Appendix C: Literature review – land-use, waste and water

The literature review undertaken for this study covered the impacts of energy, land-use, waste and water. The energy sector is covered in full in the main report, with the detail for the other impacts provided in this appendix.

1.1. Land-use literature review

1.1.1. Overview

The Entec report was the only study to consider the issues of land-use in detail, with a focus on housing development within England over the next 15 years. The Bioregional report does give some consideration to land-use, but the figures are provided in terms of the ecological footprint which are not particularly useful since they are difficult to compare with actual land-use calculations.

In terms of housing density, both Bioregional and Entec assume relatively low levels of density, with a maximum of 80 dwellings per hectare considered by Bioregional. Such conservative assumptions limit the scope of exploring what is possible. In addition, the Entec report does not actually calculate land-use figures at different housing densities, which appears to be a significant omission given that density has such a major impact on the levels of land-use.

Given the limited time and remit set for the Entec study, the analysis provides a useful basis for the land-use implications of additional house building and highlights some important areas for policy consideration, although many of these are not made explicit within the text.

Key messages and areas of consensus

- Additional housing demand will require a substantial area of land – both previously-developed land (PDL) and greenfield
- Building at higher densities will reduce the land required and associated environmental impact
- Planning is crucial in achieving an appropriate balance between PDL and greenfield land take

Level of potential savings

In relation to land-use, potential savings can be considered to relate to the amount of greenfield take avoided. There are two options to decrease greenfield take – either reduce the number of houses built in total or build more houses on PDL. Given the current under-supply of houses, the first option is not feasible. In terms of the second option, the benefits of an increase in housing density are apparent, with a net gain in the non-market benefits associated with a lower greenfield take. However, under the remaining scenarios, Entec assumes a constant proportion of greenfield take under each scenario and so does not consider the impact of building at higher density on the balance of development.

Reasons for lack of uptake

Land-use issues are essentially determined by the planning system, although this is not discussed in great detail in either of the reports.

1.1.2. Bioregional

The Bioregional report provides a brief consideration of the environmental impact of the land-use associated with building new homes, although only in terms of the ecological footprint of the home (expressed in global hectares), which includes built land for mobility, goods and services as well as housing and is therefore not easily comparable to the figures provided in other reports.

Under the baseline scenario, Bioregional assumes a density of 40 homes per hectare with an average height of 2 storeys which is calculated to be equivalent to an ecological footprint of 0.324 gha. Since Ecohomes standards provide no direct credit for building at higher densities, Scenarios 2 and 3 also assume a density of 40 dwellings per hectare, although with an average of 2.5 storeys, resulting in a 10% reduction in the ecological footprint. In the Z^2 scenario, dwelling density is doubled to 80 per hectare, with an average of 3 storeys, giving a 20% reduction in the associated footprint.

1.1.3. Entec

The Entec study provides substantial detail on the impacts of additional housing on land-use, with consideration of greenfield and PDL (previously developed land) take, as well as development of the urban fringe.

The analysis considers four different land-take scenarios with assumptions about how many dwellings are built between 2001-2016, the density of development (giving an implied land take) and the split between PDL and greenfield sites. These scenarios also form the basis for the analysis of the environmental impacts of construction and occupation, as outlined in the sections above.

As a baseline, Entec has assumed the continuation of current completion rates along with the additional dwellings associated with the Communities Plan. Scenario 1 also incorporates the Communities Plan figures but with continuation of current targets given in Regional Planning Guidance (RPG). Scenarios 2 and 3 build upon Scenario 1 but include additional dwellings of 39,000 and 139,000 per annum respectively, based upon the levels proposed in the Barker report to cover current need and radical increase (Barker 2004). Housing densities are assumed to be 40 dwellings per hectare (net density) in urban areas (50 per hectare in London) and 20 dwellings per hectare (gross density – recognising need for non-residential land-use) on greenfield sites (resulting in the different proportions for dwellings and land take in Table 1). The impact of building at higher densities was not explored for land take, the same densities being used across all scenarios. The report stresses that the land take scenarios are intended to explore the environmental impacts of the additional housing rather than providing a judgement about what level of housing growth is required.

A summary of the scenario outputs is provided in Table 1. The total number of dwellings and land take increases across the scenarios, with the split between PDL and greenfield assumed to remain constant. Scenario 1 emerges as the most favourable scenario in terms of the environmental impact from land take (with a net benefit over the baseline), due to the lower requirement for greenfield land compared to the other scenarios. However, the associated impacts from PDL land are not included in this analysis, which may alter the picture. Scenario 3 represents a doubling over the baseline, with 46% of the dwellings built in the South East, London and the East of England, representing around a 23-26% increase in stock over 15 years. Over 70,000 ha of PDL land are required, although currently only 66,000 ha of PDL has been identified and only 11% is estimated to be effectively available for development (English Partnerships 2003). Under all scenarios, at least 20% of the greenfield land take is concentrated in the South East.

