A Critique of the CSH Water Efficiency Requirements.

Produced by NBT Consult for the Good Homes Alliance

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Contents

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All errors and opinions are those of the author and not the GHA.

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A critique of the CSH water requirements.

The Government has taken a bold move in calling for urgent reductions in carbon emissions and water consumption in new buildings. The proposed roadmap is the Code for Sustainable Homes and the timescale is Code level 6 by 2016. In the context of climate change, water is crucial both in terms of scarcity in dry years, and in terms of associated CO_2 emissions – mostly for heating it[1]. This importance is reflected in the Code as water targets are compulsory and cannot be traded against other measures.

The core problems

This document sets out to elaborate on some concerns that were first highlighted in a shorter report in June 2007[2]. Having tried working with the Code for over a year, I am of the firm opinion that the water methodology requires urgent and major revision rather than incremental adjustment as has been occurring.

Whilst I apologise for the length of this document, I have only touched the surface and new practical problems emerge almost every time an assessment is carried out. As with the Energy section of the Code I understand this complexity to be inherent in the approach taken.

The calculated whole-household performance approach used by the Code was deliberately adopted after 'stakeholder consultation' in preference to performance standards for individual fittings. Ironically whilst the performance approach was probably seen as a soft option allowing a trade off between fittings, the reliance on the water calculation tends to force appliance water use values that are far lower than any appliance standard would have ever been likely to enforce. For example whilst 1.7 l/minute spray taps for the kitchen sink are a logical step to meeting the Code it is unlikely that a proposal for kitchen taps with a flow rate less than 8 litres/minute would have ever been accepted by any 'stakeholders'. This is particularly relevant in light of the Water Regulations revision and the Part G proposals for water efficiency in the Building regulations.

In summary, the current calculator:

1. makes compliance impossible without installing fittings that will be unacceptable to most users. This will lead to disillusionment with sustainable technologies and is likely to create a market for retrofit high water use products. Luckily fittings such as tap outlets and showerheads can be easily replaced and bath overflows can be blocked.

2. is very complex and open to errors, confusion, interpretation and clever loopholes. There are an almost infinite (sic) number of solutions that can be modelled despite a finite number of functioning products.

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[1] At Passivhaus levels of thermal performance (Code 5 and 6) domestic hot water annual energy requirements exceed that for space heating (i.e. > 15kWh/(m^2.year).

[2] Code for Sustainable Homes and the BRE Water Calculator; A brief analysis of some of the problems. Nick Grant, Elemental Solutions and NBT Consult June 2007. Distributed by email but not published.

3. measures such as reduced deadlegs, leak detection, effective warning devices for float operated valves and leak free WC mechanisms gain no credit as they cannot be modelled.

4. cannot account for user behaviour, yet behaviour change is required to deliver the required savings. In attempting to design out behaviour it drives down flow rates and bath volumes to unacceptable levels. Householders wanting or needing[3] a normal size bath for occasional use will be penalised by the calculator.

5. is based on the assumption of a linear correlation between flow rate and water use. This not supported by evidence or intuition, particularly for kitchen taps. A points system based on this, inevitably drives performance beyond the limit of acceptability.

6. means that higher levels of the code (3-6) require unacceptable performance (flow and volume) and typically reuse. Reuse is very questionable in practical, economic and environmental terms and as will be shown offers very limited savings and no guarantee of compliance.

7. penalises bidets which are assumed to use more water even though they can be used to reduce showering frequency.

8. rewards those who find clever loopholes and penalises sensible design that is not anticipated by the scoring system. Considerable effort goes into finding ways to score points rather than designing better, more sustainable buildings.

9. averages out volumes and flows for all fittings in a building (eg if there are 3 baths the average volume is taken) whilst the proposal for Part G is to use the highest value. The averaging creates an anomaly in large houses where a higher score can be achieved by installing a large bath in the family bathroom and small baths (to lower the average bath volume) in the other bathrooms even though showers should use less water. Additionally there is confusion in the industry about how bath volumes are specified, see figure 1.

