# Setting Energy and Sustainability standards for three MOD sites in Bath

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|---|---|---|---|---|
| 1 | Draft | ML & MT | BS | 13/02/12 |

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Job No: 60214450 Reference: Bath MOD Sustainability Standards Review Date Created: 13th February 2012

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# Executive Summary

AECOM have been commissioned to assist Bath and North East Somerset (BANES) to understand the potential energy and sustainability standards that could be applied to three sites on the edge of Bath that are being considered for disposal by the Ministry of Defence (MOD).

This report reviews the current and future regulations and policy that will apply to development on the site and reviews the possible additional standards that could be applied. The three sites have been reviewed to assess the opportunities and constraints that could impact upon the technical and financial viability of meeting the standards assessed. The report concludes by making recommendation on the standards that could be applied across all of the sites and the specific considerations for each site.

**Context and options**

Setting standards at this early stage of the project is made difficult by the constantly shifting regulatory framework, particularly in regards to the Building Regulations for which there are revisions planned for 2013, 2016 and 2019.

The BANES Core Strategy, which has just been through inspection, sets out policy requirements for new dwellings which include sustainable design and construction principles, CSH and BREEAM targets and the consideration of district heating and combined heat and power technology.

The requirements of the Code for Sustainable Homes and BREEAM are also not static and are revised over time to stay ahead of regulations and standard industry practice.

Possible standards and targets assessed in this study for their suitability as targets for the new development proposed on the three sites include the following:

- Code for Sustainable Homes
- BREEAM
- Sustainable Design and Construction Standards

**Analysis of standards**

A desktop study to review the sites suggests that there a no environmental issues that would present a significant constraint to the achievement of any rating under the CSH or BREEAM. Local issues of air quality and conservation areas could limit the use of some low and zero carbon (LZC) energy technologies on some of the sites but this is unlikely to make the achievement of the energy standards unachievable.

Based on assumed scenarios for development of the sites we have assessed the cost implications for meeting different targets of the CSH and BREEAM

- The cost uplift associated with meeting CSH 4 from 2013 onwards will be around 2%.
- The cost uplifts for achieving CSH Levels 5 and 6 is much higher (around 20% and 40% respectively)
- The cost uplift associated with meeting the BREEAM Very Good rating for an office or school is negligible (<1%) but an Excellent rating could be greater (different studies have found different impacts).
- The report shows the potential allowable solutions from the three sites would provide considerable funds to support other carbon mitigation measures.

**Recommendations and conclusions**

The general recommendations for all three sites arising from the results of this study are:

- Minimum requirement across all three sites for all dwellings to achieve **Code Level 4**
- Part of one or more sites to be designated for delivery of **Code Level 5 or 6**
- All large non-domestic buildings to achieve **BREEAM Very Good or Excellent**
- Other specific requirements could be incorporated into a set of **Sustainable Design and Construction Standards**

Capabilities on project:
Building Engineering

The specific recommendations for **Ensleigh** include:

- A focus on creating an element of reliance and self-reliance in this relatively isolated site including live/work capabilities, amenities and community facilities and space for local food production.
- The energy strategy is likely to demand an additional focus on passive design measures in the layout of the masterplan and design of the dwellings with microgeneration technologies

The specific recommendations for **Warminster** include:

- A focus on a sensitive approach to meeting energy and sustainable construction standards in a very visible location with conservation designations
- The importance of the location may dictate the materials and the use of visible LZC technologies but this should not significantly impact on the ability to meet the targets proposed
- The energy strategy likely to rely on passive design, good fabric and microgeneration technologies

The specific recommendations for **Foxhill** include:

- A focus on delivering a development that integrates with and enhances the existing community
- Potential to consider the implementation of district heating across the site with possible connection to existing local buildings including residential, care homes and schools
- Consideration of the potentially significant allowable solutions fund to support the district heating scheme and/or fund improvements to the existing local building stock
- Foxhill might have more scope to set higher targets for a proportion of dwellings and/or self-build units.

# Introduction, Background and Context

# 1 Introduction, Background and Context to this Study

## 1.1 Purpose of this study

The Ministry of Defence (MOD) have three sites located in the city of Bath and have indicated to Bath and North Somerset Council (BANES) that they are looking to dispose of the sites. The Council will be working with the MOD and the Homes and Communities Agency (HCA) to prepare the sites and assess the development that would be applicable and the conditions that will be attached to their sale.

Bath and North East Somerset Council have asked AECOM to undertake a study to identify and assess potential targets and standards relating to energy and sustainable design and construction that could be proposed for inclusion in the developer requirements for these sites.

This study aims to provide the Council with the following:

- Recommended standards that the Council could chose to propose for inclusion in the developer requirements for each of the sites
- An understanding of their technical and financial implications of these requirements
- An evidence base to support the argument for including the proposed targets and standards in the developer requirements

## 1.2 The Sites

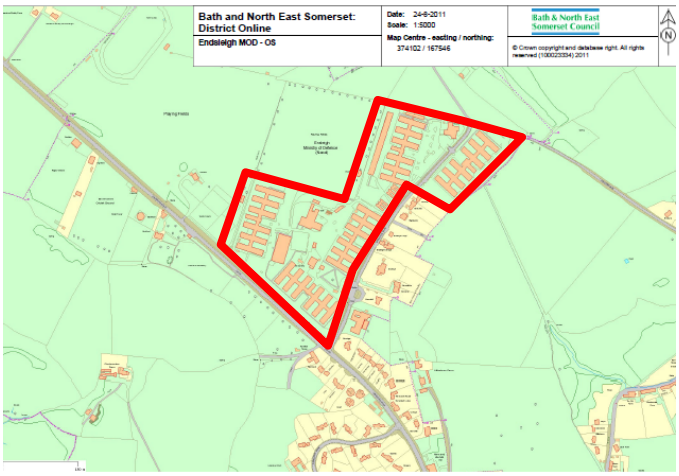
The three sites are all located on the outskirts of the city of Bath. At this early stage in the development process no masterplanning work has been undertaken so there is little information about the likely development of the sites beyond what has been set out in the Strategic Housing Land Availability Assessment (SHLAA) [1].

The following summary of each of the sites includes the information that has been made available to inform this study.

[1] *Bath and North East Somerset Council Local Development Framework: Strategic Housing Land Availability Assessment: Report of Findings*, December 2010.

### 1.2.1 Ensleigh

The Ensleigh Site is located around 3km to the north-east of the centre of Bath. The site is on the very edge of the city and surrounded on most sides by countryside.



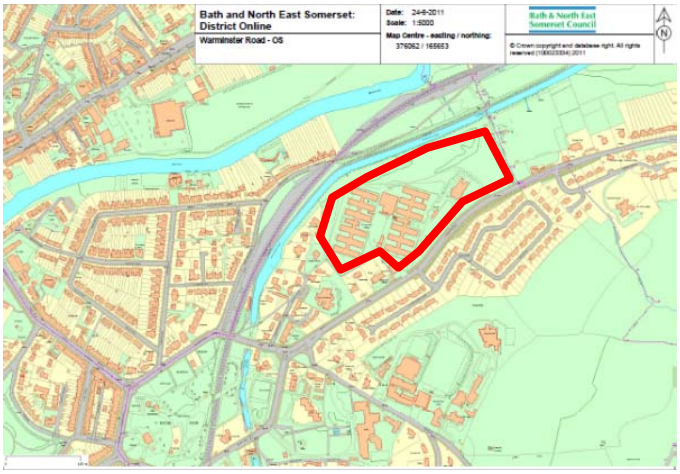

The SHLAA assessment suggests the following development potential:

- 400 dwellings at 50dph
- Primary School
- 10,000sqm B1 use
- 1,000sqm A1 use

The location and precedent set by the existing buildings and nearby existing dwellings would suggest that this site would be comprised primarily of houses.

### 1.2.2 Warminster Road

The Warminster Road Site is located around 3km to the north-east of the centre of Bath.



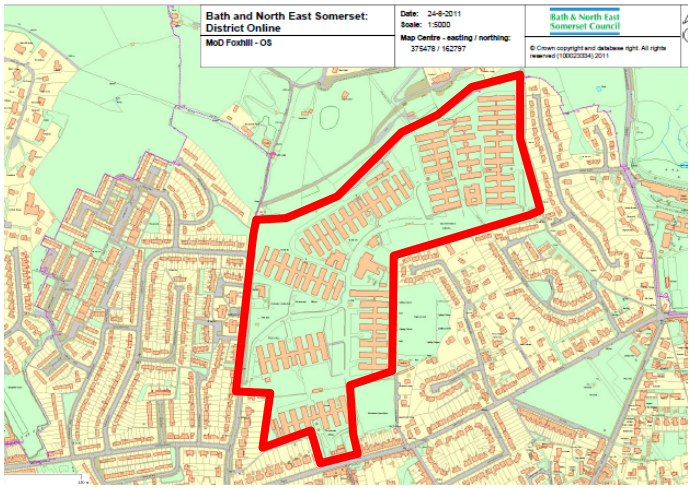

The SHLAA assessment suggests the following development potential:

- 140 dwellings at 40dph
- 2000sqm B1 use (possible)

The location and precedent set by the existing buildings and nearby existing dwellings would suggest that this site would be comprised primarily of flats and terraced houses.

### 1.2.3 Foxhill

The Foxhill Site is located around 2km to the north-east of the centre of Bath.




The SHLAA assessment suggests the following development potential:

- 750 dwellings at 50dph
- Primary school
- 10000sqm office use (B1) (possible)
- 1000sqm retail use (A1)

The Emerging Draft Concept Statements provided by BANES suggests that

The location and precedent set by the existing buildings and nearby existing dwellings would suggest that this site would probably comprise of a mix of different house types.

# Review of targets and standards

# 2 Review of targets and standards

## 2.1 Existing Site Development Standards

### 2.1.1 Homes and Communities Agency

We are aware that the Homes and Communities Agency (HCA) are involved in the disposal of the three sites. The HCA has a set of design and sustainability standards that apply to developments[2] that they are involved with and we would therefore assume that these standards would be applicable to the sites.

In regards to sustainability the standards require all dwellings should be assessed under the Code for Sustainable Homes and sets a minimum Level 3 rating. The standards also have requirements for internal environment, by setting minimum housing quality indicators scores for unit size, layout and services, and the external environment, by setting minimum standards in relation to the Building for Life 'Delivering Great Places' document.

### 2.1.2 Standards for new schools

The current requirements for new schools include a requirement to undertake a BREEAM assessment and to achieve a score of 'Very Good' or better.

However, a review of the standards in July 2011 suggested that the requirement for BREEAM should be reviewed.[3] Recently this issue has been in discussion and the outcome of this is still to be decided.

### 2.1.3 Sustainable Design and Construction Supplementary Planning Documents

There are a number of SPDs relating to sustainable design and construction in place in Local Authorities across the UK. One of the most detailed is the Mayor of London's SPD on Sustainable Design and Construction, first published in 2005 and due for revision shortly.

Many of the measures are similar or identical to those covered in the Code for Sustainable Homes and BREEAM schemes but there are a number that cover additional areas including the use of passive solar design, specific requirements for materials, local sourcing of materials and labour and the use of green roofs.

## 2.2 Building Regulations

The Building Regulations set the minimum standards for building performance and must be met for a building to be approved for construction. All dwellings delivered on the three sites will need to meet the requirements that are in place at the time of construction.

Part L of the Building Regulations focuses on the conservation of heat and power and sets specific requirements for the fabric performance, building services efficiency, overheating and the $CO_2$ emissions. The current and future requirements of Part L of the Building Regulations, for both domestic and non-domestic buildings, are discussed in the following sections.

### *2.2.1 Part L 2010*

Part L of the Building Regulations, which deals with the conservation of fuel and power, was last updated with the release of the 2010 version of the Building Regulations in October 2010.

The main alteration relating to energy consumption and $CO_2$ emissions was the increase in the standard relating to the $CO_2$ emission rate for new buildings, which was set as a 25% improvement on the 2006 standards.