Table 1 Summary of land take scenarios, Entec report

	Baseline	Scenario 1	Scenario 2	Scenario 3
Total no. of dwellings 2001-2016 (000s)	2,200	2,400	3,000	4,500
% of dwellings on PDL	57%	64%	64%	64%
% of dwellings on greenfield	43%	36%	36%	36%
Total land take (ha)	78,500	80,000	99,000	148,000
% as PDL	40%	47%	47%	47%
% as greenfield	60%	53%	53%	53%
PVB* lost from greenfield (over 30 years)	£378m	£337m	£417m	£623
PVB lost over baseline	0	+ 10%	-10%	- %64

*Present Value of Non-Market Benefits

The analysis considers the urban fringe (an area within 1-2km of the outskirts of an urban area) as a potential location for new housing development on greenfield sites, identifying this as a neglected policy area which needs a more positive approach. A calculation of the area available identifies 4 million hectares within 1km of urban areas and 7.5 million hectares within 2km. Of this, 15% is estimated to be 'unconstrained' ie available for development and not subject to policy constraint of any kind. Entec suggests that these areas could be sufficient to cover the scale of greenfield take under the various scenarios, although the report stresses that these figures are only broadly indicative.

Under the economic analysis, Entec estimates the value of the non-market benefits of urban fringe land, which include landscape or scenic quality, recreation opportunities, wildlife habitats and biodiversity, air quality and climate control. Taking the amount of land developed as a proxy measure for these benefits results in the PVB (present value of non-market benefits) estimates given in Table 1. Entec also proposes an alternative economic analysis which assumes all development occurs on lowest grade of land. This results in a much lower baseline PVB of £68m with the same percentage changes for each scenario as given in Table 1. Entec emphasises the limitations to these analyses and that the figures are only indicative of the actual level of costs.

The report also flags other issues that need to be taken into consideration in planning for new developments such as flood risk, the role of rural areas in accommodating future growth, the protection and enhancement of green spaces in urban areas and minimising adverse environmental effects from the development of agricultural land. Entec also proposes a review of the purposes and objectives of the green belt at a regional and sub-regional level with an assessment of how far the green belt assists in achieving sustainable development objectives.

In terms of policy, Entec identifies the planning system as the primary instrument to influence patterns of land use. Alongside this, the study suggests there need to be objectives to discourage the use of undeveloped land and encourage the clean-up and re-use of PDL. Economic instruments have a role to play by encouraging the purchase, use and disposal of land, possibly through greenfield or development taxes, a tax on the holding of undeveloped land or through tradable development rights.

1.2. Waste literature review

1.2.1. Overview

Four of the reports consider household waste (Bioregional, EA, Entec and SDC), with the Entec and SDC reports also covering construction and demolition waste.

In terms of household waste, there is a strong emphasis on increasing recycling and composting rates in the reports, with some consideration of reducing waste production overall. Whilst it is desirable to improve levels of recycling, in the context of the full environmental impact of housing, it would be preferable to encourage a move towards greater resource efficiency and sufficiency in general. This would involve action both on the part of the householder and further up the resource chain, for instance, in terms of the amount of packaging provided by manufacturers. However, there is little discussion of how to achieve such a shift.

There is heavy reliance on behavioural change to achieve higher recycling rates, with three out of the four reports proposing the installation of segregated bins to assist this change, backed up by sufficient provision of Local Authority schemes. All the reports appear to assume that the provision of such bins and services will automatically result in the proposed increases, although these are not necessarily guaranteed – historically in the UK recycling rates have been low and slow to rise. SDC raises the issue of the extra space required within the house to accommodate these bins. Only the Bioregional report highlights the potential increase in costs to the householder associated with higher levels of recycling and composting, painting a more realistic picture of the likely implications of these changes. Higher costs associated with CHP (energy from waste) and bio-digesters are mentioned in the EA report, but not specifically at a household level.

None of the reports consider the total amount of waste produced for all UK households, either historically or projected into the future, and the consequent implications for landfill requirements. The Entec report does estimate a total waste figure, but this only relates to the additional dwellings proposed in the South of England over the next 15 years. Apart from an estimate of the external costs, the report makes no comment as to the consequences of this increase in waste production.

In terms of construction and demolition waste, little data are provided, reflecting the lack of detailed data available in this sector despite the fact that it represents a considerable proportion of total waste generated in the UK. The Entec report assumes a certain level of waste production associated with the construction of individual units, but gives no detail as to how these figures were determined. This provides an indication of total construction waste associated with building additional dwellings, although does not incorporate potential demolition waste arising from preparation of previously developed land.

No attempt is made in any of the reports to estimate the total waste arisings in the UK as a whole as a result of future construction and demolition in the housing sector. The SDC cites the volume of waste associated with construction and demolition as a key reason to focus on refurbishment and the re-use and recycling of materials, although no detailed analysis is provided as to how re-use and recycling might work in practice and what savings these processes could deliver.