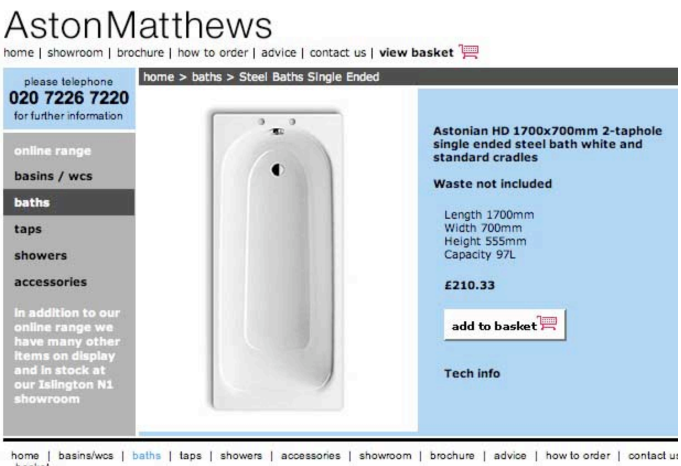

Figure 1. 97 German litres or 167 UK litres. Continental bath volumes are quoted allowing for bather displacement. This confusion is being exploited, probably in innocence.

[3] e.g. bigger people, length and or breadth.

Behaviour

The current goal of the Code is 80 litres/(capita.day) based on the calculator. Even this target can be met in practice with efficient fittings and some care from users such as showering in preference to baths and turning off the tap when brushing teeth. Indeed with best practice fittings and a little care it is not difficult to get below 60 litres/(person.day)[4]. However as the Code assumes a fixed behaviour it can only demonstrate water saving by enforcing sub-optimal flow rates and volumes.

A few technologies have been able to demonstrate win-win improvements in efficiency and performance, for example the best examples of showerheads, white goods and WCs can all be shown to work better than some more water extravagant models. Such technologies promise to save water without behavioural change but they can't stop us spending 20 minutes in the shower, washing a single item of clothing or rinsing plates under a running tap. All technologies have a limit and to push too far will inevitably lead to poor performance.

It has been argued that the CSH cannot regulate behavioural change. However the water consumption targets of the Code cannot be guaranteed by technology alone and it is likely that Code compliance will actually promote behaviour that leads to higher levels of water consumption. For example one of the recognised ways to achieve code compliance[5] is very low flow tap outlets of 1.7 l/min. Such a spray is completely inadequate for anything other than a hand basin and so is likely to be removed. At best it will be replaced with something sensible but at worst it will simply be removed resulting in unregulated flow, and if we are, for a moment, to believe the CSH water calculator, extremely high water consumption.

The same argument applies to showers and again it is unlikely that disgruntled users will be looking for a water saver shower as a replacement. WCs are more difficult to modify for higher flush. The easiest way is to raise the water level but this increases the risk of wastage down the internal overflow. If performance is marginal then double flushing is a risk. Baths are also harder to modify but as most manufacturers are choosing to achieve low volumes by lowering the overflow there is always going to be the temptation to raise this or blank it off.

The other issue is where conscientious householders make an informed decision but are penalised by the fixed assumptions in the Code. For example there is no way to account for people whom mainly shower but enjoy an occasional soak in a standard depth bath. Similarly the installation of a bidet is assumed to use additional water despite the lack of evidence for this and anecdotal evidence to the contrary. Where a sensible flow is provided at the kitchen tap to allow the filling of pans and washing up bowls, this will be penalised severely by the calculator although extra water use might not occur. Water use behaviour is not a simple case of flow rate multiplied by duration. It is function specific, so lowering the flow rate will not necessarily lead to a lower water use.

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[4] The author's home (2 person) achieves 51 l/p.d, the Tree House Clapham (2 person) achieves 50 l/p.day and the author's business partner (4 person including 2 young girls) achieves 45 l/p,d. All homes use best practice measures and all achieve zero points by the CSH water calculator.

[5] Personal communication with BRE Water Centre and observation of the buildings at the BRE Innovation Park.

Figure 2. The Code can be expected to drive innovation. Amazon.com give this a 5 star rating.

How low should we go?

Some measures only work at the individual household scale (energy efficiency, water fittings, drought tolerant planting) whilst others work far better at the national or regional level (energy generation, water supply, leak fixing, incentive based tariffs).

