As more systems are put in place, the costs may come down. The key may actually be the cost of water. The increase in cost will result in a more rapid payback on any system that reduces the usage.

Second is the knowledge of the homeowners. The survey showed that homeowners are aware and knowledgeable about greywater systems. There is also the indication that certain incentives would encourage the installation in new construction.

Finally regulations will play a huge role in this implementation of greywater recycling systems. Such regulations must be simple and easily understood to help gain public support. Some of the key regulations recommended by the researchers are as follows:

- Regulators use a multi-tiered system to manage the greywater systems.
- Limit the cost of an application which would encourage applicants to actually apply for the application.
- Make the application short and easy for the applicant.
- Make the laws short and easy to understand.
- Regulation must promote the use of greywater recycling systems.
- Require that residential plumbing to designate an area for the future use of a greywater recycling system.
- Require that the waste and water supply distribution systems be plumbed separately throughout the home to promote future use of a greywater recycling system.

These regulations will improve the implementation of greywater recycling systems which in return will help the cost of these systems. In the United States, there is a limited amount of greywater recycling systems suppliers at this time. If the demand increases, it would promote competition of these systems which would help reduce the cost associated with the systems.

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