Key messages and areas of consensus

- There is scope for reducing both the overall amount of waste produced per household and levels of construction and demolition waste produced
- There is potential for significant increases in recycling, composting and waste recovery from households, ranging from 15-100%, some of which depends on the provision of systems and services and some of which requires behavioural change.
- Costs associated with a modest increase in recycling (around 25%) are likely to be low. Beyond this, costs increase significantly due the requirement of a local waste-fired CHP plant or bio-digester to achieve higher rates of waste recovery.
- Local Authorities play a key role in provision of services and awareness raising
- Current costs to households of sending waste to landfill do not incentivise recycling or include the full environmental impacts
- Construction and demolition waste in the UK represents a significant environmental impact, particularly given proposed new developments
- There is an interaction between the recycling and re-use of construction and demolition waste and the requirement for new materials – a closed loop could be created with double environmental benefits

Areas of significant differences

The key area of difference between the reports lies in the levels of recycling rates proposed rising from current levels of around 12% to aspirational levels of up to 100%. As with the estimates for water consumption, it is difficult to judge which figures (if any) are more reliable since explicit information on the measures underlying the targets is not provided. These differences serve to highlight the difficulties associated with predicting behavioural responses and the uncertainties of related savings.

Level of potential savings

Table 2 summarises the potential decrease in household waste production and increases in recycling rates proposed in each of the reports.

Table 2 Comparison of household waste assumptions across the reports

	Baseline		Scenario 1		Scenario 2		Scenario 3	
	t/h/yr	% recycled	t/h/yr	% recycled	t/h/yr	% recycled	t/h/yr	% recycled
Bioregional	1.2	12	1.2	15.5	1.0	25*	0.9	50
EA	1.2	12	-	25	-	33-100	-	-
Entec	1.25	-	1.0	-	0.88	-	-	-
SDC	-	17	-	-	-	-	-	-

* Bioregional also assume 25% composting, giving a total of 50% recycled and composted

In terms of construction and demolition waste, only the Entec report considers levels of potential savings: between 10-20% in construction waste for new build.

Reasons for lack of uptake

Implicit in the assumptions in the Bioregional and EA reports is that a lack of segregated bins and appropriate Local Authority schemes is a hindrance to increased recycling. This implies that the process has to be made easy as possible for householders if they are to take action.

The main reasons for lack of uptake include low awareness about recycling and consumption in general, competition for space for additional bins and the lack of facilities and services (which are also not standardised across Local Authorities).

For construction and demolition waste, many of the issues are similar, although applied to the construction and demolition industry in general, rather than individual householders. Unlike the domestic sector, there are no specific targets set for this sector.

1.2.2. Bioregional

The Bioregional report considers only household waste. Under the baseline scenario, average national figures for annual waste production are taken as 520 kg per person, of which 79% goes to landfill – equivalent to 957 kg per household each year. Recycling is assumed to be at 12%, with 9% of the waste incinerated. This gives rise to an annual cost of £22 per person for waste management (£51 per household).

For waste, Bioregional has attributed different behaviour to the 'environmentally aware' resident, therefore figures under Scenarios 2 and 3 are different. Scenario 2 assumes the same levels of waste production as the baseline, but with a higher recycling rate of 15.5%, due to the provision of segregated bins as part of the Ecohomes 'Very Good' standard. This results in a lower percentage of 75% to landfill (920 kg per household), with the proportion incinerated remaining constant. These changes give rise to a 14% increase in costs to £25 per person per annum (£58 per household).

Scenario 3 assumes a 15% reduction in overall consumption leading to a 15% decrease in waste production accompanied by an increase in recycling levels to 25%. These behavioural shifts are assumed to be due to an increased awareness about consumption amongst residents. This results in a drop in the proportion of waste sent to landfill to 70% (720 kg per household per annum), with only 5% incinerated. Costs under this scenario rise by 27% over the baseline to £28 per person (£65 per household).

Under the Z^2 scenario, a 25% reduction in consumption and waste (over the baseline) is assumed along with the introduction of a four quarters strategy for waste: 25% recycled, 25% composted, 25% to a local combined heat and power (CHP) plant and 25% to landfill (227 kg per household). Such a significant shift in waste management requires a comprehensive waste and recycling strategy, with segregated internal bins, external bulk bins, good integration with Local Authority schemes, on-site composting and local CHP. This represents the most expensive scenario with a per capita cost of £34 (£70 per household) – a 55% increase over the baseline.

Bioregional also calculates the CO_2 emissions figures associated with waste and consumer items, ranging from 0.4-0.3 tC per person per annum. However, it is not clear from the report how these figures are calculated and may include materials consumption as well as waste patterns.

