Discussion of the effects of diverting graywater from the wastewater stream on the treatment system and dispersal area

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GTS

Introduction

- My background
  - Sales Rep for MicroSepTec: 2002-2003
  - Independent OWTS technology rep: 2003-present
  - ROFG – not a PhD, PE, RS, etc.

Effects of Graywater Removal

- AzOWRA Conference - June 2011
  - Tucson graywater regulations: remove graywater at source, but no design change to wastewater treatment and disposal
  - We have not found any jurisdictions that require design changes to wastewater treatment and disposal with graywater removal
- Led us to the questions:
  - What happens to what’s left in the waste stream?
  - How will what’s left effect septic tank treatment?
  - How will it effect the disposal field?

Studies

- Few published studies that address what's left in the waste stream once graywater is removed (i.e. a 'blackwater' study)
- No studies found that address what effect the leftover waste will have on a soil treatment area

Blackwater Studies

- Marek Brandes Study
  - Can only find abstracts, not the actual report
  - One home in Ontario, Canada in 1978
  - Applicability of study results?

Blackwater Studies

- Classic Swedish Study
  - Apartment building plumbed for graywater in Stockholm in 1967
  - Study reports only 34 gpd/person and 93% of flow is graywater.
  - To contrast:
    - USEPA table 3-2 reports 54-67 gpd/person
    - 93% is the highest ratio reported in any study we found
  - Applicability of study results?

Different approach

If we can define graywater characteristics, we should be able to subtract that from the wastewater characteristics to deduce the anticipated blackwater characteristics.

- Define graywater characteristics
- Define wastewater characteristics
- Deduce blackwater characteristics

Once we determine what will go into the septic tank, we can look into how the tank will treat it and ultimately what will go into the field.

Graywater Studies

- Found many studies, but most were focused on applications of graywater
- Found several definitions of graywater
  - Different studies contained different sources for graywater. For example: is kitchen waste included? is dishwashing included? is there a garbage disposal? are EPACT fixtures used? is laundry wash water included? is non-phosphorus detergent used? These answers vary study-by-study, even though the materially effect the outcome.

Graywater Studies Definitions

2 Definition and terminology of greywater

2.1 Definition

There are several definitions for greywater in the literature. The biggest difference is whether kitchen wastewater is perceived as greywater or not. Table 1 gives an overview on definitions of greywater used in the literature.

Table 1: Definitions of greywater used in the literature

Definition	Kitchen included	References
Wastewater from baths, showers, hand basins, washing machines and dishwashers, laundries and kitchen sinks.	Yes	(Ledin et al., 2001a)
Wastewater without any input from toilets, which means it corresponds to wastewater produced in bathtubs, showers, hand basins, laundry machines and kitchen sinks, in households, office buildings, schools…	Yes	(Eriksson et al., 2002)
Wastewater excepting toilet wastes and food wastes derived from garbage grinders.	Partially	(Greywater.com, 2004)
Wastewater from washing machines, washing bowls, showers, bath tubes, cleaning containing mainly detergents	No	(Wilderer, 2003)
Wastewater without input from toilets (i.e. wastewater from laundries, showers, bathtubs, hand basins and kitchen sinks).	Yes	(Ottoson and Stenstrom, 2003)
Grey water arises from domestic washing operations. Sources include waste from hand basins, kitchen sinks and washing machines, but specifically exclude black water from toilets, bidets and urinals.	Yes	(Jefferson et al., 2001)
Graywater is defined as all wastewaters generated in the household, excluding toilet wastes. It can come from the sinks, showers, tubs, or washing machine of a home.	Yes	(Casanova et al., 2001)
Greywater is defined as all wastewater from non-toilet plumbing fixtures around the home. The use of kitchen greywater is not recommended as a greywater source.	No	(Christova Boal et al., 1996)
Grey wastewater (grey water) from bathrooms, washing machines and kitchen with little nutrients.	Yes	(Otterpohl et al., 1999)
Wastewater from buildings excluding that fraction discharged from the WC.	Yes	(Dixon et al., 1999)