An important distinction between domestic and non-domestic buildings was also introduced. It was decided that domestic properties would continue to be assessed against a 'flat rate' target, i.e. all dwelling types would be expected to meet the same standard, but non-domestic buildings would be assessed

[2] http://www.homesandcommunities.co.uk/ourwork/design-and-sustainability-standards
[3] https://www.education.gov.uk/publications/eOrderingDownload/Review%20of%20Education%20Capital.pdf

against an 'aggregate' target, i.e. different standards set for different building types, recognising that the ability of certain building types to achieve targets is limited compared to others.

Amongst a number of other changes the minimum fabric standards were also improved and the $CO_2$ emissions factors associated with the different fuel types was updated.

### *2.2.2 Part L 2013*

In 2013, another revision of Building Regulations is planned which is expected to require a further reduction in the $CO_2$ emissions from new buildings. Further detail of the expected standards is discussed separately for domestic and non-domestic buildings in the following sections.

### *2.2.3 Part L 2016*

The revisions of Building Regulations proposed to take effect in 2016 (for dwellings) and 2019 (for non-domestic buildings) are expected to require a 'zero carbon' standard to be achieved.

The definition of the 'Zero Carbon' standard has changed a number of times since it was first proposed in 2007. The most recent definition, proposed in the budget in May 2011,

The proposed approach has been developed by the Zero Carbon Hub (ZCH), which was tasked by national government with developing the definition of zero carbon for Part L 2016. The Hub recommended that zero carbon could be achieved by taking a three step process:

- Energy Efficiency, which will set minimum standard for the performance of the building fabric;
- Carbon Compliance;
- Allowable Solutions.

Unregulated emissions are no longer included in the definition of zero carbon.

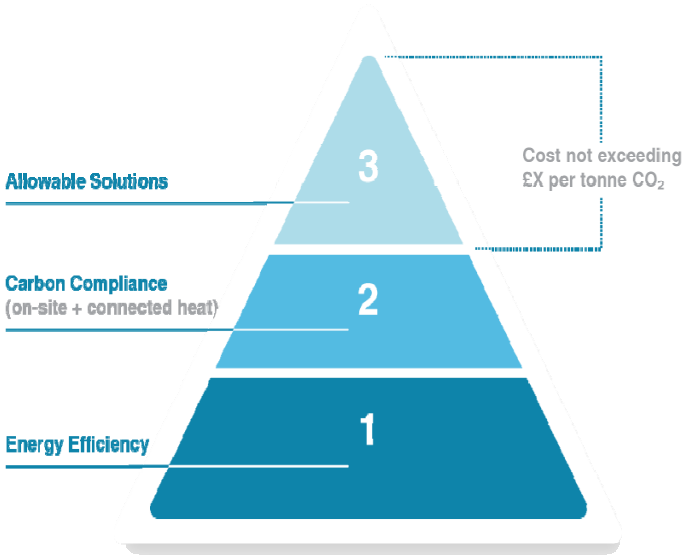



*Figure 1: Proposed Zero Carbon Methodology*

Work is still underway to define the Allowable Solutions and to create a mechanism to operate it. The most recent work has been undertaken by the Zero Carbon Hub who have suggested that the most likely mechanism for allowable solutions will be a fund administered by the Green Investment Bank which will make funds available to the Local Authority to spend on $CO_2$ mitigation measures. This reflects the understanding that there are diminishing returns for the money invested in reducing $CO_2$ emissions on site and that this can be better spent at scale on retrofitting projects for existing buildings or on large scale low and zero carbon energy projects.

### *2.2.4 Future Building Regulations – Dwellings*

| | Improvement relative to Building Regulations Part L 2010 (Regulated Emissions only) |
|---|---|
| 2013 | 25% [flat rate] |

| | |
|---|---|
| **2016** | 100% 'Zero Carbon' (minimum 25-47% Carbon Compliance Onsite + Allowable Solutions) |

*Table 1: Planned Changes to Building Regulation Part L Requirements for Dwellings.*[4]

The standard proposed for the 2013 revision of Building Regulations Part L is a 25% improvement on Part L 2010. This is equivalent to the current mandatory energy standard required for Level 4 of the Code for Sustainable Homes.

The work on the definition of Zero Carbon for Part L 2016 has been undertaken by the Zero Carbon Hub. In regards to the Fabric Energy Efficiency Standard the recommended approach is to set a standard for the energy demand for space heating and cooling, expressed in kWh/m$^2$/year. The levels currently proposed have been split by dwelling type as follows:

- Flats and mid-terraced houses: 39kWh/m$^2$/year
- Detached and Semi-detached houses: 46kWh/m$^2$/year. [5]

The Carbon Compliance targets have also been investigated and the recommended approach is to frame the standards in regards to absolute emissions rate rather than improvements relative to previous versions of the regulations. The targets currently proposed are:

- 10 kg $CO_2$(eq)/m²/year for detached houses
- 11 kg $CO_2$(eq)/m²/year for attached houses
- 14 kg $CO_2$(eq)/m²/year for low rise apartment blocks (four storeys and below). [6]

The recommendations include the need to look more closely at other dwelling types, particularly small dwellings and high rise units.

These standards relate to as built performance rather than the designed performance used in the current version of Building Regulations. As such they cannot be directly compared to current standards but for consistency the targets outlined above are broadly equivalent to the following improvements over Building Regulations Part L 2006 (in addition to any savings required by moving from designed to built performance):

- 60% for detached houses
- 56% for attached houses
- 44% for low rise apartment blocks (four storeys and below).

### *2.2.5 Future Building Regulations – Nondomestic buildings*

The revisions of Building Regulations proposed to take effect in 2019 are expected to require non domestic buildings (assessed under Part L2A) to achieve a 'zero carbon' standard. Much less work has been undertaken into the standards for Part L for future building regulations for non-domestic buildings.

AECOM were commissioned by CLG to investigate the non-domestic definition for zero carbon. The study they produced, *Zero Carbon non-domestic buildings – Phase 3 Final Report*[7] provides the most recent recommendations on the level of improvement required from energy efficiency and carbon compliance measures. The 'aggregate targets' are set out in

[4] Sources: CLG ,'Building Regulations: Energy efficiency requirements for new dwellings - A forward look at what standards may be in 2010 and 2013', 2007; and Zero Carbon Hub, 'Carbon Compliance: Setting an appropriate limit for zero carbon new homes - Findings and Recommendations', 2011.
[5] *Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes,* Zero Carbon Hub, November 2009.

[6] *Carbon Compliance: Setting an appropriate limit for zero carbon new homes - Findings and Recommendations*, Zero Carbon Hub, February 2011.
[7] *Zero Carbon non-domestic buildings – Phase 3 Final Report*, AECOM for CLG, July 2011. http://www.communities.gov.uk/documents/planningandbuilding/pdf/1940106.pdf

the following table (with the different levels recommended in the low, medium and high scenarios):

| *Improvement relative to Building Regulations Part L 2010 (Regulated Emissions only) [Aggregate]* | | | |
|---|---|---|---|
| ***SCENARIO*** | ***Low*** | ***Medium*** | ***High*** |
| **2013** | 9% | 11% | 13% |
| **2016** | 17% | 21% | 25% |
| **2019** | 100% - 'Zero Carbon' | | |
| | 25% + Allowable Solutions | 32% + Allowable Solutions | 39% + Allowable Solutions |

*Table 2: Future improvements over Building Regulations 2006 recommended by the Zero Carbon non-domestic buildings Phase 3 Final Report (converted to reduction on Part L 2010)*

It is noted that current non domestic building regulations set different targets for different building types via an aggregate methodology and that achieving a 40% improvement relative to Building Regulations may not be achievable in practise for all building types, especially if connection to a low carbon community heat source is included in the notional building. In such instances it is likely that contributions to a local borough offset fund may be required to meet carbon targets.

The targets for specific targets for the Medium scenario are set out in the table below (here compared to Part L 2006):

| Building type | 2013 | 2016 | 2019 |
|---|---|---|---|
| Deep Plan Office Air Con | 21% | 26% | 33% |
| Shallow Plan Office Air Con | 27% | 32% | 40% |
| Shallow Plan Office Heated | 30% | 43% | 62% |
| High Street Retail | 12% | 12% | 12% |
| 5 Star Hotel | 20% | 26% | 33% |
| Out-of-town Supermarket | 12% | 12% | 19% |
| Retail Warehouse | 44% | 54% | 60% |
| Distribution Warehouse | 55% | 66% | 72% |
| Acute Hospital | 31% | 40% | 55% |
| Cultural | 21% | 24% | 29% |
| Defence | 42% | 48% | 56% |
| Prison | 65% | 72% | 82% |
| Secondary School | 30% | 36% | 47% |
| Primary School | 23% | 57% | 60% |
| 3 Star Hotel | 27% | 34% | 53% |
| Country Hotel | 34% | 56% | 72% |
| Mini Supermarket | 12% | 12% | 17% |
| Aggregate reduction | 33% | 41% | 49% |

*Figure 2: Improvements beyond building regulations 2006 proposed for future revisions of the building regulations for a range of building types under the Medium Scenario of the Zero Carbon non-domestic buildings Phase 3 Final Report*

The different levels reflect the differences in the ability to achieve $CO_2$ emissions reductions in different building types.

## 2.3 Environmental Assessments

### *2.3.1 Code for Sustainable Homes*

The Code for Sustainable Homes was developed by BRE and is supported by the Department of Communities and Local Government (CLG) It sets out a national rating system to assess the sustainability of new residential development, replacing the previous system 'Ecohomes'. The Code consists of a number of mandatory elements which can be combined with a range of voluntary credits to achieve a credit level rating of between 1 and 6 covering nine sustainability criteria including $CO_2$ reduction, water, ecology, waste, materials, management and pollution. If the mandatory elements for a particular level are not reached, irrespective of the number of voluntary credits, then that code level cannot be achieved. This

means that to achieve a full code rating, a range of sustainability issues will have to be incorporated into the building and site design.

| Minimum Requirements | | | |
|---|---|---|---|
| Code Levels | Credit ENE1 % Improvement over 2010 TER | Credit ENE2: FEE (kWh/m2/yr) | Total score out of 100 |
| Level 1 (★) | 0% ( compliance with L1A2010) | Not mandatory | 36 |
| Level 2 (★★) | 0% ( compliance with L1A2010) | Not mandatory | 48 |
| Level 3 (★★★) | 0% ( compliance with L1A2010) | Not mandatory | 57 |
| Level 4 (★★★★) | 25% | Not mandatory | 68 |
| Level 5 (★★★★★) | 100% | ≤39 or ≤46 | 84 |
| Level 6 (★★★★★★) | Zero Net CO2 Emissions | ≤39 or ≤46 | 90 |

*Table 3: Mandatory requirements of each Level of the Code for Sustainable Homes (Code for Sustainable Homes Technical Guidance, Nov 2010)*

Since May 2008 it has been compulsory for new homes to have a CSH rating. There is currently no national minimum requirement for the rating that they achieve and as such a 'nil' rating is allowed for homes that have not been assessed. However, residential developments supported by Homes and Communities Agency funding are currently required to achieve Level 3 and in some cases Level 4.

The following graph shows the achievement of different CSH levels for different housing sectors since the inception of the scheme in April 2008. This clearly shows that the majority of the assessments have been in the public sector and have been for CSH Level 3.