The cost differences between the scenarios are mainly due to the fact that the full environmental impacts of sending waste to landfill are not included in current charges. The rise in costs reflects the necessary increase in infrastructure and higher levels of recycling. Bioregional stresses the need to change underlying consumption patterns rather than trying to find alternative treatment technologies.

1.2.3. EA

Like the Bioregional report, the EA analysis also considers only household waste. The study gives a baseline figure for household waste generation of 23.8 kg per week which equates to 1.2 tonnes per household per annum – similar to that assumed by Bioregional. According to Defra figures quoted by the EA, of this waste, 14% is recycled, 16% goes to Civic Amenity sites, 5% to other sources and 64% to landfill or incinerated. These proportions are somewhat different to those given by Bioregional, further confused by the fact that the EA later goes on to give the current recycling rate as 17%. This illustrates the uncertainty that surrounds data on waste production.

However, under the three scenarios, the EA actually only considers changes in the amount of waste recycled, giving levels of 12%, 25% and 33-100%, rather than any reduction in the actual amount of waste produced. These recycling rates are more ambitious than those proposed by Bioregional, with a 25% rate in the achievable scenario (equivalent to the UK Waste Strategy 2005 target) assumed to be attained through the provision of internal and external bins and the establishment of Local Authority recycling schemes for different types of waste. At the lower end, the aspirational scenario meets the UK Waste Strategy 2015 target of 33%, requiring progressive changes in behaviour but no further recycling facilities in the home. At the upper end, further behavioural change is necessary (eg waste minimisation and separation) as well as the availability of local anaerobic bio-digesters and CHP plants to achieve 100% recycling.

In terms of costs, the provision of appropriate bins under the achievable scenario is estimated to be £100 per dwelling, although there would also be additional costs to the Local Authority in establishing the necessary recycling schemes. Costs are taken to be the same for the lower end of the aspirational scenario, but rising to between £5000-£10,000 per dwelling to cover the cost of CHP and bio-digesters, indicating these are therefore only viable on a larger scale. Unlike the Bioregional report, there is no consideration of how such changes would be reflected in annual costs to the householder.

1.2.4. Entec

The Entec report covers both household waste and construction and demolition waste. In terms of domestic waste, Entec only considers the total volume of waste generated and makes no distinction as to how this waste is treated (recycled, landfilled, incinerated etc). Current levels (2001) are given as 25.6 million tonnes per year – equivalent to around 1 tonne per household (assuming 24.4 million households in 2001). However, the baseline figure in the scenario calculations is taken as 1.25 tonnes per household per annum, similar to the Bioregional and EA numbers. Building homes to an Ecohomes ‘Very Good’ standard is assumed to result in a 20% decrease in annual waste production to 1 tonne per household, with an ‘Excellent’ standard taken to correspond to a 30% cut to 0.88 tonnes per household. These reductions are more ambitious than the corresponding assumptions made by Bioregional – a 33% decrease being far greater than the 25% cut under the Z^2 scenario. However, no detail is provided by Entec as to how these reductions are expected to have occurred.

Under scenario 3, the most extreme house-building scenario (an additional 301,000 houses built per annum), annual waste production would increase by between 4.1 and 5.9 million tonnes by 2016, depending on which standard the houses were built to (Ecohomes ‘Excellent’, Ecohomes ‘Very Good’ or Building Regulations). This represents a 16-23% increase over current levels of domestic waste production.

Current levels of construction and demolition waste are given as 24.4 million tonnes per annum, although this is contradicted later in the document where a figure of 70 million tonnes is quoted (17% of total waste generated in the UK). The additional houses under scenario 3 are calculated to result in an additional 2.7 to 3.4 million tonnes per annum, depending on the standard of the build. A house built to current Building Regulations is assumed to result in 11.25 tonnes of waste per dwelling, reducing by 10% to 10.13 tonnes per unit under Ecohomes 'Very Good' and down by 20% under Ecohomes 'Excellent' to 9 tonnes per unit. Again, no detail is provided as to how these cuts are achieved – whether through better waste management, use of different or recycled materials or less wasteful construction processes.

Entec also considers the use of aggregates in the new buildings – an issue relating to waste generation in terms of the extent to which materials are re-used or recycled and the type of construction method employed (eg Modern Methods of Construction reduce the requirement for aggregates). A house built to current Building Regulations is assumed to require 60 tonnes of aggregate, reducing to 57 tonnes under a Ecohomes 'Very Good' standard and down by 10% to 54 tonnes under Ecohomes 'Excellent' standard. The proportion of recycled aggregate used is assumed to increase from 10% (Building Regulations) through to 20% (Ecohomes 'Excellent'), although in the calculations, the proportion of virgin aggregate used is held constant at 90% therefore these totals do not tally with the total aggregate figures provided. Building to a higher density is assumed to reduce aggregate consumption, but levels of waste generation remain the same.