Practitioners have long since recognised that achieving a zero fossil energy dwelling that meets modern comfort expectations is a very difficult and expensive challenge. A similar pattern can be observed for water. Although the potential savings are less compared with energy, the requirement for such drastic savings is also less since water is, up to a point, a naturally renewable resource.

Thus a crucial strategic decision is how low do we go at the building level? Practical and economic factors suggest opting for the most cost effective measures first and applying them widely to achieve the required global savings. It is important to stop short of measures that have a high environmental or opportunity cost. This has been the standard methodology as promoted by the Environment Agency, Ofwat, and Water Companies but the Code does not seem to follow this approach.

Furthermore, the question needs to be asked as to whether a UK wide standard makes sense for water or should regional water stress lead to different requirements? Does Cumbria face the same challenges as the Thames Gateway?

Rain and greywater

It is generally recognised that the higher levels of the Code effectively force builders to add greywater or rainwater systems with associated diseconomies of scale in terms of economics,[6] life cycle impact[7,8] and effectiveness. Given the evidence, it seems very questionable to require water harvesting or reuse and yet some consultants suggest installing rainwater systems even at level 3 of the Code to allow a larger bath to be installed.

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[6] E.g. see Assessing the Cost of Compliance with the Code for Sustainable Homes, WRc for the EA, September 2006.

[7] Thorndon, J. 2008. Rainwater Harvesting Systems; are they a green solution to water shortages? Green Building Magazine, Vol 17, No. 4.

[8] Crettaz, P. Jolliet, O. Cuanillon, J-M. and Orlando, S, 1999. Life cycle assessment of drinking water and rain water for toilet flushing. *Aqua* 48(3),pp.73-83.

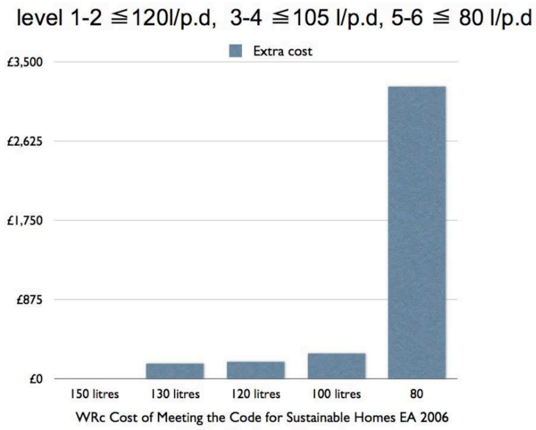

Figure 3. The jump in cost is due to rainwater reuse. This graph could also represent user dissatisfaction.

Additionally[9] rainwater reuse:
1. does not reduce sewage volume (the reason given in the Code for not allowing groundwater to count as non potable water)
2. has a high opportunity cost (the money could be better spent on other measures)
3. is not applicable to typical dwellings with small roofs
4. is least effective in areas of low rainfall in dry years when savings are most needed
5. requires ongoing repair and maintenance
6. can waste a considerable amount of mains water if a valve or float switch jams
7. uses more electricity than to treat and deliver mains water
8. allows larger dwellings to fit larger baths or less efficient WCs leading to more water use in droughts.

Similar issues apply to greywater but analysis has focussed on rain as this is usually seen as the most promising technology.

Since we have no way of guaranteeing a particular level of consumption based on a simplistic micro-component model and a large range of user behaviour, it is questionable whether we should even be setting a standard in terms of daily water use per person[10]. A better approach which fits with the historic role of the Water Fittings Regulations, would perhaps be to set appropriate performance and efficiency standards for fittings and specifying proven techniques to guard against accidental wastage or 'undue consumption'. A tool such as the Water Calculator can still be used to illustrate the effect of changes including showering rather than bathing.

Code for Sustainable Homes water calculation method

The CSH water calculator is based on a simple micro-component model that sums the product of capacity or flow, a use factor (e.g. minutes of use for a shower) and frequency of use per person per day.

[9] Grant, N. 2002. Water Conservation products. 2006. Water Demand Management, Butler, D. Ali Memon, F. Eds. IWA Publishing.
[10] This need not stop us setting consumption targets required for water resource planning and then looking at ways of encouraging people to help meet the targets.