Definition	Kitchen included	References
Wastewater from washing, dish, bath water and the like.	Yes	(Gunther, 2000)
Wastewater from your laundry, bathtubs, showers, and bath sinks (lavatories). Water from kitchen sinks and dishwaters is not considered greywater.	No	(Little)
The domestic wastes from baths, showers, basins, laundries and kitchens specifically excluding water closet and urinal waste. Greywater does not normally contain human waste unless laundry tubs or basins are used to rinse soiled clothing or baby's napkins.	Yes	(Queensland, 2002) (Australian/ New Zealand Standard AS/NZS 1547: 2000 "On-site domestic wastewater management")
Graywater is washing water from bathtubs, showers, bathroom washbasins, clothes washing machines and laundry tubs, kitchen sinks and dishwashers.	Yes	(Del Porto and Steinfeld, 2000)
Greywater is wastewater which is not grossly contaminated by faeces or urine, i.e. the wastewater arising from plumbing fixtures not designed to receive human excrement or discharges and includes bath, shower, hand basin, laundry and kitchen discharges.	Yes	(NSWHealth, 2000)
Greywater is wastewater generated in the bathroom, laundry and kitchen, and is therefore the components of wastewater which have not originated from the toilet.	Yes	(Greywatersafer.com, 2004)

Wastewater from kitchen sinks and dish washing is sometimes excluded from greywater sources because of the potential to introduce microbial contaminants and/ or oils and greases that would negatively impact the receiving environment (TOWTRC, 2003). But in most sources kitchen wastewater is also contained in greywater.

Graywater Studies

- Variations in strength
  - Ranges of characteristics
    - Within an individual study (e.g. 26-130 mg/L BOD – Eriksson Study)
    - Between studies (e.g. 26-291 mg/L BOD – Crook Memorandum)

Table 4. Graywater Quality

Constituent or Parameter	Source of Graywater			
	Composite	**Bath/Shower***	**Laundry Wash**	**Laundry Rinse**
Temperature (^{o}C)	21.6 – 28.2			
pH (units)	6.5 – 8.7			
EC (µS/cm)	325 – 1140	82 – 250	83 – 880	
COD (mg/L)	52 – 622	96		
BOD (mg/L)	26 – 291	45 – 330	10 – 520	
TSS (mg/L)	7 – 330	37		
Turbidity (NTU)	22 – <200	28 - 96	39 - 296	14 - 29
NH_4-N (mg/L)	0.02 – 25.4	0.11 – 0.37	0.1 – 3.47	0.06 – 0.33
NO_3-N (mg/L)	<0.02 – 0.98			
Total N (mg/L)	1.7 – 6.4			
PO_4 (mg/L)	1.4 – 35			
Total P (mg/L)	0.28 – 27.3			
Sulfate (mg/L)	0.3 – 110			
Chloride (mg/L)	3.1 – 141			
Hardness (mg/L)	15 – 144			
Alkalinity (mg/L)	149 – 382			
Ca (mg/L)	20.6 – 78			
K (mg/L)	5.9 – 7.4			
Mg (mg/L)	1.7 – 31.4			
Na (mg/L)	29 – 415			
Total bacteria (CFU/100 mL)	4.0 x 10^{7} – 6.1 x 10^{8}	1.0 x 10^{7} – 1.0 x 10^{8}	1.0 x 10^{7} – 1.0 x 10^{8}	1.0 x 10^{7} – 1.0 x 10^{8}
Total coliform (CFU/100 mL)	6.0 x 10^{3} – 1.9 x 10^{8}	2.7 x 10^{1} – 2.4 x 10^{7}	199 – 3.3 x 10^{5}	56
Fecal coliform (CFU/100 mL)	1.82 x 10^{4} – 7.94 x 10^{6}	<10 – 2 x 10^{8}	2 x 10^{1} – 10^{7}	
Fecal streptococci (CFU/100 mL)	2.38 x 10^{2}	1.9 x 10^{1} – >2.4 x 10^{5}	<3 – <2.4 x 10^{5}	<3 – <2.3 x 10^{3}
E. coli (CFU/100 mL)	<1 x 10^{2} – 1.0 x 10^{6}	3.9 x 10^{5}		
Fecal enterococci (CFU/100 mL)	Not detected – 2.4 x 10^{2}	2.5 x 10^{3}		2.5 x 10^{4}
Pseudomonas aeruginosa (CFU/100 mL)	2.0 x 10^{4}			
Clostridium perfringens spores (CFU/100 mL)	2.0 x 10^{3}			
Salmonella veltereden (MPN/L)		Detected but not quantified		
Giardia (organisms/L)		0.5 – 1.5		
Coliphages	<1 – 2.0 x 10^{3}			

* Some samples included water from bathroom sinks.