Entec mentions two current economic incentives in this area: a product tax on aggregate extraction which encourages the use of alternatives and the landfill tax, which addresses waste generations, although this does not differentiate by type of waste.

In terms of costs, unit external costs for domestic waste are taken to be £15 per tonne (the cost of delivering 77% of waste to landfill and 9% to incineration) and £2 per tonne for construction and demolition waste.

1.2.5. SDC

The SDC report also covers both household waste and construction and demolition waste. In terms of household waste, SDC quotes the UK sustainable development indicators (Defra/ONS 2005) which state that household waste has increased by 1.4% between 1999 and 2004 to around 500 kg per person per annum, accounting for 8% of total UK waste generation. The report also quotes the Entec study, with the increases in housing provision likely to result in a 25% rise in waste production (although this is at the upper end of the scale associated with homes built to the standard of current Building Regulations). SDC suggests that around 50-60% of household waste could be recycled or composted, similar to levels found in comparable European countries. These proportions are in line with the more extreme Bioregional and EA scenarios.

The study recommends that UK targets are made more aspirational, with requirements for waste separation and storage incorporated into the Building Regulations and Code for Sustainable Buildings to promote sustainable waste management in new and refurbished buildings. Major opportunities exist for the provision of recycling and composting facilities although there is a lack of standardised guidance for Local Authorities on the optimal level of such provision. Consequently, there is wide variation in services provided between Local Authorities making it difficult to standardise the necessary house facilities. Barriers to better waste management also include: lack of information on recycling options, lack of facilities and services and also the competition for space with decreasing kitchen size in new developments. Financial incentives, at either a national or local level, could be used to encourage waste reduction and recycling, for instance, through varying charges dependent on waste production.

SDC considers construction and demolition waste to be the most significant environmental impact of the construction process, representing 24% of UK waste at 90 million tonnes per annum in 2003 – three times the amount of household waste. SDC points out that at current rates, existing landfill capacity will only last for another 6.5 years, and therefore recommends that refurbishment, rather than demolition and re-build, should be the priority as a key route to reducing construction and demolition waste.

SDC supports the waste management hierarchy of Reduction – Reuse – Recovery – Disposal. SDC considers this waste stream to be a potential resource, acting to close the loop through recycling and re-use, although the market for recycled materials is currently immature and needs support. The study also points out that recycling and re-use has a double environmental benefit through reducing the impact of waste treatment and the need to quarry for new materials. This results in reduced transportation, land use, pollution and embodied energy as well as lower visual impacts. SDC identifies the lower use of materials in refurbishment as further evidence in favour of refurbishment over redevelopment, particularly if at higher density and within existing cities to reduce the need for new infrastructure.

SDC highlights a range of barriers to achieving more sustainable waste practices, such as insufficient information, lack of awareness regarding the waste generated, poor management and separation, and absence of specific national targets for waste reduction, re-use or recycling from construction. Economies of scale also tend to be a barrier to re-use in smaller scale building works, which are considered least likely to have sustainable waste management practices. In addition, the lack of information available to purchasers/specifiers on materials is a barrier to making sustainable choices and building up the market in this area.

The report identifies a number of programmes and measures which are in place that could be extended or enhance. Financial incentives are provided through the landfill tax and legislation such as the Clean Neighbourhoods and Environment Act 2005 may require site waste management plans for construction and demolition projects over £200,000. The Aggregates Levy encourages more recycling of construction and demolition waste. Guidance is available to promote a closed loop through the ‘demolition protocol’ developed by the Institute for Civil Engineers and CIRIA’s ‘Design for Deconstruction’. Over-ordering is a particular problem which could be addressed through careful auditing and assessment. The Waste and Resources Action Programme (WRAP) is funded to support waste minimisation and recycling activities – SDC recommends that this is extended to cover small-scale construction waste, along with waste management guidance for small refurbishment projects (less than £200,000). The study also proposes that information provision is increased to professionals and small builders/householders, that further incentives are introduced and that the Building Regulations and Code for Sustainable Buildings are extended to cover both the sourcing of materials and construction waste management.

1.3. Water literature review

1.3.1. Overview

Four of the reports consider household water consumption: Bioregional, EA, Entec and SDC, the first three being focused on new build only. The reports vary in the level of potential savings they propose, although there is consensus that much can be done through the installation of existing more efficient technologies, requiring little behavioural change and that there is no premium for these water-efficient products. Such changes are potentially straightforward for both new build and the existing stock. It should be noted that this is a strongly technology-focused perspective, similar to calculations often made within the energy efficiency field.

Further savings are predicted through more of a focus on infrastructure and supply-side issues, with the installation of rainwater and greywater systems. This also requires a certain level of behavioural change to adapt to these new systems. Whilst these are suitable for new build, such systems are less feasible for existing buildings due to the cost and difficulties of retrofitting.