As it is a regulatory tool, frequency of use for all activities is fixed and is based on interpretation of the 180 page report 'Increasing the Value of Domestic Water use Data for Demand Management[11]'. Whilst such models provide interesting what-if scenarios, there is little evidence of their value in predicting water saving let alone with the accuracy implied by the Code water calculation tool.

A more accurate model would need to account for the correlation between fitting specifications such as bath capacity and shower maximum flow rate and measured water use. The data is simply not available for such predictions to be made. For example a very large bath may only be partially filled or rarely used because it feels extravagant or takes a long time to fill by combi boiler. Similarly shower flow rate might be set by user preference or the water-tightness of the shower cubicle rather than the maximum flow rate.

Similarly it seems very unlikely that kitchen tap water use is proportional to flow rate given the need to fill vessels and washing up bowls. Also a flow rate that is too low to fill the bowl quickly might lead to washing up being performed under a running tap. The tap prediction is particularly inaccurate as should be obvious from the worked examples in appendix A.

Interestingly EcoHomes simply assumed a 50% saving if some sort of water efficient tap was installed. Whilst even this may be too optimistic in terms of savings, it is likely to be a more accurate prediction and neatly avoids rewarding spray taps in the kitchen sink.

Possible solutions

Given the resources that have gone into developing the Current CSH water calculator it seems unreasonable to present a fully worked out alternative here but the following is offered as a starting point for discussion.

Any system should:

- Be evidence based
- Encourage value-for money solutions in terms of water and energy saved
- Avoid unintended paradoxical consequences
- Reward good creative design rather than a tick box mentality
- Avoid giving water saving a bad name, which the widespread installation of tiny baths or spray taps in kitchens will induce.

Option 1. Preferred but previously rejected by 'stakeholders'

The current performance based system and calculations should be abandoned as there is no evidence to support the predictions or the effectiveness of the measures that are forced by it. The current Code encourages easily replaced fittings to be specified at minimum volumes in order to maximise bath and WC volumes. Also, known efficiency measures such as reduced dead legs, monitoring and leak detection are difficult to model and so are ignored. Instead standards would be set for fittings performance. This option would be compatible with a revised Water Fittings

[11] Increasing the Value of Domestic Water use Data for Demand Management; P6832. WRc 2005.

Regulation and any point of sale regulation or labelling. These standards can be tightened in line with improved performance as technology advances.

Points could be awarded for measures beyond the base case but with no incentives for solutions that save water at the expense of energy or other life cycle impacts. BREEAM for offices (1998) awarded points for measures such as leak detection, monitoring, extra water meters etc.

Option 2. Political compromise with inherent limitations.
A political compromise would be to use an improved version of the EcoHomes calculation with its bracketed predictions and upper and lower limits to flow rates and bath volumes. The usage assumptions and or predicted water targets would also need to change to avoid the need for poor performance or high environmental and financial cost measures (grey and rain). For example the bath to shower ratio could be reduced and a caveat added to state that the model assumes (say) one bath per week and 5 showers. BREEAM and Eco-Homes used a simplified calculation matrix that assumed a 50% saving for water saving basin taps (flow regulators, aerators or auto shut off) and no saving for the kitchen tap other than if a dishwasher was installed[12]. Whilst the simpler Ecohomes calculation method shines by comparison there are still a number of issues that need to be addressed. WC use would probably be calculated in a standard micro-component way but with some grouping of equivalent flush volumes based on evidence[13]. The number of steps should be reduced from the current 5 to perhaps 3.

[12] As dishwashers can be added or removed very easily and as ownership is increasing it makes sense to assume a dishwasher whether fitted or not.

[13] The evidence exists to group similar products into quite crude groups given the large variation in actual flush volume. This would prevent the market being driven to the limit of function and would avoid inaccurate comparisons being made on the basis of stated nominal flush volumes and assumed ratios of full to part flush.

Appendix A; Worked examples to highlight some issues.