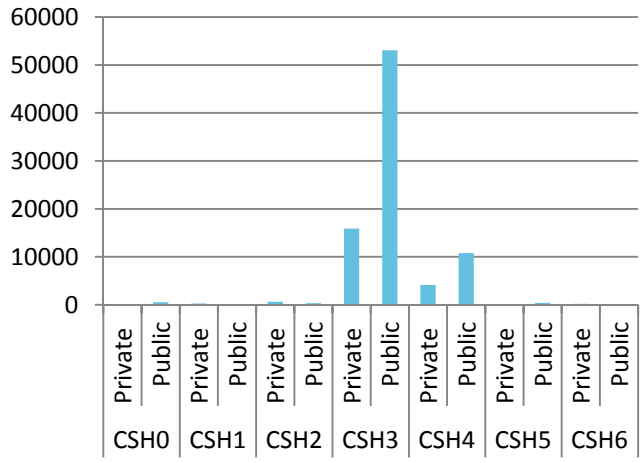



*Figure 3: Number of dwellings achieving different levels of the Code for Sustainable Homes between April 2008 and September 2011(Code for Sustainable Homes Statistics, Nov 2011)*

Since its inception in April 2008 there has been a significant increase in the number of assessments. The following graph shows the number of completed Design & Procurement stage assessments per month from April 2008 to September

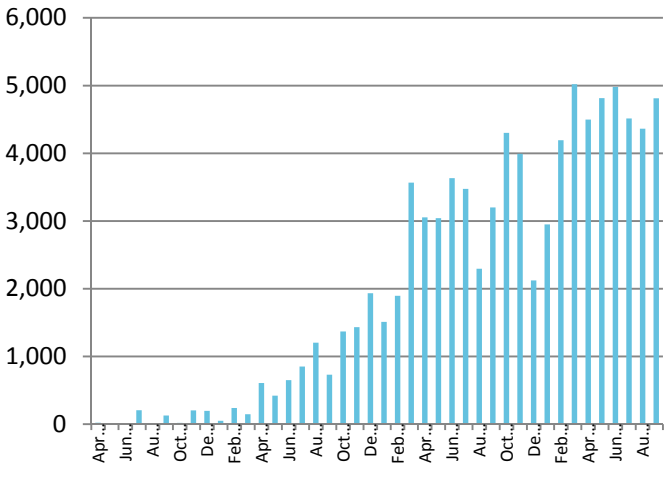



*Figure 4: Monthly number of dwellings certified under the Code for Sustainable Homes from April 2008 to September 2011(Code for Sustainable Homes Statistics, Nov 2011)*

During this time the proportion achieving Level 4 has been increasing, despite several revisions to the CSH assessment

methodology during this time. This reflects the reducing financial costs of achieving this level, as documented in the several revisions of the 'Cost of the Code' document produced by the department of Communities and Local Government.

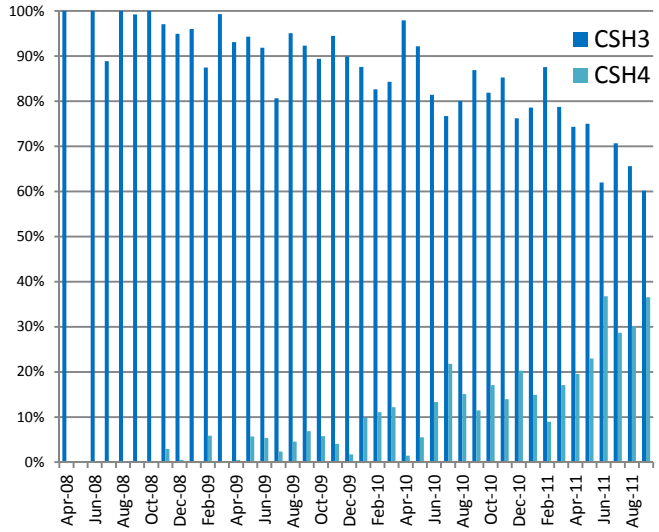



*Figure 5: Relative proportion of developments achieving CSH Levels 3 and 4 from April 2008 to September 2011(Code for Sustainable Homes Statistics, Nov 2011)*

### *2.3.2 BREEAM*

BREEAM (Building Research Establishment Environmental Assessment Method) is a voluntary assessment scheme which aims to help developers minimise the adverse effects of new non-residential buildings on the environment. Like the Code for Sustainable Homes, BREEAM allows the environmental implications of a new building to be assessed at the design stage by independent assessors to provide an easy to understand comparison with other similar buildings. It therefore provides a consistent and independent assessment tool which can be used in planning. An overall rating of the building's performance is given using the terms Pass, Good, Very Good, Excellent, or Outstanding. The rating is determined from the total number of BREEAM criteria met, multiplied by their respective environmental weighting.

BREEAM was initially launched in 1990 as an environmental assessment methodology aimed specifically at office buildings (BREEAM Offices). Since then versions of the assessment have been developed for numerous other building types including schools, industrial, retail and healthcare. At the basic level the schemes for non residential buildings are all fairly similar in their approach and contain similar credit compliance criteria. Credits are typically grouped in to the following categories:

- Management
- Health and Well Being
- Energy
- Transport
- Water
- Materials and Waste
- Land Use and Ecology
- Pollution

Buildings which do not fall neatly under one of the established BREEAM schemes are able to be assessed using a bespoke methodology. In policy terms BREEAM is useful as it provides a single assessment method which covers a number of key topics relating to sustainable construction. A properly conducted BREEAM assessment can influence design both in terms of the masterplanning process and detailed architectural and mechanical and electrical specifications.

## 2.4 Local Planning Policy

### 2.4.1 Core Strategy

The Core Strategy of the Bath and North East Somerset Local Development Framework is still in consultation. The proposed objectives and policies relevant to the consideration of sustainable design and construction standards for the three sites are set out below

Objective 1: Cross cutting objective: Pursue a low carbon and sustainable future in a changing climate

- encouraging and supporting the increased generation and use of renewable and low carbon energy, including through the delivery of community led schemes
- promoting sustainable and energy efficient design and construction
- shaping places so as to minimise vulnerability and provide resilience to impacts arising from climate change including increased flood risk
- facilitating the prudent use and reduced consumption of key natural resources such as undeveloped land, energy, water and minerals

### Policy CP2: Sustainable construction

Sustainable design and construction will be integral to new development in Bath & North East Somerset. All planning applications should include evidence that the standards below will be addressed:

- Maximising energy efficiency and integrating the use of renewable and low-carbon energy;
- Minimisation of waste and recycling during construction and in operation;
- Conserving water resources and minimising vulnerability to flooding;
- Efficiency in materials use, including the type, life cycle and source of materials to be used;
- Flexibility and adaptability, allowing future modification of use or layout, facilitating future refurbishment and retrofitting;
- Consideration of climate change adaptation.

For major development a BREEAM and/or Code for Sustainable Homes (CfSH) (or equivalent) pre-assessment will be required alongside a Planning Application. Post-construction assessments will also be required. These assessments must be undertaken by an accredited assessor.

The standards set out in the table below will be requirements for major development over the plan period:

| Type of Development | 2011-2012 | 2013 | 2016 | 2019 |
|---|---|---|---|---|
| Residential Development | Code for Sustainable Homes Code 3 (in full) | Code for Sustainable Homes Code 4 (in full) | Code for Sustainable Homes Code 6 (in full i.e. zero carbon) | n/a |
| Non-Residential | | | | BREEAM Excellent (to include zero carbon) |

Applications for all development other than major development will need to be accompanied by a B&NES Sustainable Construction Checklist.

### Policy CP3 Renewable energy

Development should contribute to achieving the following minimum level of Renewable Electricity and Heat generation by 2026.

| | Capacity (Megawatt) |
|---|---|
| Electricity | 110MWe (Megawatt Electricity) |
| Heat | 165MWth (Megawatt Thermal) |

Proposals for low carbon and renewable energy infrastructure, including large-scale freestanding installations, will be assessed under the national policies and against the following:

a. a potential social and economic benefits including local job creation opportunities
b. contribution to significant community benefits
c. the need for secure and reliable energy generation capacity
d. environmental impact (see Policy CP6)

### Policy CP4 District heating

The use of combined heat and power (CHP), and/or combined cooling, heat and power (CCHP) and district heating will be

encouraged. Within the identified “district heat priority areas”, shown on diagram 19, development will be expected to incorporate infrastructure for district heating, and will be expected to connect to existing systems where and when this is available.

Masterplanning and major development in the district should demonstrate a thermal masterplanning approach considering efficiency/opportunity issues such as mix of uses, anchor loads, density and heat load profiles to maximise opportunities for the use of district heating. The Council will expect all major developments to demonstrate that the proposed heating and cooling systems (CHP/CCHP) have been selected considering the heat hierarchy, in line with the following order of preference:

1. Connection with existing CHP/CCHP distribution networks
2. Site wide CHP/CCHP fed by renewables
3. Gas-fired CHP/CCHP or hydrogen fuel cells, both accompanied by renewables
4. Communal CHP/CCHP fuelled by renewable energy sources
5. Gas fired CHP/CCHP

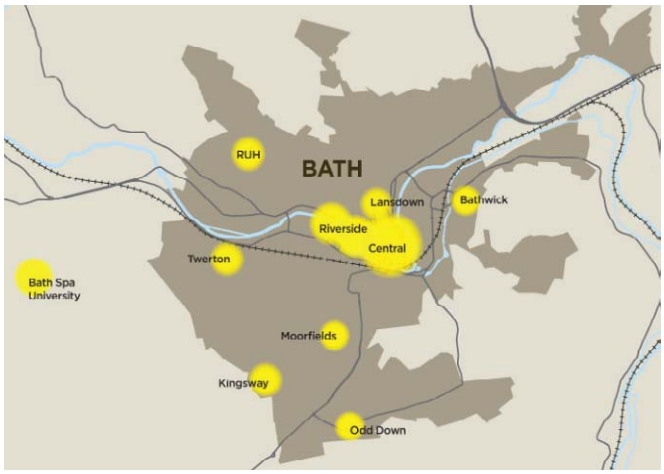



*Figure 6: Diagram from the Bath and North East Somerset Core Strategy showing the location of district heating priority areas in and around Bath*

## 2.5 Conclusions

Based on the review carried out above the Code for Sustainable Homes and BREEAM are likely to offer the most appropriate formal methodology by which targets can be attached to the sites in relation to sustainability and energy.

A set of design principles or a sustainable design and construction supplementary planning guidance would be a way of setting out other requirements and considerations that developers should take and can be tailored to each of the sites.

In addition to this a key additional consideration will be the impact of the future revisions to the Building Regulations, including the Zero Carbon policy and the potential Allowable Solutions funds that these developments may deliver.

# Analysis of standards

# 3 Analysis of possible standards

## 3.1 Assessment methodology

In **Section 3.2**, the sites have been reviewed to understand the environmental opportunities and constraints that may impact upon meeting energy and sustainability standards.

**Section 3.3** considers energy strategy constraints and opportunities for achieving the dwelling emission rate reduction requirements for different CSH levels, drawing upon local assessment of suitable technologies for Bath, and national government research on the cost of the CSH.

**Section 3.4** summarises the development scenarios which were developed for each of the sites. These were based on the outcomes of the SHLAA assessment[8] and discussions with officers from BANES Council.

The assessment seeks to assess the technical and financial viability of achieving the targets and standards on each of the three sites in **Section 3.5** (CSH), **Section 3.6** (Zero Carbon), and **Section 3.7** (BREEAM).

## 3.2 Assessment of site opportunities and constraints

Various site specific environmental factors can affect the strategies which are available to developers to achieve higher ratings in BREEAM and CSH assessments. Significant site constraints could present a technical challenge to setting higher targets on the three sites.

Some of the main opportunities and constraints to be aware of are considered below. The assessment is based on the latest versions of CSH (2010) and BREEAM (2011).

**Ecology -** The existing ecological value of the site determines the ability to achieve BREEAM credits in the Land Use and Ecology category:

- LE1 – Re-use of land
- LE3 – Ecological value of site and protection of ecological features
- LE4 – Mitigating ecological impact
- LE5 – Enhancing site ecology

Similar credits are also available in the Code for Sustainable Homes:

- Eco1 – Ecological Value of the Site
- Eco2 – Ecological Enhancement
- Eco3 – Protection of Ecological Features
- Eco4 – Change in Ecological Value of Site

Whether or not Ecology credits can be achieved has a significant influence on the overall costs of meeting the higher levels of the CSH and BREEAM, and is highly site specific. There are several heavily weighted credits available in this category, many of which may be relatively easily achieved on brown field sites of low inherent ecological value. For greenfield developments, however, these credits can be very costly or not feasible to achieve. Developers of these sites may instead have to target higher cost credits under the other heavily weighted categories such as building to Lifetime Homes and Secured by Design standards.

**Flooding -** The ability to gain credits under BREEAM Pol 3 (Surface water run-off) and Code for Sustainable Homes Sur 2 (Flood risk) can be limited if the development site is in a flood risk area.

**Transport –** Only the BREEAM assessment considers transport and local amenity provision. The location and accessibility of the site by public transport determines the ability of the development to achieve credits under BREEAM Tra1 and Tra2. Up to 3 credits are available for schools and business developments for Tra1, which assesses provision of public transport, and 1 credit is available under Tra2, which assesses proximity to local amenities.