Similar to the energy calculations, Bioregional, EA and Entec base their savings potential on Ecohomes standards but as noted in Section **Error! Reference source not found.**, the use of these standards is not particularly helpful when assessing and comparing savings because it is unclear what underlying measures have been assumed.

There appears to be little data available on consumption and savings potential in existing households in relation to water and none of the reports look at historic and future trends for consumption in the UK stock as a whole. Therefore it is difficult to establish the overall level of savings that might be possible across the country. A more detailed bottom-up model of consumption, as developed for the energy sector, would be of benefit here.

The Entec report does provide an estimate of future consumption resulting from new additional buildings, which serves to underline the importance of addressing water efficiency as part of any new development, particularly given the wider environmental impacts associated with increased water abstractions.

Key messages and areas of consensus

- There are parallels with energy efficiency and conservation and relevant lessons to be learnt within the water sector
- There are significant inefficiencies in the water supply infrastructure and consumption
- The focus should be on demand reduction rather than increasing supply
- Water is a very regional-specific issue and the South East of England is likely to be under the most pressure from increased demand accompanied by low rainfall
- Greater water efficiency is a crucial aspect of increased levels of development
- Failure to address improved water conservation and efficiency will have complex and far-reaching effects on water flow in rivers, pollution levels and ecology
- A substantial increase in water efficiency (25-40%) is achievable through available technology with little or no associated cost and no required behavioural change
- Greater savings are possible through grey-water and rainwater systems, particularly in new-build, whereas retrofit costs for existing buildings may be prohibitive
- Water consumption is highly dependent on household size (occupancy levels)

Areas of significant differences

The main area of differences between the reports is within the estimates of potential savings, both in terms of volume and costs and the link between the two. Bioregional assumes the most dramatic reduction in consumption, but the associated costs savings are on a level with those proposed by EA and SDC for a much lower reduction in demand. However, since the figures are quoted as desirable targets, with little detail provided as to the underlying measures by which they would be achieved, it is not possible to pass judgement as to which figures could be considered more reliable.

Level of potential savings

Table 3 summarises the potential decrease in household water consumption and associated cost savings proposed in each of the reports.

Table 3 Comparison of household water consumption across the reports

	Baseline		Scenario 1		Scenario 2		Scenario 3	
	l/p/d	£/h/yr	% reduction (l/h/d)	% cost saving	% reduction (l/h/d)	% cost saving	% reduction (l/h/d)	% cost saving
Bioregional	134	263	39	23	39	23	65	35
EA	122	295	25	19	30-40	30	-	-
Entec	165	-	15	-	22	-	-	-
SDC	154	-	40[a]	36[b]	-	-	-	-

a – More recent SDC report gives a figure of 30% reduction per home as achievable
b – Based on £100 savings quoted by SDC, assuming an annual bill of £280 pa (average of Bioregional & EA figures)

Reasons for lack of uptake

The main issue appears to be the lack of a standardised labelling system for fittings and appliances in order to provide a basis for transformation of the market towards more efficient technologies, as has happened within the energy field. The lack of metering is also identified as an issue, which could assist in the provision of improved information on water consumption for households. Low awareness and interest in water conservation, particularly since rainfall is perceived to be plentiful, is also prevalent. In some cases, the purchasing decision chain may be a factor, with plumbers rather than the householders playing the key role – this suggests a wider set of actors, rather than householders alone should be considered.

1.3.2. Bioregional

Water demand is considered under the same four scenarios as those outlined for energy. The report focuses on reducing water demand in new build housing and does not consider scenarios for the retrofitting of existing housing stock. The baseline is taken to be 134 litres per person per day (based on Ofwat figures), equivalent to 312 litres per household per day (on their assumed 2.33 people per household), with an annual cost of £113 per person (£263 per household).

As with energy demand, water demand under scenarios 2 and 3 (both houses built to Ecohomes 'Very Good' standard but occupied by a typical UK resident in scenario 2 and an environmentally aware resident in scenario 3) is assumed to be the same, with savings achieved though technology rather than behaviour. As pointed out in Section **Error! Reference source not found.**, this assumption is debatable since increased environmentally awareness is quite likely to be accompanied by more water-conserving behaviour. Water demand is reduced by 39% under these two scenarios to 82 litres per person per day (191 litres per household). The key measures employed are low flush toilets, shower flow restrictors, low water-use appliances and rainwater butts. The financial savings are estimated to be £26 per person per annum (£61 per household) – a 23% reduction over the baseline.

Under the Z^2 scenario, water consumption is further reduced to 47 litres per person per day (110 litres per household) – a decrease of 65% relative to the baseline. This includes low water-use fittings and appliances along with rainwater harvesting and grey-water recycling for non-potable demand. In addition, permeable paving reduces stress on drainage and river systems. These measures result in savings of £39 per person per annum (£91 per household) – a 35% reduction. The report notes that these calculations are based a development of 100 houses which is at the lower end of financial viability and therefore savings could potentially be far greater.