Source: Adapted from Rose et al. [1991] ; Eriksson et al. [2003] ; Casanova et al. [2001] ; Western Australia Department of Health [2002]; California Department of Health Services [1998]; Jeppesen [1996]; Christova-Boal et al. [1995]; Christova-Boal et al. [1996]; Ottoson and Stenstrom [2003]; California Department of Health Services [1979]; City of Los Angeles, [1992]; Birks and Hills [2005]

Graywater Studies

- Variations in strength

Graywater				
	Washington Light[1]	Washington Dark[2]	Casanova	Crook
TSS	7-200	45-330	15-112	7-330
BOD	26-130	90-290	41-85	26-291
Nitrogen				1.7-6.4
FOG				
pH		6.6-8.7		6.5-8.7
Alkalinity		125-382		149-382

[1] Light Gray Water
[2] Dark Gray Water (incl. kitchen waste)

Graywater Studies

- Variations in flow
  - What percentage of the total waste stream is graywater?
    - Swedish Study – 93%
    - Charles P. Gerba Presentation – 86%
    - WERF 2006 – 72%
    - Mayer & DeOreo, 1999 – 40%

Graywater Studies

Conclusion:

- Simply looking at the conclusion tables of each study can be very misleading if the details of the study are unknown.
- Developing a concise definition of graywater characteristics is problematic

Wastewater Characteristics

- Variations in strength

Influent Strength Comparison				
	USEPA	**NSF**	**Washington**	**Arizona**
TSS	155-330	100-350	350	430
BOD	155-286	100-300	300	380
Nitrogen	27-75	30-70	NA	53
FOG	70-105	NA	100	75
pH		6.5-9.0		
Alkalinity		175 mg/l		

Wastewater Characteristics

- Variations in flow

Flow Rate Comparison	
	Gal/Person/Day
USEPA	50-70
EPA: Seattle	54-57.1
EPA: Eugene	63.8-83.5
EPA: Phoenix	66.9-77.6
EPA: Los Virgenes	61-69.6
EPA: Lompoc	56.1-65.8
EPA: San Diego	54.1-58.3

Wastewater Characteristics

Conclusion: developing a universal definition of wastewater characteristics is problematic

Blackwater Characteristics

Because there are so many variable ranges in anticipated strengths and flows of both graywater and combined wastewater, there's no clean way to deduce the characteristics of what's left to be treated in a septic tank.

Tank Efficiency

Even if we knew the characteristics of the concentrated flow entering the septic tank, how do we know what the tank will do with this flow?

- If we compare influent and effluent data, we can determine septic tank efficiency

Tank Treatment Efficiencies*				
	EPA	Washington University	Washington	AZ
TSS	60 to 80%	77%	59%	83%
BOD	30 to 50%	60%	50%	61%
Nitrogen				
OG		79%	70%	

*These efficiencies are based on combined household flow.

Tank Efficiency

- There are no studies about how increased detention times will impact treatment efficiency.
- There are no studies about how increased concentrations will impact treatment efficiency.
- If we don’t know how graywater removal will impact the tank, how can we know what it will do to the disposal field?

Graywater-Blackwater Modeling Tool

Engineers at MicroSepTec developed a tool for calculating effluent strength to the disposal field once the graywater has been removed

INPUT NUMBERS							CALCULATED NUMBERS						COMPARISON	COMPARISON
#people per bedroom	Number of Bedrooms	[1] Flow per person GPD	Wastewater Components	[2] Wastewater Tot. Influent Strength	[3] Graywater Estimated Strength	[4] Graywater Flow % to reuse	Tank Influent Flow GPD	Tank Influent Strength	[5] Typical Septic Tank Efficiency %	[6] Effluent Strength to Field	[7] Organic Loading to Field lbs/sqft/day	[8] Potential Conversion in Field	[9] Typical Septic Tank Effluent Strength	[10] AZ Effluent Strength R-18-9-E302 B
			TSS, mg/l	225	120			495	70%	149		1	101	75
			BOD, mg/l	200	155			316	40%	189	0.00095	2	147	150
			TKN, mg/l	50	5			166	10%	149		111	68	53
2	2	75	NO3-N, mg/l	0	0	72%	84	0	0%	0		20	0	NA
			FOG, mg/l	87.5	9			289	79%	61		1	36	NA
			Alkalinity, mg/l	175	158			219	0%	219		-	-	NA

Hydraulic loading rate: 84.00 GPD

Tank Volume	**1000**	**Gal**
Retention Time	285.7	hrs

[1] Flow based on 2-3 bedroom home in AZ

[2] Influent NSF Standard 40 median except FOG which is taken from EPA manual, table 3-7 range of 70 to 105 mg/l, median 87.5 mg/l.