[8] http://www.bathnes.gov.uk/environmentandplanning/planning/planningpolicy/localdevelopmentscheme/Pages/strategichousinglandavailabilityassessment.aspx

**Air Quality -** The use of biomass boilers or gas-fired CHP is likely to require air quality assessments, particularly in sensitive locations such as an Air Quality Management Area (AQMA), to demonstrate that the impact on local air quality does not result in breaches of the required concentrations.

**Access -** As well as impacting on BREEAM transport credits, accessibility may also be an issue if biomass technologies are being considered due to the need for frequent fuel deliveries.

**Materials** – Achieving high energy performance standards should be feasible regardless of the building materials used. Timber, masonry and steel frame constructions have all been shown to deliver high performance buildings and dwellings although each has its own relative advantages and disadvantages with regards to energy as well as lifecycle environmental impact.

**Ability to use development to improve existing local buildings -** Should there be opportunities to retain and retrofit existing buildings on site, this may be more sustainable than redevelopment. Where there are opportunities to retrofit other buildings in the vicinity of the site this may be an opportunity for use of Allowable Solutions contributions.

Each of the above factors has been considered for the individual MOD sites, based on information provided by BANES Council and outline conclusions have been drawn based on current information. References to the ability to achieve credits under BREEAM and CSH should not be taken as definitive, and will all be subject to more detailed assessment when the sites are brought forward. Where information from BANES has suggested that additional site-specific factors may need consideration, these have also been discussed:

### 3.2.1 Ensleigh

The Ensleigh site is located at the northern edge of the city. Its location makes it a potentially more isolated community and the provision of sustainable design measures could help to provide an in-built level of resilience to the future community. The provision of some local amenities would reduce the need to travel for basic provisions and access to communal facilities and the provision of facilities to enable home/remote working would reduce the need for commuting into the city. Local food production opportunities and other community facilities would also help to provide a focus for the future community and the ability to live sustainable lifestyles.

#### Ecology

As this site has already been developed and no significant ecological features are mentioned in the SHLAA, there should be reasonable scope to achieve ecology credits. A qualified ecologist would need to be appointed to carry out assessments to confirm this and measures would need to be implemented. It is harder to gain credits for sites which are greenfield or which have high levels of biodiversity, which may be indicated by the presence of trees or wild open space.

#### Flooding

A review of the Environment Agency flood map shows that the risk of flooding from rivers or sea is low at the site. However for credits under BREEAM Pol 3 (Surface water run-off) and Code for Sustainable Homes Sur 2 (Flood risk) a site specific Flood Risk Assessment would need to confirm that there is a low risk of flooding from all sources.

#### Transport

The SHLAA assessment of the site highlights accessibility as a potential constraint to development. There is a good road connection to the city but additional traffic could lead to congestion. Design measures or initiatives to reduce car use such as live/work dwellings, community space with a hub for remote working, bicycle storage, reduced parking, free bus passes for an introductory period after moving in could help to address this issue.

An initial brief survey of local transport nodes and bus frequencies suggests that the ability of the Ensleigh site to gain credits in a BREEAM assessment is likely to be limited unless public transport links are improved, but this would need to be assessed when development occurs. An initial internet-based survey suggests that the proximity to local amenities credit is unlikely to be achieved.

**Air Quality**

The site is not in an AQMA.

**Access**

The site is accessible from Lansdown Road or Granville Road. A Transport Assessment is required to determine the impact on local roads and junctions. It seems unlikely that access will limit the suitability of fuel deliveries if biomass technologies are considered although this would need to be confirmed.

**Ability to use development to improve existing local buildings**

BANES note that retrofit opportunities are limited for this site. Planning policies require the developer to consider the retention and retrofit of existing buildings.

### 3.2.2 Warminster Road

The Warminster Road site is located close to the centre of the city and is therefore the sensitivity of the development will be key to reflect the conservation area and World Heritage Site designations. These requirements are likely to have an impact on the nature and design of the development but should not impact on the technical ability to meet the sustainability and energy standards being considered but may affect the measures, materials and technologies that are used.

**Ecology**

The ability of development on this site to perform well under the ecology credits of BREEAM and the Code for Sustainable Homes is likely to be limited, as part of the site is undeveloped greenfield land and an area of nature conservation interest, with important trees on site.

Due to its elevated and prominent location which will restrict housing height and density, the ability to gain Code for Sustainable Homes credit Eco5 which relates to building footprint (the ratio of net internal floor area to net internal ground floor area) is also likely to be limited.

**Flooding**

A review of the Environment Agency flood map shows that the risk of flooding from rivers or sea is low at the site. However for credits under BREEAM Pol 3 (Surface water run-off) and Code for Sustainable Homes Sur 2 (Flood risk) a site specific Flood Risk Assessment would need to confirm that there is a low risk of flooding from all sources.

**Transport**

This site may include only domestic properties. However, should it include non-domestic uses, an initial brief survey of local transport nodes and bus frequencies suggests that the Warminster Road site is likely to be limited under Tra1 of BREEAM unless public transport links are improved, but this would need to be assessed when development occurs. An initial internet-based survey suggests that the proximity to local amenity credit is unlikely to be achieved, and the SHLAA also states that the site is fairly remote from local services.

**Air Quality**

Warminster Road just to the South of the site is in an AQMA.

**Access**

The SHLAA does not indicate that access would be a barrier as far as considerations such as biomass fuel deliveries are concerned. The site is just off an A-road.

**Ability to use development to improve existing local buildings**

BANES states that retrofit opportunities are limited for this site. Planning policies require the developer to consider the retention and retrofit of existing buildings.

**Materials**

The Warminster site is likely to have more constraints with regards to the material choices given the very prominent location however this is unlikely to impact upon the ability to meet high energy and sustainability standards.

**Visibility**

The site is in a conservation area and this means that the design of the development will need to be sensitive. This could impact upon the design of the buildings and may therefore limit the use of materials for construction or the use of low and zero carbon energy technologies, particularly PV and solar thermal panels. However there should be ways to address this issue if considered early in the design, guidance is available on incorporating technologies into historic buildings from English Heritage[9].

### 3.2.3 Foxhill

The Foxhill site is much larger than the other sites and has the potential to deliver a significant number of new dwellings as well as a mix of other building types. One of the key issues for this site is to ensure that the new development is properly integrated into the existing community around the site. It is hoped that the redevelopment could help to enhance the area by providing facilities that help to address some of the issues associated with this area, including deprivation, limited amenities and lack of a community focal point.

**Ecology**

As the site is previously developed land and is within an existing urban area, with little substantial vegetation, there may be potential to gain credits under BREEAM and the Code for Sustainable Homes for protecting and enhancing the ecological value of the site. A qualified ecologist would need to be appointed to carry out assessments to confirm this and measures would need to be implemented.

**Flooding**

A review of the Environment Agency flood map shows that the risk of flooding from rivers or sea is low at the site. However for credits under BREEAM Pol 3 (Surface water run-off) and Code for Sustainable Homes Sur 2 (Flood risk) a site specific Flood Risk Assessment would need to confirm that there is a low risk of flooding from all sources.

**Transport**

An initial brief survey of local transport nodes and bus frequencies suggests that the Foxhill site may have fairly good potential to gain credits under BREEAM Tra1, but this would need to be assessed when development occurs. An initial internet-based survey suggests that there may be potential to achieve the proximity to local amenities credit, given the site's proximity to existing development.

**Air Quality**

The site is not in an AQMA.

**Access**

The presence of housing and the impact on residential streets nearby would need to be considered if biomass technologies requiring frequent fuel deliveries were being proposed, although the site does have potential access points from non-residential roads.

The SHLAA states that a Transport Assessment will be required to determine the impact of the overall development on existing roads.

**Ability to use development to improve existing local buildings**

[9] http://www.climatechangeandyourhome.org.uk/live/climate_change_publications.aspx

Retrofit opportunities have been identified by BANES as being most relevant for this site. The neighbouring estate has homes in fuel poverty and consists of 1950s/60s buildings with scope for retrofit. This could be considered as a target for Allowable Solutions spending. Planning policies require the developer to consider the retention and retrofit of existing buildings.

**Other**

The SHLAA identifies the presence of mining works in the vicinity of the site. If these extend under the site they may need to be assessed if vertical bore ground source heat pumps are being considered.

The proximity to Cotswolds AONB and Bath Conservation Area to the North may also limit the suitability of certain technologies on the grounds of visual impacts.

### 3.2.4 Summary

**Implications for the Code and BREEAM:**

- Ensleigh is unlikely to score highly on transport credits under BREEAM but may have the potential to score well on ecology credits.
- Warminster Road is likely to score less well on ecology credits as part of the site is greenfield, but may score better on transport credits.
- Of the three sites, Foxhill is likely to score the highest on transport credits under BREEAM and may also have the potential to score well on ecology credits.
- Where Transport and Land Use and Ecology credits are not gained under BREEAM, work by AECOM for the Market Development Fund suggests that the most cost-effective credits to target are in the Water, Materials and the Health and Well-being sections.[10]
- All sites are outside river and sea flood zones suggesting they have the potential to score well for surface-water run-off or flood risk.

**Implications for the suitability of low and zero carbon technologies:**

- None of the sites are within an AQMA, but the Warminster site is close to a declared area, which may make biomass or gas CHP installations more sensitive at this site.
- Access is not likely to be an issue for biomass deliveries although the impact of frequent deliveries on surrounding housing at Foxhill would need to be considered if such a strategy was adopted.
- The mining works and aquifer beneath the Foxhill site and the proximity of the AONB may limit certain technologies on this site.

## 3.3 Opportunities and Constraints for Energy Strategies

### 3.3.1 Opportunities for passive solar design

Achieving the energy standards associated with future Building Regulations requirements and the additional targets considered in this study should incentivise the consideration of energy from the outset of the development process.

By addressing the orientation and layout of the masterplan, the dwelling/building types and their form and design will have a significant impact. Optimising the orientation and design of the buildings, including the proportion of glazed areas, the degree of thermal mass and the use of shading, will enable useful solar gains to reduce the energy required for space heating, cooling and lighting.

Another key design issue will be to maximise the proportion of roof space suitable for the use of solar technologies. This will

[10] Target Zero: http://www.targetzero.info/. See, for example, *Target Zero: Guidance on the Design and Construction of Sustainable, Low Carbon School Buildings*, AECOM and Cyril Sweett, 2011

favour unshaded roofs orientated south at a pitch of around 30°.

### 3.3.2 Opportunities for energy efficiency

The last two revisions of the Building Regulations have resulted in significant improvements in the energy efficiency of new homes and buildings and the proposals for the next revisions are likely to set specific mandatory standards.

Improvements to the fabric and energy efficiency normally represent the most cost effective way to reduce $CO_2$ emissions and should also be the most reliable way to achieve the modelled savings. This is a position supported by the Energy Savings Trust and promoted through their Fabric First[11] guidance.

Encouraging energy efficiency could either be achieved indirectly by setting Code for Sustainable Homes and BREEAM targets, that have credits for improvements in this area, or using additional direct targets could be included in relation to the FEE standard, although more detailed work might be required to robustly justify this. Another option would be to include a standard in a design guidance document that requires developers to maximise fabric and energy efficiency performance

The PassivHaus standard is widely recognised in Europe and has been gaining weight in the UK. Setting a target in relation to achievement of this standard is likely to be onerous however based on our understanding of the technical and financial implications of compliance.

### 3.3.3 Opportunities for District Heating

#### 3.3.3.1 Ensleigh

The scale and density of the development on the Ensleigh site is unlikely to be suitable for a district heating system. Furthermore there are no significant loads in close proximity to the site that would make a wider network possible.

#### 3.3.3.2 Warminster

The scale and density of development indicated for the Warminster site is unlikely to make a stand-alone district heating system viable.

The site was identified in the Bath and North East Somerset District Heating Study as part of the Bathwick cluster (see excerpt below), which also included two nearby schools and a hotel. However, this cluster was deemed to have a low level of viability relative to the other clusters identified. The developer should be encouraged to review this potential opportunity when preparing an energy strategy for the site and the council is likely to need to support them in this by providing data and assist in engaging the stakeholders.