In terms of the Code requirements, a **prediction** of 120 l/p.d is the compulsory level that is proposed for the new Part G Building Regulations Approved Document with 80 l/p.d a legal requirement by 2016.

max water	credits	level
120	1	1&2
110	2	1&2
105	3	3&4
90	4	3&4
80	5	5&6

Other than the base case, the following scenarios all assume very efficient white goods[14] although these are not usually supplied by the house builder and the actual water use is not likely to be the same as the rather optimistic value quoted on the Energy Label[15]. No bidet or water softener is installed, or at least only a water softener where the '*volume of water consumed per regeneration cycle does not exceed 4% of the total capacity of the water softener. The volume of water consumed per regeneration cycle must be specific to the region of the UK in which the development is located*[16]'.

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	**12.0**	**12.0**	**14**	**225**	**6.0**	**6.0**	**49**	**13**	**1**	**1**
Use factor	0.67	0.67	5	0.4	0.33	0.67	1	1	2.64	
uses/p.d	7.9	7.9	0.6	0.4	1.58	3.216	0.34	0.3	2	n/a
= CSH factor	5.293	5.29	3	0.16	1.58	3.216	0.34	0.3	5.28	12.5
fudge factor	0.67	0.67								
=	**42.3**	**42.3**	**42.0**	**36.0**		**28.8**	**16.7**	**3.9**	**5.3**	**12.5**
Rain	**0.0**	0%	60m2	0.8m/y						
Total PCC	**229.8**									
Credits	**0**									
Code	**0**									

Figure 4. simplified water calculator used for this report with normally hidden cells visible but rainwater harvesting turned off.

Scenario 1 CSH Base Case

If we consider the base case for a new home as described in the CSH Technical Document (April 2008 version) we get the following prediction according to the BRE Water Calculator[17]:

[14] Best practice figures from EcoHomes have been used for a fair comparison.
[15] Grant, N 2003. The Economics of Water Efficient Products in the Household. Environment Agency, Worthing.
[16] CSH technical Guide April 2008.
[17] The actual BRE Water Calculator is not in the public domain. Also as it is locked with hidden formulas, it is not possible to check it or fix the errors that emerge in use. This simplified version includes the 2/3 tap flow fudge factor in the use factor both of which are hidden in the pasted table.

Scenario 1; CSH 'Building Regulations' standard fittings

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	**12.0**	**12.0**	**14**	**225**	**6.0**	**6.0**	**49**	**13**	**0**	**0**
=	**42.3**	**42.3**	**42.0**	**36.0**		**28.8**	**16.7**	**3.9**	**0.0**	**0.0**
Rain	**0.0**	0%	60m2	0.8m/y						
Total PCC	**212.0**									
Credits	**0**									
Code	**0**									

Even with efficient white goods and 6 litre WCs, we need to achieve a further 43% reduction in predicted water use to achieve the Code minimum requirements. Interestingly the prediction is 41% higher than for an average 2.7 person occupancy dwelling of around 150 l/p.d. An average dwelling would probably have a 9 or 7.5 litre per flush WC and a 60-100 litre per cycle washing machine.

For comparison we can put the equivalent[18] fittings into EcoHomes:

Ecohomes 2006

	vol	use/d	total/d
WC	6.5	6	39
Basin	1	12	12
Shower	67.5	0.7	47
Bath	90	0.3	27
Sink	12	1	12
Wash m/c	60	0.3	18
Dish wash	25	0.25	6
Total			**162**

Despite the simplifications and less efficient white goods this is closer to what we would expect for a standard household.

Scenario 2 BMA Water Efficient Labelled Products

If we then update the specification to include efficient white goods and only fittings that meet the requirements of the Bathroom Manufacturer's Association Water Efficient Products Labelling Scheme, we get the following result:

Scenario 2; BMA Water Efficient labeling Scheme Specification throughout.

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	**12.0**	**12.0**	**13**	**200**	**6.0**	**4.0**	**40**	**12**	**0**	**0**
=	**42.3**	**42.3**	**39.0**	**32.0**		**22.4**	**13.6**	**3.6**	**0.0**	**0.0**
Rain	**0.0**	0%	60m2	0.6m/y						
Total PCC	**195.3**									
Credits	**0**									
Code	**0**									

[18] Ecohomes groups fittings into categories, for example large, medium and small baths.