[3] Graywater Estimated TSS, BOD from NSF Standard 245 Median. TKN, FOG assumed.

Alkalinity mean of 158 mg/l from Tier Two and Three Greywater Subsurface Irrigation Systems/Guidance, Washington State, pg 14.

[4] Graywater is reused , i.e. does not enter tank

Flow % from WERF Long Term Effects Of Landscape Irrigation Using Household Graywater-Literature Review And Synthesis, 2006.

[5] TSS, BOD from EPA as decribed. Nitrogen assumed. FOG from Seabloom, Bounds, Louden. Alkalinity no data.

[6] If BOD, TSS & FOG are higher than typical numbers, the drain field needs to be larger
(could still cause severe clogging & biomat formation otherwise)

[7] Typical rock & pipe trench and hydraulic loading information provided by Peter Livingston, Bosque Engineering, Tucson, AZ.

[8] Assumes enough oxygen is available for nitrification in aerobic zone of field; alkalinity comes from effluent only
Denitrification assumes 50% of effluent BOD is available in anaerobic zone of field
Assumes complete removal (99%) in field of TSS, BOD, & FOG

[9] Average numbers from EPA Onsite Wastewater Treatment Manual

[10] Numbers from Title 18 Chapter 9 Arizona Administrative Code

Variables

The tool allows the user to enter the following variables (in **bold** on the spreadsheet)

- Influent flows
- Influent strengths
- Graywater strengths
- Graywater flow ratio
- Septic tank efficiency

"NSF" Scenario

Had to use multiple standards

SEPTIC TANK

"NSF"Scenario Applied To AZ Home

[7] Hydraulic loading to field (design requirement):	0.6	GPD/sqft

INPUT NUMBERS							CALCULATED NUMBERS						COMPARISON	COMPARISON
#people per bedroom	Number of Bedrooms	[1] Flow per person GPD	Wastewater Components	[2] Wastewater Tot. Influent Strength	[3] Graywater Estimated Strength	[4] Graywater Flow % to reuse	Tank Influent Flow GPD	Tank Influent Strength	[5] Typical Septic Tank Efficiency %	[6] Effluent Strength to Field	[7] Organic Loading to Field lbs/sqft/day	[8] Potential Conversion in Field	[9] Typical Septic Tank Effluent Strength	[10] AZ Effluent Strength R-18-9-E302 B
2	2	75	TSS, mg/l	225	120	72%	84	495	70%	149	0.00095	1	101	75
			BOD, mg/l	200	155			316	40%	189		2	147	150
			TKN, mg/l	50	5			166	10%	149		111	68	53
			NO3-N, mg/l	0	0			0	0%	0		20	0	NA
			FOG, mg/l	87.5	9			289	79%	61		1	36	NA
			Alkalinity, mg	175	158			219	0%	219		-	-	NA

Hydraulic loading rate: 84.00 GPD

Tank Volume	**1000**	**Gal**
Retention Time	285.7	hrs

[1] Flow based on 2-3 bedroom home in AZ
[2] Influent NSF Standard 40 median except FOG which is taken from EPA manual, table 3-7 range of 70 to 105 mg/l, median 87.5 mg/l.
[3] Graywater Estimated TSS, BOD from NSF Standard 245 Median. TKN, FOG assumed.
Alkalinity mean of 158 mg/l from Tier Two and Three Greywater Subsurface Irrigation Systems/Guidance, Washington State, pg 14.
[4] Graywater is reused , i.e. does not enter tank
Flow % from WERF Long Term Effects Of Landscape Irrigation Using Household Graywater-Literature Review And Synthesis, 2006.
[5] TSS, BOD from EPA as decribed. Nitrogen assumed. FOG from Seabloom, Bounds, Louden. Alkalinity no data.
[6] If BOD, TSS & FOG are higher than typical numbers, the drain field needs to be larger
(could still cause severe clogging & biomat formation otherwise)
[7] Typical rock & pipe trench and hydraulic loading information provided by Peter Livingston, Bosque Engineering, Tucson, AZ.
[8] Assumes enough oxygen is available for nitrification in aerobic zone of field; alkalinity comes from effluent only
Denitrification assumes 50% of effluent BOD is available in anaerobic zone of field
Assumes complete removal (99%) in field of TSS, BOD, & FOG
[9] Average numbers from EPA Onsite Wastewater Treatment Manual
[10] Numbers from Title 18 Chapter 9 Arizona Administrative Code