*Figure 7: Excerpt of the Bathwick cluster from the Bath and North East Somerset District Heating Study (2010)*

[11] http://www.energysavingtrust.org.uk/england/Publications2/Housing-professionals/New-build/Fabric-First-October-2010-edition

#### 3.3.3.3 Foxhill

Of the three sites Foxhill is likely to present the most likely opportunity to consider district heating because the scale of the development could be sufficient in its own right to justify this approach.

Based on the SHLAA around 750 units are possible on the site at a density of 50dph. The Carbon Trust's guide to community heating[12] suggests that a density of 55dph is normally required for such a scheme to be viable. It should be noted that this document was published in 2005 however and as a result of improving energy efficiency and the resulting reduction in space and water heating demands, this density requirement is likely to be higher for the dwellings being built now or in the near future.

Increasing the density of the development would increase the viability of a district heating option. This is likely to change the mix of dwelling types to more flats and terraced houses rather than semi-detached and detached properties

In regards to possible connection to existing buildings near the site the following diagram shows the location of other allocated development sites and the heat demand density (from the South west Heat Map) for the area around the Foxhill site. This suggests that in general the demand levels are relatively low which is reflected in the general typology of the area which is mainly low density housing.

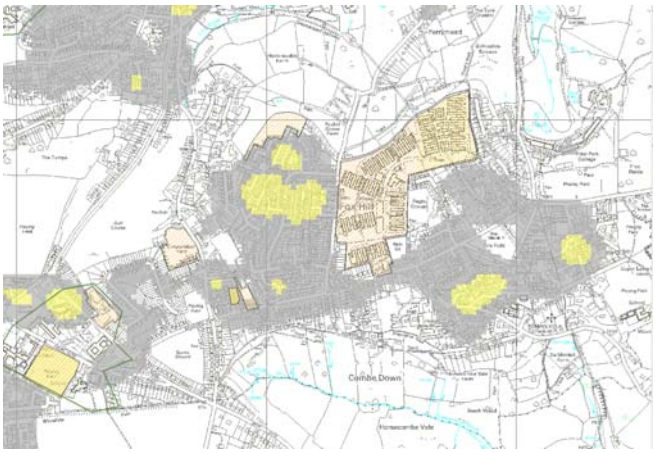


*Figure 8: Map showing the South West Heat Map heat density in the area around the Foxhill site*

However, there are a number of specific buildings that could have high enough heat demands to warrant connection to a heat network on the Foxhill site. The map on the following page shows the buildings of most significant interest.

The conditions associated with this site should include a requirement for a developer to at least consider the incorporation of a site-wide heat network and investigate the potential connection to the neighbouring buildings identified here. The viability of this option will be very dependent on the relative cost of this option compared to alternative compliant solutions to the standards that are in place at the time of delivery and therefore we cannot provide a more definitive analysis at this time.

12 http://www.localpower.org/documents/reporto_est_communityheating.pdf

Capabilities on project:
Building Engineering


The **Red** outline shows the indicative site boundary of the Foxhill site

The **Orange** outlines indicate the location of nearby development sites. These include two sites to the west of Foxhill that are included in the SHLAA and a site south of North Road that has been recently developed.

The **Green** outlines indicate the locations of schools. These include Priory Park, a large private school of around 600 pupils which includes boarding accommodation, Monkton School, another private school with boarding accommodation and a swimming pool and Combe Down Primary School.

The **Blue** outlines indicate the locations of higher density housing

The **Purple** site indicates the location of an extracare home

### 3.3.4 Opportunities for low and zero carbon energy technologies

The BANES Renewable Energy report identifies site typologies in the area and suggests suitable low and zero carbon energy technologies for each typology.

For medium-scale urban infill sites such as Ensleigh and Warminster Road, the report suggests that the following technologies are identified as likely to be appropriate:

- PV
- Small scale wind
- Heat pumps

For large-scale urban infill sites, which Foxhill is likely to represent, the report suggests that the following technologies are likely to be appropriate:

- PV
- District heating

We would also suggest that in addition to the technologies indicated above, biomass boilers (either individual or communal application) and solar hot water systems are also likely to be applicable to the sites and development options suggested for them.

The conditions for the site, possibly in the form of a design principles document as previously described, should require developers to thoroughly consider all the options for including low and zero carbon technologies on the site in order to ensure that the most appropriate technology is delivered. This should take account of the following:

- ability to meet the required standards and targets;
- total $CO_2$ reductions, capital costs;
- running costs for future home/building occupants;
- value (in regards to cost per tonne $CO_2$ saved);
- design implications;
- environmental implications; and
- management and operational implications.

### 3.3.5 Energy strategies for meeting CSH targets

The *'Cost of Building to the Code for Sustainable Homes: Updated Cost Review'* document sets out the likely solutions for meeting the mandatory energy standards for different levels of the Code for Sustainable Homes.

#### 3.3.5.1 Code Level 3

The report notes that consultation with house builders has indicated a relatively standard approach to date across the industry to achieve the Code Level 3 dwelling emission rate standard, which is equivalent to 2010 Building Regulations. Normally this has involved improvement of the building fabric in combination with a solar thermal system or small PV array. The emission rate standard can be achieved through fabric improvement alone at a similar extra-over cost to strategies involving low carbon generation.

#### 3.3.5.2 Code Level 4

To achieve the Code Level 4 dwelling emission rate standard, the report identified the common approach to be a further improvement in fabric standard, combined with a PV array.

The carbon reduction delivered by solar thermal alone is too limited to achieve compliance, and while compliance through fabric improvement alone may be technically achievable, it is challenging.

#### 3.3.5.3 Code Levels 5 and 6

The consultation carried out to inform the report found too little experience of building to Code Level 5 or 6 for any common approaches to be identified. In the absence of industry data, technical and cost modelling was performed to estimate the extra-over costs of a range of energy systems options, sized appropriately to the higher levels of the CSH.

At Code Level 5 and 6, biomass-based community energy strategies tend to be more cost-effective than technologies installed at the dwelling scale, particularly in the larger-scale, higher density development scenarios. The extra-over costs of the lowest cost energy strategies for each Code level and development type are shown in the figure below, taken from the report.

The *Cost of building to the Code* report identifies several issues with achieving the energy requirements of Code levels 5 and 6:

- The dwelling emission rate improvements required are very challenging to achieve and, even where biomass is used as the primary heating fuel, large quantities of renewable electricity generation are required.
- Where this cannot be achieved centrally, for example using a central combined heat and power plant, it leads to a requirement for large amounts of photovoltaics, which may be difficult to accommodate in the available roof area – between 3.5 to 6.5 kWp of photovoltaic is required for the Code level 6 energy strategies included in Figure 9, depending on dwelling and development type.
- There are several concerns regarding widespread use of biomass, principally the current nascent state of the supply chain, the air quality restrictions on its use in some areas (and use of biomass is expected to result in lost credits under the Pollution category), and ultimate limitations on the resource availability.
- The use of on-site wind could provide a cost-effective alternative to supply of low carbon electricity, but its applicability is also heavily limited, by site constraints and geographic variability of the wind resource.

In terms of overall approach to the Code, there are low cost credits available under the Materials, Pollution, Management and Waste categories, which home-builders are likely to address at all Code levels. Once these low cost credits have been exhausted, the more costly issues remaining under the Energy, Health and Well-being, Management and Ecology categories will need to be progressively addressed as the target standard advances beyond Code level 3.

The C*ost of building to the Code* report identifies several CSH extra-over costs that are affected by development scale. Issues that are addressed at a site level rather than at the individual dwelling level will tend to benefit from economies of scale (i.e. the per dwelling cost will tend to be lower), and these include issues under the Management category (Home User guides, Considerate Constructors, Construction Site Impacts), Construction Site Waste Management, as well as issues requiring professional fees (e.g. Code assessors, ecologists, energy consultants, daylighting assessors). In the following section, different potential development densities are considered for each of the MOD sites.

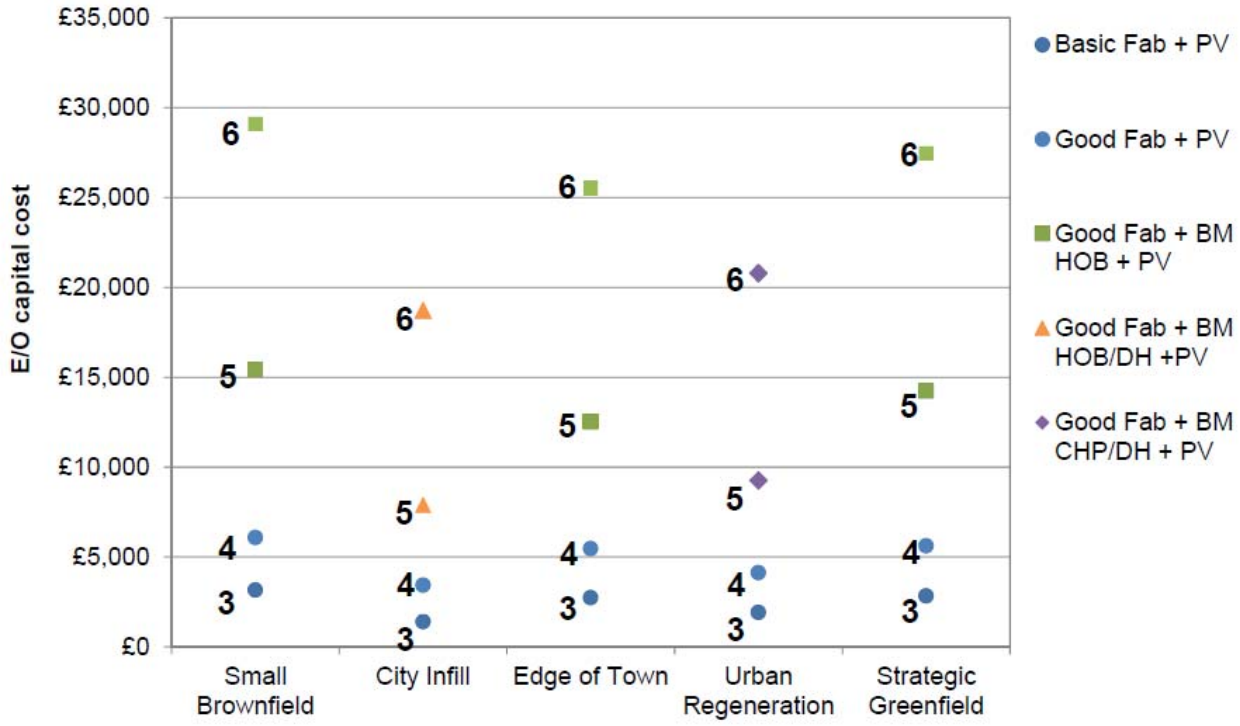



*Figure 9: Extra-over costs of the least cost energy strategy at Code levels 3 to 6 for different development types. The 'Edge of Town' scenario is considered to be most similar to the Bath MOD sites. The data point labels denote the target Code level and the legend identifies the nature of the energy strategy. The figures are based on **Part L 2006** baseline data (Fab = Fabric specification; BM = biomass; HOB = Heat-Only Boilers; DH = District Heating). Source: Cost of building to the Code for Sustainable Homes: Updated cost review, Element Energy and Davis Langdon for CLG, August 2011.*[13]

[13] http://communities.gov.uk/publications/planningandbuilding/codeupdatedcostreview

### 3.4 Site scenarios

Information provided by BANES Council has been used to set development scenarios for each of the MOD sites, against which costs of achieving higher CSH levels, zero carbon homes and higher BREEAM levels can be assessed (see the following sections: 3.5, 3.6, 3.7). For each site, two development scenarios have been considered:

- **Scenario 1**: housing density as recommended under the SHLAA
- **Scenario 2**: a higher housing density scenario.

For Warminster Road, an additional higher housing density scenario has also been considered (**Scenario 3**). For all the sites, office use has also been considered as a sub-option under each scenario. For Ensleigh and Foxhill, primary school use has also been considered.

The assumptions made for each site are set out below. Numbers in brackets indicate the reduced housing levels assumed should office development also be included on the sites. Based on guidance from BANES, primary school uses are assumed to have no impact on housing numbers.