Again according to EcoHomes calculations we get:

Ecohomes 2006	vol	use/d	total/d
WC	4.5	6	27
Basin	1	12	12
Shower	67.5	0.7	47
Bath	70	0.3	21
Sink	12	1	12
Wash m/c	40	0.3	12
Dish wash	12	0.25	3
Total			**134**

This shows an improvement on standard specifications but the rather high shower flow rate is penalised, what we might expect.

Scenario 3 (Very) Good Practice, Code zero.

This scenario represents very good water efficient practice that should be acceptable to most people without loss of comfort. The kitchen tap is set at 8 litres per minute for acceptable performance when filling vessels and the bath is modest but suitable for normal size people. The WC exceeds the requirements of the Water technology list (6/4) but stops short of 4/2 (nominal) flush because of limited choice and concerns by some manufacturers about flush volumes less than 6 litres. The shower is a 'water saver' aerated model as used in a number of successful trials.

Scenario 3; Good practice water efficiency specification.

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	**8.0**	**6.0**	**8**	**160**	**6.0**	**3.0**	**40**	**12**	**0**	**0**
=	**28.2**	**21.2**	**24.0**	**25.6**		**19.2**	**13.6**	**3.6**	**0.0**	**0.0**
Rain	**0.0**	0%	60m2	0.6m/y						
Total PCC	**135.4**									
Credits	**0**									
Code	**0**									

Ecohomes 2006	vol	use/d	total/d
WC	4	6	24
Basin	0.5	12	6
Shower	37.5	0.7	26
Bath	70	0.3	21
Sink	12	1	12
Wash m/c	40	0.3	12
Dish wash	12	0.25	3
Total			**104**

Scenario 4 Best Practice

For this scenario we have fitted a specially shaped water saving acrylic bath, an aerated water saver shower with an additional flow regulator to reduce the flow to 6l/min, a 4/2.6 litre WC, sprays in the basins and a low flow aerator in the kitchen sink.

This specification should be acceptable to keen greens and is achievable using available products without too high a cost penalty although the choice of styles is currently limited and the bath must be acrylic rather than steel. The basin spray tap is ideal for brushing teeth and washing hands but will require some patience if a basin is to be filled with hot water.

Scenario 4; Best practice water efficiency specification.

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	6.0	1.7	6	149	4.0	2.6	40	12	0	0
=	21.2	6.0	18.0	23.8		14.7	13.6	3.6	0.0	0.0
Rain	0.0	0%	60m2	0.6m/y						
Total PCC	100.9									
Credits	3									
Code	4									

This gets us comfortably into code 3 and 4 and earns 3 credits out of a maximum of 5 but this is a specification for enthusiasts.

Ecohomes 2006

	vol	use/d	total/d
WC	3	6	18
Basin	0.5	12	6
Shower	26.5	0.7	19
Bath	60	0.3	18
Sink	12	1	12
Wash m/c	40	0.3	12
Dish wash	12	0.25	3
Total			**88**

Achieving Code 5 and 6

As scenario 4 probably already pushes the boundaries of what is acceptable we are forced to try grey or rainwater reuse if we are to meet our legal obligation for 2016.

Scenario 5 Rainwater

Scenario 5 adds rainwater to scenario 4 and assumes a reasonable $60m^2$ roof, 600mm/year rainfall to reflect a semi-detached house in the South East. The number of bedrooms has been set at a rather modest 2, which leads to 3 person occupancy according to the calculator. A higher occupancy would leave less rain available per person.

Despite the low flows and volumes we still don't meet Code 5 and 6. Also notice that rain only provides15% of water use in an average year rather than the often-quoted 50%. In a dry year it will provide less and during a drought it may provide nothing. In fact as it makes poor economic sense to install the most efficient WC with a rainwater system[19], it is likely that water consumption in a drought will be higher than for the equivalent dwelling where the budget was spent on a more efficient WC.

Scenario 5; scenario 4 plus rain.