*NSF Std. 350 (the new graywater standard) uses a synthetic wastewater that does not emulate kitchen waste

Arizona Scenario

Using ADEQ influent strengths, Casanova graywater strengths, Charles P. Gerba flow %, AZ Tank Efficiencies

SEPTIC TANK

AZ Scenario

[7] Hydraulic loading to field (design requirement):	0.6	GPD/sqft

INPUT NUMBERS							CALCULATED NUMBERS						COMPARISON	COMPARISON
#people per bedroom	Number of Bedrooms	[1] Flow per person GPD	Wastewater Components	[2] Wastewater Tot. Influent Strength	[3] Graywater Estimated Strength	[4] Graywater Flow % to reuse	Tank Influent Flow GPD	Tank Influent Strength	[5] Typical Septic Tank Efficiency %	[6] Effluent Strength to Field	[7] Organic Loading to Field lbs/sqft/day	[8] Potential Conversion in Field	[9] Typical Septic Tank Effluent Strength	[10] AZ Effluent Strength R-18-9-E302 B
2	2	75	TSS, mg/l	430	35.09	86%	42	2856	83%	485		Field Overload!	101	75
			BOD, mg/l	380	64.85			2316	61%	903	0.00451	Field Overload!	147	150
			TKN, mg/l	53	5			348	0%	348		271	68	53
			NO3-N, mg/l	0	0			0	0%	0		2	0	NA
			FOG, mg/l	75	8			487	79%	102		1	36	NA
			Alkalinity, mg	175	158			279	0%	279		-	-	NA

Hydraulic loading rate: 42.00 GPD

Tank Volume **1000** **Gal**
Retention Time 571.4 hrs

[1] Flow based on 2-3 bedroom home in AZ
[2] Influent values taken from ADEQ page 5, item 42, "Typical Sewage". Alkalinity NSF Standard 40.
[3] TSS and BOD taken from Casanova, Gerba and Karpiscak 2001, Casa Del Agua Study. Nitrogen and FOG assumed.
Alkalinity mean of 158 mg/l from Tier Two and Three Greywater Subsurface Irrigation Systems/Guidance, Washington State, pg 14.
[4] Graywater is reused , i.e. does not enter tank.
Flow % from Charles P. Gerba Powerpoint Presentation. Pg 12-13. Sources Of Graywater In Pima County.
[5] TSS, BOD & Nitrogen calculated w/ ADEQ influent & effluent strengths. FOG from Seabloom, Bounds, Louden. Alkalinity no data
[6] If BOD, TSS & FOG are higher than typical numbers, the drain field needs to be larger
(could still cause severe clogging & biomat formation otherwise)
[7] Typical rock & pipe trench and hydraulic loading information provided by Peter Livingston, Bosque Engineering, Tucson, AZ.
[8] Assumes enough oxygen is available for nitrification in aerobic zone of field; alkalinity comes from effluent only
Denitrification assumes 50% of effluent BOD is available in anaerobic zone of field
Assumes complete removal (99%) in field of TSS, BOD, & FOG
[9] Average numbers from EPA Onsite Wastewater Treatment Manual
[10] Numbers from Title 18 Chapter 9 Arizona Administrative Code

Arizona Scenario

Possibly a more everyday life scenario?

SEPTIC TANK

AZ/Broad Scenario

[7] Hydraulic loading to field (design requirement):	0.6	GPD/sqft

INPUT NUMBERS							CALCULATED NUMBERS						COMPARISON	COMPARISON
#people per bedroom	[*] Number of Bedrooms	[1] Flow per person GPD	Wastewater Components	[2] Wastewater Tot. Influent Strength	[3] Graywater Estimated Strength	[4] Graywater Flow % to reuse	Tank Influent Flow GPD	Tank Influent Strength	[5] Typical Septic Tank Efficiency %	[6] Effluent Strength to Field	[7] Organic Loading to Field lbs/sqft/day	[8] Potential Conversion in Field	[9] Typical Septic Tank Effluent Strength	[10] AZ Effluent Strength R-18-9-E302 B
2.58	1	66.9	**TSS, mg/l**	**225**	**35.09**	**72%**	48.32856	713	**70%**	214		Field Overload!	*101*	*75*
			BOD, mg/l	**200**	**64.85**			548	**40%**	329	0.00164	Field Overload!	*147*	*150*
			TKN, mg/l	**50**	**5**			166	**10%**	149		105	*68*	*53*
			NO3-N, mg/l	**0**	**0**			0	**0%**	0		12	*0*	*NA*
			FOG, mg/l	**87.5**	**8**			292	**79%**	61		1	*36*	*NA*
			Alkalinity, mg	**175**	**158**			219	**0%**	219		-	*-*	*NA*