Bioregional also calculates the CO_2 implications for the various levels of water consumption, which appear to be related to the energy associated with pumping and treating the required level of water, although there is no detail providing the basis for this calculation. The estimated CO_2 levels are fairly low at 0.006, 0.004, 0.004 and 0.002 tC per person per annum under the four scenarios, reflecting the low energy input required.

Bioregional also makes the point that the UK as a whole is not water-stressed but some regional areas are.

1.3.3. EA

The EA report also considers water demand under the same three scenarios used for energy. The baseline is taken to be 122 litres per person per day, based on Environment Agency data, which is slightly lower than the Ofwat figure used by Bioregional. This is equivalent to 305 litres per household, which is closer to the Bioregional figure due to the fact that the EA assumes a higher average household occupancy figure of 2.5 (compared to Bioregional's 2.33). The average water bill in England and Wales 2005 is given as £295, from Ofwat data. However, there appears to be no reconciliation of this amount with the water consumption figure – this would give a price of £0.97/litre (not allowing for standing charges). The Bioregional report appears to assume a charge of £0.84/litre (although this is not stated explicitly).

Under the achievable standard, a reduction of 25% to 92 litres per person per day (230 litres per household) is proposed through changes to the hardware eg pipework, fittings and appliances. The EA states that this is roughly equivalent to Ecohomes standards (but does not say which standard), although not directly comparable since the Ecohomes standard focuses on the efficiency of appliances installed rather than usage patterns. The cost of achieving these water efficiency improvements are taken to be insignificant – other research by the EA has demonstrated that there is rarely a positive correlation between the costs of fittings and appliances and water efficiency. Therefore, the only expenditure assumed in this scenario was £20 for a rainwater butt. The savings to the householder would be in the order of £55 per year – a 19% reduction in costs – without any behavioural change necessary. This scenario results in slightly lower reductions than Bioregional scenarios 2 and 3.

Additional efficiency measures, including grey-water recycling or rainwater collection, and some level of behavioural change are required under the aspirational scenario to give a 30-40% reduction in water demand to 71-84 litres per person (178-210 litres per household). This is broadly equivalent to the Ecohomes 'Excellent' standard and has associated costs of between £1000-£2000 per household for a rainwater harvesting and conservation system. The EA notes that the payback of such systems is in the order of 10-15 years, but these costs could be reduced substantially, by up to half, if installed on a communal basis. The financial savings to the household are around £88 per year – a 30% cut. However, the EA equate this level of savings with a 50% reduction in water consumption, inconsistent with the aspirational standards set. On the basis of the cost per litre of £0.97 calculated earlier, a household consumption of 178-210 litres would result in a bill of £173-£204 – a saving of between £91 and £122. Therefore, whilst the financial savings quoted are about right (although not completely consistent with the scenario), the link with the 50% reduction in water demand is incorrect. Whilst the decrease in water consumption under Bioregional's Z^2 scenario is far more ambitious, the cost savings are of the same order of magnitude.

The EA report suggests a number of ways in which more water efficient behaviour could be encouraged, such as innovative tariff structures for metered homes, labelling of fittings and appliances and raising awareness through education and information provision. There is a brief mention of water poverty – 9% of UK households spend more than 3% of their income on water charges. It is interesting to note that this is a much lower benchmark than the 10% of income assumed in the fuel poverty definition. The report also notes that there are wider benefits to achieving greater water efficiency: reduced water abstraction could result in improved water quality and ecology and rainwater harvesting would reduce storm-water run-off and flood risk. Higher water efficiency could also allow for increased levels of development where water availability is a limiting factor – particularly pertinent to the South East of England at present.

1.3.4. Entec

As with the Bioregional and EA reports, the Entec report considers the implications for water demand under the three scenarios modelled for energy use. Entec also calculates the amount of water requiring disposal (assumed to be 10% less than water supplied, allowing for leaks and watering of gardens), but the focus here will be on water supplied.

The baseline is taken as 165 litres per person per day which equates to 180 Ml per household per annum, based on their assumed average occupancy level of 3 people per household. Entec notes that these figures are on the high side of current estimates. Under the Ecohomes 'Very Good' scenario, per capita water consumption is reduced to 140 litres per day – a 17% decrease. The 'Excellent' scenario assumes a further cut to 129 litres per day – a 22% reduction over the baseline (although there is some inconsistency between the description of the scenario at 140 litres/day with the figure used in the data-tables of 140Ml – equivalent to 129 litres/day – given in Appendix I of the report). No detail is provided as to the measures assumed to achieve these reductions and there is no calculation of the savings available to individual households.

In comparison to the Bioregional and EA calculations, the figures are vastly different in both absolute terms and in percentage reductions. The most ambitious Entec scenario is similar to the baselines assumed by both Bioregional and EA, with the percentage reduction below that achieved in the more cautious Bioregional and EA scenarios. This does cast some doubt on the numbers used by Entec, although the report states that only typical and best practice options were considered and potentially greater savings are available.