#### 3.4.1 Ensleigh

| Ensleigh site development scenarios | | |
|---|---|---|
| | **Scenario 1** | **Scenario 2** |
| *Housing density (dph)* | 50 | 60 |
| Primary School | Y | Y |
| Office ($m^2$) | 2000 | 2000 |
| Total Residential units *[and number if office use included]* | 400 [375] | 480 [450] |
| Flats (10%) | 40 [38] | 48 [45] |
| Terraced Houses (50%) | 200 [188] | 240 [225] |
| Semi-detached houses (20%) | 80 [75] | 96 [90] |
| Detached houses (20%) | 80 [75] | 96 [90] |

#### 3.4.2 Warminster Road

| Warminster Road site development scenarios | | | |
|---|---|---|---|
| | **Scenario 1** | **Scenario 2** | **Scenario 3** |
| *Housing density (dph)* | 40 | 50 | 70 |
| Primary School | N | N | N |
| Office ($m^2$) | 1000 | 1000 | 1000 |
| Total Residential units *[and number if office use included]* | 140 [120] | 175 [150] | 245 [210] |
| Flats (25%) | 35 [30] | 44 [38] | 61 [53] |
| Terraced Houses (75%) | 105 [90] | 131 [113] | 184 [158] |

#### 3.4.3 Foxhill

| Foxhill site development scenarios | | |
|---|---|---|
| | **Scenario 1** | **Scenario 2** |
| *Housing density (dph)* | 50 | 60 |
| Primary School | Y | Y |
| Office ($m^2$) | 2000 | 2000 |
| Total Residential units *[and number if office use included]* | 750 [725] | 900 [870] |
| Flats (25%) | 188 [181] | 225 [218] |
| Terraced Houses (50%) | 375 [363] | 450 [435] |
| Semi-detached houses (12.5%) | 94 [91] | 113 [109] |
| Detached houses (12.5%) | 94 [91] | 113 [109] |

### 3.5 Cost of Achieving Code for Sustainable Homes Levels

In this section, figures for the extra-over cost of meeting different CSH levels have been estimated compared to a baseline cost of compliance with 2010 Building Regulations. The costs for each dwelling type have been taken directly from the *Cost of building to the Code for Sustainable Homes* report and applied to the housing potential figures identified in section 3.4 above.

An indicative comparison has also been made to evaluate the costs of meeting Code Levels 5 and 6 as compared to a baseline of meeting the anticipated Part L 2013 carbon reduction target of a 25% (equivalent to the ENE1 mandatory target for Code Level 4), in recognition of the fact that the timescales for development at the MOD sites mean that they are likely to be developed under 2013 or 2016 Building Regulations rather than 2010. The methodology used in the Cost of building to the Code for Sustainable Homes: Updated cost review report for updating the baseline from a Part L 2006 to a Part L 2010 Building Regulations-compliant development has been applied, i.e. the cost of the energy component for meeting Code Level 4 has been removed as this will become equivalent to meeting Part L of Building Regulations in 2013. However, this method does not take into account future changes to the Code for Sustainable Homes assessment and results are indicative only: the requirements of the Code are likely to be tightened further in future revisions, involving additional extra-over costs.

The results for each site are presented below (note that costs of non-domestic buildings are not included in any of the costs).

| | % cost uplift compared to compliance with Building Regulations 2010 | | | |
|---|---|---|---|---|
| | CSH 3 | CSH 4 | CSH 5 | CSH 6 |
| Ensleigh | 1.7% | 5.9% | 24.6% | 42.6% |
| Warminster | 1.9% | 5.7% | 24.5% | 43.4% |
| Foxhill | 1.9% | 6.0% | 24.4% | 43.6% |

These show that the relative uplift associated with CSH Level 3 is relatively insignificant, with a slightly higher uplift associated with CSH Level 4 and a much more significant uplift associated with CSH Levels 5 and 6.

We have also estimated the uplift costs compared to the proposed Building Regulations 2013 energy requirements, the results of which are summarised in the following table:

| | % cost uplift compared to compliance with Building Regulations 2013 (indicative) | | | |
|---|---|---|---|---|
| | CSH 3 | CSH 4 | CSH 5 | CSH 6 |
| Ensleigh | 0 | 2.3% | 20.4% | 37.8% |
| Warminster | 0 | 2.5% | 20.7% | 39.1% |
| Foxhill | 0 | 2.4% | 20.2% | 38.8% |

The costs associated with achieving CSH Level 4 decrease significantly and become relatively insignificant. This is because the proposed energy requirements for the Building Regulations in 2013 are the same as the CSH 4 mandatory energy standard, which is the major component of the cost uplift relative to Building Regulations 2010. The cost uplifts associated with CSH Levels 5 and 6 is still high however as a result of the significant additional costs associated with the mandatory energy standards for these Levels.

The table below uses the per unit cost uplift of achieving CSH Levels 5 and 6 compared to achieving CSH Level 4:

| Unit Type | 2b-Flat | 2b-Terrace | 3b-Semi | 4b-Detached |
|---|---|---|---|---|
| 5 | 13.8% | 18.7% | 17.4% | 17.0% |
| 6 | 40.8% | 34.5% | 33.6% | 34.2% |

*Table 4: Extra-over costs of CSH Levels 5 and 6 on a per unit basis compared to units achieving CSH Level 4*

The results of this assessment show that the cost-uplift of achieving CSH Level 5 and 6 compared to CSH Level 4 are reasonably significant. As such it is unlikely that a target for these higher levels could be applied to one or more of the sites without significantly affecting the land value. It may therefore be more appropriate to consider selection a portion of one or more of the sites to allocate to a number of units to achieve these standards if a higher target was desired.

The specific costs for the three sites and the development scenarios for each are set out in the Appendix

### 3.6 Cost Achieving of Zero Carbon Homes Assessment

The cost of achieving 'zero carbon' homes has been assessed in this section, using the Zero Carbon Hub's *Estimated Cost of Zero Carbon Homes*, December 2011 report.[14] The cost has been calculated at 2016 prices in order to estimate the likely contribution each development would make to an Allowable Solutions fund and to assess the cost of compliance with zero carbon standards compared to the cost of meeting Part L 2010. As in the previous section, costs have been applied to the housing potential figures identified in section 3.4 above. The costs are broken down into the costs of meeting:

- Fabric energy efficiency standards,
- Expected levels of carbon compliance (excluding fabric), and
- Allowable Solutions costs.

The allowable solutions costs could be used to fund CO2 mitigation projects around Bath or be specifically targeted at local interventions such as funding energy efficiency refurbishment measures in neighbouring buildings or contributing to a district heat network at Foxhill.

The analysis is based on the definition of Zero Carbon Homes following the 2011 Budget announcements which removed unregulated emissions from the definition (discussed in section 2.2 above). As noted in the Zero Carbon Hub report, cost estimates are sensitive to the price of carbon, which is priced in this assessment at £46/tonne (as used in DCLG's *Zero Carbon Homes Impact Assessment Report*, May 2011), and commercial decisions should not be made based on this carbon price. The extra-costs of meeting this standard (compared to Building Regulations 2010) for different unit types are set out in the following table

| Unit Type | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| Flat | £36 | £1,332 | £1,055 | £2,423 |
| Mid-terrace | £0 | £3,004 | £1,159 | £4,163 |
| Semi | £57 | £3,444 | £1,159 | £4,660 |
| Detached | £1,358 | £4,033 | £1,627 | £7,018 |

These costs have been used to identify the indicative costs of Zero Carbon compliance for the three sites based on the scenarios outlines earlier. The results are summarised in the following table:

14 http://www.zerocarbonhub.org/resourcefiles/Estimated_Cost_of_Zero_Carbon_Homes.pdf

| Unit Type | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of 'Zero Carbon' over Part L 2010 |
|---|---|---|---|---|
| Ensleigh – Scenario 1 | £114,640 | £1,252,240 | £496,880 | £1,863,760 |
| Ensleigh – Scenario 2 | £137,568 | £1,502,688 | £596,256 | £2,236,512 |
| Warminster – Scenario 1 | £1,260 | £362,040 | £158,620 | £521,920 |
| Warminster – Scenario 2 | £1,575 | £452,550 | £198,275 | £652,400 |
| Warminster – Scenario 3 | £2,205 | £633,570 | £277,585 | £913,360 |
| Foxhill – Scenario 1 | £139,406 | £2,077,219 | £893,625 | £3,110,250 |
| Foxhill – Scenario 2 | £167,288 | £2,492,663 | £1,072,350 | £3,732,300 |

These results are based on a significant number of assumptions and very predictive cost data so should only be viewed as a relative indication of the cost implications of meeting the Zero Carbon target and the scale of the Allowable Solutions funds that the development might release.

The full results for each site are presented in the Appendix.

### 3.7 Cost of Achieving BREEAM Ratings Assessment

Evidence on the cost of achieving higher BREEAM ratings has been reviewed for offices and schools, as these are the two main non-domestic uses being considered on the MOD sites. Each building type is considered separately below.

The following sources have informed this assessment:

**For offices:**

- *Putting a Price on Sustainability*, Cyril Sweett and BRE, 2005;[15]
- *Target Zero: Guidance on the Design and Construction of Sustainable, Low Carbon Office Buildings*, AECOM and Cyril Sweett, 2011.[16]

**For schools:**

- *Putting a Price on Sustainable Schools*, BRE and Faithful+Gould, 2008;[17]
- *Target Zero: Guidance on the Design and Construction of Sustainable, Low Carbon Office Buildings*, AECOM and Cyril Sweett, 2011.[18]

It should be noted that the quantitative information available on the cost of higher BREEAM ratings for offices is less extensive and up-to-date than equivalent information for homes and schools. Due to the lower numbers of non-domestic buildings and the lower level of standardisation within their design, it is more difficult to select representative building designs, and studies have tended to focus on single case study buildings when assessing the cost of achieving higher BREEAM levels. Therefore, whilst relevant evidence is referenced and discussed below, it is not possible to provide the same level of quantitative analysis for non-domestic buildings as for homes.

#### 3.7.1 Offices

BRE and Cyril Sweett produced a study in 2005, *Putting a Price on Sustainability*, which assessed the cost of achieving higher BREEAM ratings (Good, Very Good and Excellent) for several building types including an office. This was assessed using BREEAM Office 2004 against a base-case building which complies with 2002 Building Regulations (this is assumed as it is not explicitly stated in report). It is also assumed that 2005 costs were used. The base case had a

[15] http://www.brebookshop.com/details.jsp?id=148983
[16] http://www.targetzero.info/guidance_reports/view/office/
[17] http://www.brebookshop.com/details.jsp?id=287598
[18] http://www.targetzero.info/guidance_reports/view/school/

capital cost of £11,430,000, for a 3-storey notional office with a gross floor area of 10,098m$^2$. Since the study took place several years ago, the results should be treated with caution and viewed as an indication of relative implications rather than being directly applicable to the potential developments on the MOD sites.

The study identified low or no-cost options to gain credits including:

- specifying water-efficient appliances,
- ensuring all timber is procured from appropriate certified sources,
- committing to good construction practice,
- providing low energy lighting,
- enhancing thermal performance through increased insulation levels.

Particularly expensive credits involved providing technologies such as photovoltaic panels or rainwater harvesting. These were included in this assessment for the BREEAM Excellent rating.

Benefits identified in achieving higher ratings included, in addition to higher environmental performance:

- Reduced running costs,
- Improved living and working environments, and
- Market differentiation.

The study looked at three location types. The 'typical' location (such as a brownfield site with some access to local amenities and public transport, based on an edge of town location) is most relevant to the MOD sites in Bath. The uplifts in capital costs to achieve higher ratings identified in the report are presented below:

| Location | BREEAM rating for base case | Increase in capital cost to achieve improved rating | | |
|---|---|---|---|---|
| | | Good | Very Good | Excellent |
| Typical | Pass | 0% | 0.2% | 7% |

A more recent study produced by AECOM and Cyril Sweett in 2011, *Target Zero: Guidance on the Design and Construction of Sustainable, Low Carbon Office Buildings*, looked at the costs of achieving BREEAM Very Good, Excellent and Outstanding in the most cost-effective ways, as well as the reduction of operational and embodied carbon through good design and construction practice. The Target Zero project used recently constructed, typical buildings as benchmarks.