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	6.0	1.7	6	149	4.0	2.6	40	12	0	0
=	21.2	6.0	18.0	23.8		14.7	13.6	3.6	0.0	0.0
Rain	14.8	15%	60m2	0.6m/y						
Total PCC	86.1									
Credits	4									
Code	4									

[19] This is particularly true when the roof area is larger than in our more typical example.

Clearly a detached mansion in Cumbria would fare better but a flat in the Thames Gateway would fare much worse and these variations have been tabulated below.

	Roof area			
rain	50	60	80	100
0.5	91	89	85	82
0.6	89	86	79	76
0.8	85	81	75	73
1	80	76	73	73
1.5	73	73	73	73

Figure 5. Predicted water use per person for scenario 4 with a range of (larger) roof areas and rainfall. Only the grey region achieves Code 5/6.

Scenario 6 Greywater

Since rainwater is limited by available rainfall and roof area, greywater might be thought to have a role if issues such as cost, maintenance, water quality and reliability can be addressed.

100% efficiency has been assumed for this calculation. As the table below shows, even a greywater system and very low flow fittings are not enough to meet Code 5 without fitting even lower flow taps or a tiny bath.

Scenario 6; as scenario 4 plus grey for all WC use.

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	6.0	1.7	6	149	0.0	0.0	40	12	0	0
=	21.2	6.0	18.0	23.8		0.0	13.6	3.6	0.0	0.0
Rain	0.0	0%	60m2	0.6m/y						
Total PCC	86.2									
Credits	4									
Code	4									

It is interesting to note that a number of buildings at the BRE Innovation park include grey and rainwater and BRE Water Calculator spreadsheet (rev04) allows the same water to be saved twice if a grey and rain system is installed.

Another anomaly; tolerance and banding

The differences in litres between code levels are much less than any uncertainty or errors. By allowing actual flow rates and volumes to be entered[20] it is common for the prediction to just miss a category. For example the table below shows an attempt to achieve Code 3 for a current project. Using standard fittings means we miss our target by 0.5 litre! It is questionable whether the developer will accept the small bath, borderline shower flow and spray basin taps so there is little room for manoeuvre without cheating. What to do?

[20] Compare EcoHomes which groups fittings into broader categories.

Scenario; Droitwich - first attempt at Code 3

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	6.0	1.7	6	150	4.5	2.7	49	13	0	0
=	21.2	6.0	18.0	24.0		15.8	16.7	3.9	0.0	0.0
Rain	0.0	0%	60m2	0.6m/y						
Total PCC	105.5									
Credits	2									
Code	2									

Figure 6. A first attempt to meet Code 3 for a current project, close but not close enough.

We could try and find a fitting that claims a very slightly lower flow rate or volume but this means looking for other manufacturers. This takes time and in the back of our mind we know that manufacture's quoted volumes are unlikely to be accurate anyway[21]. Because it is cheap and easily changed the obvious solution is to fit a 3 l/min spray in the kitchen. This is clearly unacceptable in practice but is allowed.

Item	Kitchen tap	Basin tap	Shower	Bath	WC		Wash m/c	Dish wash	Bidet	Water softner
					Full	Short			1/0	1/0
vol/flow	3.0	1.7	6	150	4.5	2.7	49	13	0	0
=	10.6	6.0	18.0	24.0		15.8	16.7	3.9	0.0	0.0
Rain	0.0	0%	60m2	0.6m/y						
Total PCC	95.0									
Credits	3									
Code	4									

This gives us 95 litres/p.d which achieves Code 3/4 and 3 credits but begs the question why not try for 90 litres and gain an extra point so that we can make less effort in other areas such as materials or energy? Given that 3 litres is already unacceptable, we might as well install a 1.7 l/min spray in the kitchen and this gets us tantalisingly close at 90.4 litres so again we are faced with the need to either make a change to a next available volume or flow rate[22].

Figure 7. Bath in the Rural Zed Code 6/7 house at Ecobuild 2008.

[21] E.g. manufacturing tolerances, installation details, rounding errors and actual flush volumes of WCs when connected to the mains.

[22] The developer later decided that the shower should be at least 8 litres/minute and the WC 6/4 so a 1.7 l/minute spray has now been specified for the kitchen sink. This will be removed once a certificate has been obtained.