In terms of total water consumption, under the most extreme house-building scenario, with a further 301,000 houses built per annum, Entec estimates that an additional 54,000 mega litres is required. Building to 'Very Good' standards reduces water demand to 46,000 Ml, whilst building 'Excellent' homes would result in additional demand of 44,000Ml.

Mitigation options are briefly discussed in the report, similar to those identified by Bioregional and EA: low flush toilets, smaller baths, flow regulators and rainwater and grey-water systems.

The Entec report highlights the fact that the potential large increases in demand as a result of increased development will result in more unsustainable water abstractions unless demand is managed and sustainable new resources developed. There are also significant regional implications. A combination of both supply and demand side measures will be necessary, although greater potential exists for demand reduction. The potential impacts of climate change on water availability are also mentioned, although these are likely to be relatively modest over the next 20 years, with a minimum change of 1-3% and an upper range of 2.5-6% (although the houses will be there for longer than 20 years).

As with energy use, Entec provides an economic analysis of the external costs related to the increased water demand due to the environmental impacts from the reduced availability of water. These are estimated to be between £0.11 million and £0.29 million over the 30 years to 2031, depending on the number of houses constructed under the various scenarios. These estimates assume a constant level of household demand over this time (which is unlikely) with constant levels of occupancy. The costs are considerably lower than those related to energy use – Entec states this is due to the tighter regulatory environment for water, with the costs of environmental investments being included in bills. The report also says that this reflects smaller changes in the physical quantity of water used compared to the other impacts, although this is an inherent aspect of their assumptions rather than a characteristic of the sector.

1.3.5. SDC

The SDC report provides a broad overview of the current situation regarding water consumption and discusses potential policy measures for encouraging greater efficiency. SDC states that there is currently little research or political activity regarding water consumption in existing buildings, although there may be useful lessons to learn from the field of energy conservation and efficiency.

Average per capita consumption in 2003 is given as 154 litres per day – a different figure yet again compared to the other reports. The report states that there has been no apparent increase in per capita consumption, although overall growth is increasing at about 1% per annum due to the strong growth in household formation.

As highlighted in the other reports, the SDC study emphasises the current inefficiency in supply infrastructure and consumption, with regional shortages which are particularly acute in the South East of England where water consumption per capita is the highest and rainfall the lowest. With the proposed scale of development, a major programme of demand management is necessary, with significant reductions in demand possible through increased water efficiency in existing buildings and setting high standards for new buildings. Increased water abstraction can have negative impacts on water flow, quality and ecology. There are also implications for sewerage systems and pollution. SDC quotes research undertaken by the EA which suggests that existing water resource capacity will be unable to meet projected demand beyond 2025. SDC also provides figures from the RSPB which indicate that making 200,000 homes more water efficient could save 55Ml/day.

SDC identifies a number of measures to encourage greater water efficiency; reducing leakage, installation of water meters, water-efficient appliances and the use of non-potable systems for low-quality demands. The report quotes figures from the Environment Agency which suggest that water consumption could be reduced by 40% through retro-fitting more water-efficient fittings and appliances and without requiring any behavioural change – similar to the Bioregional estimates under scenarios 2 and 3. The associated financial savings are estimated to be around £100 per year, which are more in line with the more extreme scenarios proposed by Bioregional and EA and therefore are possibly an overestimate. Further reductions could be made through introducing parallel non-potable grey-water or rainwater systems in new build, with cost estimates of £1000-£2000 based on the EA figures. The cost of retrofitting such systems to existing buildings is likely to be prohibitive, but these households would still benefit from a simple rainwater system, such as a water butt.

As in the EA report, the SDC stresses the fact that there is no cost premium attached to water-efficient products and therefore no financial barrier if part of routine replacement. Barriers that do exist are identified as: low number of meters (only 22% of households in England and Wales are currently metered), absence of a standardised labelling system, lack of information at the point of sale of appliances, lack of interest and awareness, the perception that rainfall is plentiful and other mis-perceptions, the purchasing decision chain (plumbers rather than householders), no incentives for landlords and confusing water bills with insufficient information on past consumption.

A number of possible opportunities are proposed such as using the regular re-fitting of kitchens and bathrooms (every 7-15 years), innovative tariff structures which reward low-water use without disadvantaging low-income households, fiscal incentives, the role of the retailer and the point of sale (of a house) as an opportunity to install water meters. The SDC recommends that high water efficiency standards are incorporated into regulation and the Code for Sustainable Buildings alongside the provision of advice through a single body and the establishment of the equivalent of the Energy Efficiency Commitment for water companies.

The SDC also raises the issue of the embodied energy involved in treating mains water, estimated to be 0.5 kWh/m^3 – therefore reducing potable demand also saves energy and CO_2 emissions.

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