Uplift costs were assessed at 2010 costs against a base case building that just meets the 2006 Building Regulation requirements for operational carbon emissions. For the office study, a 10-storey Grade A city centre office building with a gross internal floor area of 33,018 m² was chosen, with a capital construction cost estimated at £61.7m (£1,869/m²). The use of a city centre high-storey office block limits the ability to directly apply the study's findings to the MOD sites, which would be of a different scale and would differ in terms of constraints on certain BREEAM credits – for example for the city centre office transport credits would be achieved which the MOD sites cannot achieve, and conversely constraints on space for technologies would be greater than in the MOD sites.

However, the report provides more recent evidence than the earlier BRE study and some of its findings could inform the development of offices on the MOD sites. The study found that:

- The 2010 Part L compliance target of reducing operational carbon emissions by 25% is achievable by using a package of cost-effective energy efficiency measures, i.e. without mandating the use of low and zero carbon technologies.

- The estimated capital cost uplifts required to achieve improved ratings are summarised below:

| Base case | Increase in capital cost to achieve improved rating | | |
|---|---|---|---|
| | Very Good | Excellent | Outstanding |
| Part L 2006 compliant | 0.17% | 0.77% | 9.83% |

- The uplift percentage is significantly lower for BREEAM Excellent than that suggested by the earlier BRE and Cyrill Sweet report. This is likely to mainly be due to improvements to Building Regulations (from 2002 to 2010) which alters the base case development, particularly reducing the uplift costs associated with the expensive energy credits, as well as being affected by learning in the interim period,

### 3.7.2 Schools

The report *Putting a Price on Sustainable Schools*, produced by BRE and Faithful+Gould in 2008, assesses the costs of achieving higher BREEAM ratings in schools compared to a Building Regulations 2006 compliant building base case. The study assesses a 210 place primary school, as is being considered for the Ensleigh and Foxhill sites. The building is single-storey with a gross floor area of 1367m$^2$ and a base case construction capital cost of £1570/m$^2$.

In the study, two location scenarios were assessed:

- A greenfield site with poor transport links (i.e. a 'poor' location in terms of environmental impact). In this scenario no location-based credits are achieved.
- A brownfield site with good transport links (i.e. a 'good' location in terms of environmental impact). In this scenario several location-based credits are achieved.

The findings of the study are summarised below:

| Base Case | Location | % uplift | | | |
|---|---|---|---|---|---|
| | | Pass | Good | Very Good | Excellent |
| Part L 2006 | Good | 0 | 0.5 | 1.4 | 4.5 |
| | Poor | 0.2 | 0.8 | 2.3 | 7.6 |

If it is assumed the MOD sites are in a 'Good' location (in reality they may fall somewhere between the two scenarios) and also have a 1367m$^2$ area, this would imply an uplift in capital cost compared to a 2006 Building Regulations compliant base case of:

| Base Case | Location | Cost uplift | | | |
|---|---|---|---|---|---|
| | | Pass | Good | Very Good | Excellent |
| Part L 2006 | Good | £273 | £11,346 | £29,937 | £96,510 |
| | Poor | £4,101 | £17,908 | £49,349 | £162,263 |

However, uplift costs will already have changed and will continue to change with the introduction of new Building Regulations and new versions of BREEAM.

The Target Zero project has also looked at the cost of achieving higher BREEAM ratings for schools in *Target Zero: Guidance on the Design and Construction of Sustainable, Low Carbon School Buildings*, AECOM and Cyril Sweett, 2011. The methodology used in this study is the same as for the Target Zero office building, using a base case building meeting Part L 2006. The building on which the school research was based is a 900 pupil BSF secondary school in Knowsley, Merseyside

with a gross internal floor area of 9,637m², so again is likely to vary from a primary school, however some of the findings could be applied to the MOD sites.

The base case building capital construction cost was £22.5m (£2,335/$m^2$). The study found that:

- Improving fabric insulation performance much more than 2006 Part L levels was less cost-effective than improvements to building services plant and their controls.
- Moderate improvements to insulation levels were found to be more cost-effective than many mainstream low and zero carbon technologies.
- However, ultra insulation was found to be less economic than most of the low and zero carbon technologies.
- The estimated capital cost uplift of the case study school building was:

| Base case | Increase in capital cost to achieve improved rating | | |
|---|---|---|---|
| | Very Good | Excellent | Outstanding |
| Part L 2006 | 0.2% | 0.7% | 5.8% |

The uplifts for achieving higher BREEAM ratings are lower than those in the earlier BRE and Faithful+Gould study. This is likely to reflect the increase in learning over the period between the reports. The full report contains more detailed useful guidance on cost-effective routes of achieving high BREEAM ratings.

The study also looked at the cost of achieving zero carbon and found that this can be achieved most cost effectively using a package of energy efficiency measures plus a 50kW wind turbine, 1,300 $m^2$ array of photovoltaics, a biomass boiler and 216$m^2$ of solar thermal panels. These measures involved an increase in capital cost of 12%. Several offsite LZC technologies were found to be capable of achieving zero carbon with a negative 25-year NPV. The most cost-effective option identified was to purchase a share in a large on shore wind farm. If offsite wind technologies are not available or allowed, i.e. not permitted as an 'allowable solution', district CHP plant was found to be the next most cost-effective option. In the absence of large-scale and offsite technologies, it is likely that solar thermal and photovoltaic technologies will be required to enable school buildings to reach on site Carbon Compliance targets. The study suggested that they may also be a cost-effective solution when compared against the cost of Allowable Solutions.

# Conclusions and Recommendations

# 4 Conclusions and Recommendations

## 4.1 General recommendation for all sites

### 4.1.1 Suggested Targets

**All homes to be assessed under the Code for Sustainable Homes and to achieve a minimum standard of Level 4**

The analysis presented in this study indicates that there are no significant locally specific technical constraints and that the financial assessments of setting Code Level 4 (or equivalent at the time of delivery) as a minimum standard across all sites should be justifiable, although the viability will be dependent on the other standards being proposed and the cumulative effect on the land value.

**All large non-domestic buildings to achieve a minimum of BREEAM 'Very Good' with potential to target 'Excellent'**

The council may wish to consider only applying this to the larger non-domestic buildings (i.e. over 1000sqm) which is likely to cover the primary schools and possibly large office buildings if proposed.

In regards to setting BREEAM targets, a requirement to deliver at least a 'Very Good' rating should be technically and financially feasible (although more practical for buildings over 1000sqm). The most recent data suggests that an 'Excellent' rating may also be possible without significant cost implications.

**Possible allocation of a portion of the site for homes to achieve a higher standard such as CSH Level 5 or 6**

Setting Code Level 5 and 6 targets have been shown to incur significant cost uplifts to deliver (around 20% and 40% respectively) and are therefore likely to be difficult to justify as site-wide targets. However allocating a proportion of one or more sites for the delivery of a number of homes to these higher standards could be a way of delivering these higher levels without significantly affecting land values. This would then enable examples of local homes meeting these standards to be realised that could assist not just in supporting higher standards in new developments but also promoting other initiatives such as the refurbishment and installation of renewables in existing buildings.

### 4.1.2 Design and Construction Principles

Additional requirements could be set out in a **'Development Principles Document'** which could include the following requirements:

- Require developers to demonstrate passive solar design principles in the masterplan and dwelling/building designs to reduce energy use and maximise potential for solar technologies
- Require developers to demonstrate how fabric performance and energy efficiency measures have been addressed through the building design. Potentially a target could be introduced here related to the Building Regulations FEE standard (see section 2)
- Require developers on the Warminster and Foxhill sites to demonstrate how the potential to incorporate a district heating system (site-wide and with connections to other local buildings) has been investigated and wither the plans for delivery or reasons for dismissing this option.
- Require developers to demonstrate how the various low and zero carbon energy technology options have been reviewed against the criteria set out in section 3.3.4 and a justification of the strategy proposed.
- Potential inclusion of other requirements, standards or targets around sustainable design and construction.

## 4.2 Specific site recommendations

### 4.2.1 Ensleigh

The Ensleigh site is likely to rely upon fabric, energy efficiency and low and zero carbon technologies to meet the

energy requirements of the standards set out above. This will place more emphasis on incorporating passive solar design measures into the masterplan and dwellings and as such will need to be considered early on in the design. In regards to wider sustainable design the development would benefit from a focus on measures that will improve the self-reliance of the future community including the inclusion of amenities and community space, live/work capability, local food growth and facilities to reduce waste and enable composting.

#### 4.2.2 Warminster

The Warminster site is close to one of the district heating clusters highlighted in the bath district heating study. The developer should be encouraged to investigate this option but the Council should be aware that delivery of such a system would be difficult. The alternative will be to deliver a low energy development through fabric and microgeneration technologies. This and other measures to deliver sustainable design and construction will need to respect the requirements of the conservation area and World Heritage Site designations.

#### 4.2.3 Foxhill

The Foxhill site is of a scale that could have the potential to include a site-wide district heating network but the viability of this will depend upon the heat demands and heat density of the eventual development. The viability could be improved by increasing the density of the development (60dph+), a typology that includes more flats and terraced housing and increasing the proportion of non-domestic uses. The opportunities for wider connection to existing buildings in the area should also be considered. Other opportunities for integration of the development should also be explored, including the provision of facilities and amenities to enhance the area. Of the three sites this is potentially the one with the most scope to set a higher target for a proportion of dwellings. This might tie in well with a suggestion for the promotion of self-build properties as these tend to be built to higher standards since the owner has a greater incentive to incorporate measures that will reduce operational costs and in the case of some, environmental impacts.

### 4.3 Other comments and considerations

Potentially significant ‘allowable solutions’ funds could be released by the sites if they are developed after 2016 (Ensleigh £560k, Warminster £160k, Foxhill £900k). Current proposals suggest local authorities would be able to access this to help deliver $CO_2$ emissions reductions elsewhere through energy efficiency refurbishment measures, development of DH networks, installation of renewables etc. This is relevant because if standards were set that require more $CO_2$ emissions to be offset through measures on-site (which would be the case for any units targeting CSH Level 5 and 6) then the allowable solutions payment received across the site would be reduced.

Our study has only been able to take account of the current understanding of the standards referenced and the costs associated with these. In reality these are likely to change over time and the authority will need to be mindful of this. However in regards to CSH and BREEAM the standards are updated over time and remain ahead of regulatory requirements but the technical and financial requirements should remain relative. BANES and the project team should be aware of the following:

- Changes to Building Regulations standards in 2013, 2016 and 2016
- Changes to the CSH and BREEAM assessments
- Changes to policy wording in the BANES Core Strategy
- Future BANES development plan documents and supplementary planning documents

# Appendix

## 1. Uplift costs for achieving different Levels of the Code for sustainable Homes on the three sites

The following tables show the costs associated with meeting the Zero Carbon policy on the three sites based on the scenarios set out in section 3.4.