Hydraulic loading rate: 48.33 GPD

Tank Volume	**1000**	**Gal**
Retention Time	496.6	hrs

[*] I input 1 to use census data for calculation. Not literally a 1 bedroom home.
[1] 2010 Census persons per household Tucson, AZ and EPA Table 3-2.
[2] Influent NSF Standard 40 Median except FOG which is taken from EPA manual, table 3-7 range of 70 to 105 mg/l, median 87.5 mg/l.
[3] TSS and BOD taken from Casanova, Gerba and Karpiscak 2001, Casa Del Agua Study. Nitrogen and FOG assumed.
Alkalinity mean of 158 mg/l from Tier Two and Three Greywater Subsurface Irrigation Systems/Guidance, Washington State, pg 14.
[4] Graywater is reused , i.e. does not enter tank
WERF Long Term Effects Of Landscape Irrigation Using Household Graywater-Literature Review And Synthesis, 2006.
[5] TSS, BOD from EPA as decribed. Nitrogen assumed. FOG from Seabloom, Bounds, Louden. Alkalinity no data.
[6] If BOD, TSS & FOG are higher than typical numbers, the drain field needs to be larger (could still cause severe clogging & biomat formation otherwise)
[7] Typical rock & pipe trench and hydraulic loading information provided by Peter Livingston, Bosque Engineering, Tucson, AZ.
[8] Assumes enough oxygen is available for nitrification in aerobic zone of field; alkalinity comes from effluent only
Denitrification assumes 50% of effluent BOD is available in anaerobic zone of field
Assumes complete removal (99%) in field of TSS, BOD, & FOG
[9] Average numbers from EPA Onsite Wastewater Treatment Manual
[10] Numbers from Title 18 Chapter 9 Arizona Administrative Code

Questions

- What are the right numbers to use?
- What impact does increased retention time have?
- If we pull out the laundry water, what does it do to pH and alkalinity? How will that affect treatment?
- Will homeowners get 20 years out of their fields?
- Will maintenance needs change? Pumping frequency?
- How will all this effect alternative treatment systems?
- Should organic loading be considered in this application?
- Should wastewater treatment system designs change to accommodate “blackwater” treatment and disposal?
- Will there be an impact on municipal plants?

Support Documentation

- Brandes, M "Characteristics Of Effluents From Grey and Black Water In Septic Tanks". Journal (Water Pollution Control Federation), vol. 50, no. 11 (Nov., 1978) Link: http://www.jstor.org/discover/10.2307/25040185?uid=3739552&uid=2&uid=4&uid=3739256&sid=21100645897606
- Tullander, Ahl and Olsen 1967. Link: Greywater.com – Swedish study page 6.htm
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- James Crook, Ph.D, P.E., Technical Memorandum on Graywater, Feb. 2009. Page 10, Table 4 – Graywater Quality.
- Charles P. Gerba, Graywater Systems And Use, Power Point Presentation. No date.
- Mayer and DeOreo 1999 referenced by Crook Technical Memorandum On Graywater, page 5, figure 2.
- Greywater Reuse In Washington State (DOH) June 2009.
- WERF Long Term Effects Of Landscape Irrigation Using Household Graywater-Literature Review And Synthesis, 2006.
- Wastewater Quality/Strength/Content – Washington State DOH, Apr.,2002 "Recommendations" pg 7
- Western Resource Advocates – Arizona Water Meter Report. Link: http://www.westernresourceadvocates.org/azmeter/
- Washington University-Seabloom, Bounds and Louden – Septic Tanks, Jan., 2004
- Septic Tank Effluent Values, Washington State DOH, Dec., 2003
- Washington State DOH, Tier 2 and 3 Greywater Subsurface Irrigation Systems-Guidance Sep, 2011
- Casanova, Gerba, Karpiscak, 2001, Chemical and Microbial Characterization Of Household Graywater