***Ensleigh***

Scenario 1 (SHLAA density at 50dph):

Compared to Part L 2010:

| Code Level | Excluding office use | | Including 2000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 3 | £32,486,920 | **£567,600** | £30,456,488 | **£532,125** | **1.7%** |
| 4 | £32,486,920 | **£1,916,400** | £30,456,488 | **£1,796,625** | **5.9%** |
| 5 | £32,486,920 | **£8,002,000** | £30,456,488 | **£7,501,875** | **24.6%** |
| 6 | £32,486,920 | **£13,850,000** | £30,456,488 | **£12,984,375** | **42.6%** |

*Table 5: Ensleigh Scenario 1: extra-over costs of CSH Levels compared to a Part L 2010 compliant development*

Compared to Part L 2013 (indicative only):

| Code Level | Excluding office use | | Including 2000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 4 | £33,649,400 | **£771,760** | £31,546,313 | **£723,525** | **2.3%** |
| 5 | £33,649,400 | **£6,857,360** | £31,546,313 | **£6,428,775** | **20.4%** |
| 6 | £33,649,400 | **£12,705,360** | £31,546,313 | **£11,911,275** | **37.8%** |

*Table 6: Ensleigh Scenario 1: extra-over costs of CSH Levels compared to a Part L 2013 compliant development*

Scenario 2 (density at 60dph):

Compared to Part L 2010:

| Code Level | Excluding office use | | Including 2000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 3 | £38,984,304 | **£681,120** | £36,547,785 | **£638,550** | **1.7%** |
| 4 | £38,984,304 | **£2,299,680** | £36,547,785 | **£2,155,950** | **5.9%** |
| 5 | £38,984,304 | **£9,602,400** | £36,547,785 | **£9,002,250** | **24.6%** |
| 6 | £38,984,304 | **£16,620,000** | £36,547,785 | **£15,581,250** | **42.6%** |

*Table 7: Ensleigh Scenario 2: extra-over costs of CSH Levels compared to a Part L 2010 compliant development*

Compared to Part L 2013 (indicative only):

| Code Level | Excluding office use | | Including 2000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 4 | £40,379,280 | **£926,112** | £37,855,575 | **£868,230** | **2.3%** |
| 5 | £40,379,280 | **£8,228,832** | £37,855,575 | **£7,714,530** | **20.4%** |
| 6 | £40,379,280 | **£15,246,432** | £37,855,575 | **£14,293,530** | **37.8%** |

*Table 8: Ensleigh Scenario 2: extra-over costs of CSH Levels compared to a Part L 2013 compliant development*

**Warminster Road**

Scenario 1 (SHLAA density at 40dph):

Compared to Part L 2010:

| Code Level | Excluding office use | | Including 1000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 3 | £10,307,045 | **£194,250** | £8,834,610 | **£166,500** | **1.9%** |
| 4 | £10,307,045 | **£587,650** | £8,834,610 | **£503,700** | **5.7%** |
| 5 | £10,307,045 | **£2,521,050** | £8,834,610 | **£2,160,900** | **24.5%** |
| 6 | £10,307,045 | **£4,476,150** | £8,834,610 | **£3,836,700** | **43.4%** |

*Table 9: Warminster Rd Scenario 1: extra-over costs of CSH Levels compared to a Part L 2010 compliant development*

Compared to Part L 2013 (indicative only):

| Code Level | Excluding office use | | Including 1000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 4 | £10,631,635 | **£269,710** | £9,112,830 | **£231,180** | **2.5%** |
| 5 | £10,631,635 | **£2,203,110** | £9,112,830 | **£1,888,380** | **20.7%** |
| 6 | £10,631,635 | **£4,158,210** | £9,112,830 | **£3,564,180** | **39.1%** |

*Table 10: Warminster Rd Scenario 1: extra-over costs of CSH Levels compared to a Part L 2013 compliant development*

Scenario 2 (density at 50dph):

Compared to Part L 2010:

| Code Level | Excluding office use | | Including 1000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 3 | £12,883,806 | **£242,813** | £11,043,263 | **£208,125** | **1.9%** |
| 4 | £12,883,806 | **£734,563** | £11,043,263 | **£629,625** | **5.7%** |
| 5 | £12,883,806 | **£3,151,313** | £11,043,263 | **£2,701,125** | **24.5%** |
| 6 | £12,883,806 | **£5,595,188** | £11,043,263 | **£4,795,875** | **43.4%** |

*Table 11: Warminster Rd Scenario 2: extra-over costs of CSH Levels compared to a Part L 2010 compliant development*

Compared to Part L 2013 (indicative only):

| Code Level | Excluding office use | | Including 1000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 4 | £13,289,544 | **£337,138** | £11,391,038 | **£288,975** | **2.5%** |
| 5 | £13,289,544 | **£2,753,888** | £11,391,038 | **£2,360,475** | **20.7%** |
| 6 | £13,289,544 | **£5,197,763** | £11,391,038 | **£4,455,225** | **39.1%** |

*Table 12: Warminster Rd Scenario 2: extra-over costs of CSH Levels compared to a Part L 2013 compliant development*

Scenario 3 (density at 70dph):

Compared to Part L 2010:

| Code Level | Excluding office use | | Including 1000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 3 | £18,037,329 | **£339,938** | £15,460,568 | **£291,375** | **1.9%** |
| 4 | £18,037,329 | **£1,028,388** | £15,460,568 | **£881,475** | **5.7%** |
| 5 | £18,037,329 | **£4,411,838** | £15,460,568 | **£3,781,575** | **24.5%** |
| 6 | £18,037,329 | **£7,833,263** | £15,460,568 | **£6,714,225** | **43.4%** |

*Table 13: Warminster Rd Scenario 3: extra-over costs of CSH Levels compared to a Part L 2010 compliant development*

Compared to Part L 2013 (indicative only):

| Code Level | Excluding office use | | Including 1000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 4 | £18,605,361 | **£471,993** | £15,947,453 | **£404,565** | **2.5%** |
| 5 | £18,605,361 | **£3,855,443** | £15,947,453 | **£3,304,665** | **20.7%** |
| 6 | £18,605,361 | **£7,276,868** | £15,947,453 | **£6,237,315** | **39.1%** |

*Table 14: Warminster Rd Scenario 3: extra-over costs of CSH Levels compared to a Part L 2013 compliant development*

**Foxhill**

*Scenario 1 (SHLAA density at 50dph):*

Compared to Part L 2010:

| Code Level | Excluding office use | | Including 2000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 3 | £56,997,750 | **£1,063,125** | £55,097,825 | **£1,027,688** | **1.9%** |
| 4 | £56,997,750 | **£3,403,125** | £55,097,825 | **£3,289,688** | **6.0%** |
| 5 | £56,997,750 | **£13,884,375** | £55,097,825 | **£13,421,563** | **24.4%** |
| 6 | £56,997,750 | **£24,838,125** | £55,097,825 | **£24,010,188** | **43.6%** |

*Table 15: Foxhill Scenario 1: extra-over costs of CSH Levels compared to a Part L 2010 compliant development*

Compared to Part L 2013 (indicative only):

| Code Level | Excluding office use | | Including 2000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 4 | £58,984,688 | **£1,442,719** | £57,018,531 | **£1,394,628** | **2.4%** |
| 5 | £58,984,688 | **£11,923,969** | £57,018,531 | **£11,526,503** | **20.2%** |
| 6 | £58,984,688 | **£22,877,719** | £57,018,531 | **£22,115,128** | **38.8%** |

*Table 16: Foxhill Scenario 1: extra-over costs of CSH Levels compared to a Part L 2013 compliant development*

*Scenario 2 (density at 60dph):*

Compared to Part L 2010:

| Code Level | Excluding office use | | Including 2000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 3 | £68,397,300 | **£1,275,750** | £66,117,390 | **£1,233,225** | **1.9%** |
| 4 | £68,397,300 | **£4,083,750** | £66,117,390 | **£3,947,625** | **6.0%** |
| 5 | £68,397,300 | **£16,661,250** | £66,117,390 | **£16,105,875** | **24.4%** |
| 6 | £68,397,300 | **£29,805,750** | £66,117,390 | **£28,812,225** | **43.6%** |

*Table 17: Foxhill Scenario 2: extra-over costs of CSH Levels compared to a Part L 2010 compliant development*

Compared to Part L 2013 (indicative only):

| Code Level | Excluding office use | | Including 2000sqm office use | | |
|---|---|---|---|---|---|
| | Base Cost | E/O cost | Base Cost | E/O cost | % Uplift |
| 4 | £70,781,625 | **£1,731,263** | £68,422,238 | **£1,673,554** | **2.4%** |
| 5 | £70,781,625 | **£14,308,763** | £68,422,238 | **£13,831,804** | **20.2%** |
| 6 | £70,781,625 | **£27,453,263** | £68,422,238 | **£26,538,154** | **38.8%** |

*Table 18: Foxhill Scenario 2: extra-over costs of CSH Levels compared to a Part L 2013 compliant development*

**Per Unit Costs**

The table below shows the extra-over costs of meeting higher CSH levels on a per unit basis, compared to a Part L 2010 compliant unit, as estimated in the *Cost of Building to the Code* report for an edge-of-town development.

| Code Level | 2b-Flat | | 2b-Terrace | | 3b-Semi | | 4b-detached | |
|---|---|---|---|---|---|---|---|---|
| | E/O cost | % uplift | E/O cost | % uplift | E/O cost | % uplift | E/O cost | % uplift |
| 3 | £1,470 | 2.7% | £1,360 | 1.7% | £1,590 | 1.8% | £1,370 | 1.5% |
| 4 | £3,950 | 7.2% | £4,280 | 5.3% | £5,360 | 6.2% | £5,920 | 6.4% |
| 5 | £12,060 | 22.1% | £19,990 | 25.0% | £21,330 | 24.7% | £22,690 | 24.5% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | £27,870 | 51.0% | £33,340 | 41.7% | £36,190 | 41.9% | £39,650 | 42.8% |

*Table 19: Extra-over costs of CSH Levels on a per unit basis compared to Part L 2010 compliant units*

The table below uses the same data to show the relative uplift to CSH Levels 5 and 6 on a per unit basis, as compared to a unit achieving CSH Level 4:

| Code Level | 2b-Flat | | 2b-Terrace | | 3b-Semi | | 4b-detached | |
|---|---|---|---|---|---|---|---|---|
| | E/O cost | % uplift | E/O cost | % uplift | E/O cost | % uplift | E/O cost | % uplift |
| 5 | £8,110 | 13.8% | £15,710 | 18.7% | £15,970 | 17.4% | £16,770 | 17.0% |
| 6 | £23,920 | 40.8% | £29,060 | 34.5% | £30,830 | 33.6% | £33,730 | 34.2% |

*Table 20: Extra-over costs of CSH Levels 5 and 6 on a per unit basis compared to units achieving CSH Level 4*

**2. Cost uplifts associated with delivering the proposed Zero Carbon policy on the three sites**

The following tables show the costs associated with meeting the Zero Carbon policy on the three sites based on the scenarios set out in section 3.4.

**Ensleigh**

*Scenario 1 (SHLAA density at 50dph):*

| | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| **Including A1 provision** | £114,640 | £1,252,240 | £496,880 | £1,863,760 |
| **Excluding A1 provision** | £107,475 | £1,173,975 | £465,825 | £1,747,275 |

*Scenario 2 (density at 60dph):*

| | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| **Including A1 provision** | £137,568 | £1,502,688 | £596,256 | £2,236,512 |
| **Excluding A1 provision** | £128,970 | £1,408,770 | £558,990 | £2,096,730 |

**Warminster Road**

*Scenario 1 (SHLAA density at 40dph):*

| | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| **Including A1 provision** | £1,260 | £362,040 | £158,620 | £521,920 |
| **Excluding A1 provision** | £1,080 | £310,320 | £135,960 | £447,360 |

*Scenario 2 (density at 50dph):*

| | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| **Including A1 provision** | £1,575 | £452,550 | £198,275 | £652,400 |
| **Excluding A1 provision** | £1,350 | £387,900 | £169,950 | £559,200 |

*Scenario 3 (density at 70dph):*

| | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| **Including A1 provision** | £2,205 | £633,570 | £277,585 | £913,360 |
| **Excluding A1 provision** | £1,890 | £543,060 | £237,930 | £782,880 |

**Foxhill**

*Scenario 1 (SHLAA density at 50dph):*

| | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| **Including A1 provision** | £139,406 | £2,077,219 | £893,625 | £3,110,250 |
| **Excluding A1 provision** | £134,759 | £2,007,978 | £863,838 | £3,006,575 |

*Scenario 2 (density at 60dph):*

| | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| **Including A1 provision** | £167,288 | £2,492,663 | £1,072,350 | £3,732,300 |

| | | | | |
|---|---|---|---|---|
| **Excluding A1 provision** | £161,711 | £2,409,574 | £1,036,605 | £3,607,890 |

**Per Unit Costs**

The table below shows the cost of zero carbon homes on a per unit basis, as estimated by the Zero Carbon Hub:

| Unit Type | Fabric (over 2010) | Carbon Compliance (excl fabric) | Allowable Solutions | Total Cost of Zero Carbon Homes over Part L 2010 |
|---|---|---|---|---|
| **Flat** | £36 | £1,332 | £1,055 | £2,423 |
| **Mid-terrace** | £0 | £3,004 | £1,159 | £4,163 |
| **Semi** | £57 | £3,444 | £1,159 | £4,660 |
| **Detached** | £1,358 | £4,033 | £1,627 | £7,018 |