5.0 Design Options

The masterplanning approach adopted is to establish the design parameters required by the three “neighbourhood infrastructures” - surface water, residential waste and operational energy - and integrate them together into high-quality urban design layouts. In other words, rather than incorporating water, waste and energy into the design “after the masterplan is done”, the opportunities and constraints of each site in terms of the three infrastructures are extracted, and the urban design originates from those. This approach will allow the developer team to determine where benefits can be exploited and ensure that sustainable development objectives are met.

The case studies in this section intends to describe best practice approaches by illustrating some of the various neighbourhood development options. The resulting costs for each approach are shown for information.
The case studies shown here intend to aid developers and their teams by demonstrating how the guidance can be applied. This will not replace the need for the developer team to carry out the detailed design work appropriate for unique sites.

5.1 Design Options: Middlemore

Middlemore: Surface Water Strategy

As the Middlemore site is currently a green field that slopes down in one direction, it is useful to begin with the surface water strategy, as this can begin to define the urban layout.

As described in Section 2, best practice would be to create a sustainable drainage system for this site that mimics nature in the way that surface water can be accommodated. Water will obviously flow downwards with gravity. Hence the approach is to allow this direction of water flow to occur in a natural way, with controls at source, site and regional levels.

Figure 5.1.1 shows a possible SUDS strategy for the Middlemore site. It shows how the site can be divided into two "sub-catchments", each with a system of source control, e.g. permeable paving and green roofs, site control, e.g. ponds, basin, swales, and regional controls, e.g. ponds, basins and wetlands. From the regional control features there will be a discharge to storm sewers after the larger or longer storms. The SUDS features are positioned so that the larger controls are at the bottom of the site (in this case, the South-East), allowing as many natural features as possible and as few underground pipes and pumps as possible.

Middlemore: Residential Waste Strategy

Section 2 describes that at present, a single 50-unit module residential-only neighbourhood is unlikely to provide the critical mass required for any special waste technology. However, at this scale there is an opportunity to investigate the provision of communal waste and recycling collection shared between multiple properties.

On this site, waste and recycling units should be situated as near access roads as much possible allowing for disability legislation requirements and not creating unfavourable distances between residents' homes and the communal collection points. On this site notional 30 metre distances between the communal stores and potential positions of housing is illustrated in figure 5.1.2. The road connection to units should be step-free for ease of bin crew movements and to reduce the noise created by refuse trucks.

On this site the approach should remove the need for a refuse truck to reverse. The units themselves are to be gated front and rear to allow easy access and would be used in conjunction with internal recycling segregation units located in the kitchens of the properties.

Figure 5.1.1: The site can be split into two sub-catchments, each with SUDS controls from the top of the site (source and site controls) to the bottom of the site (regional controls)

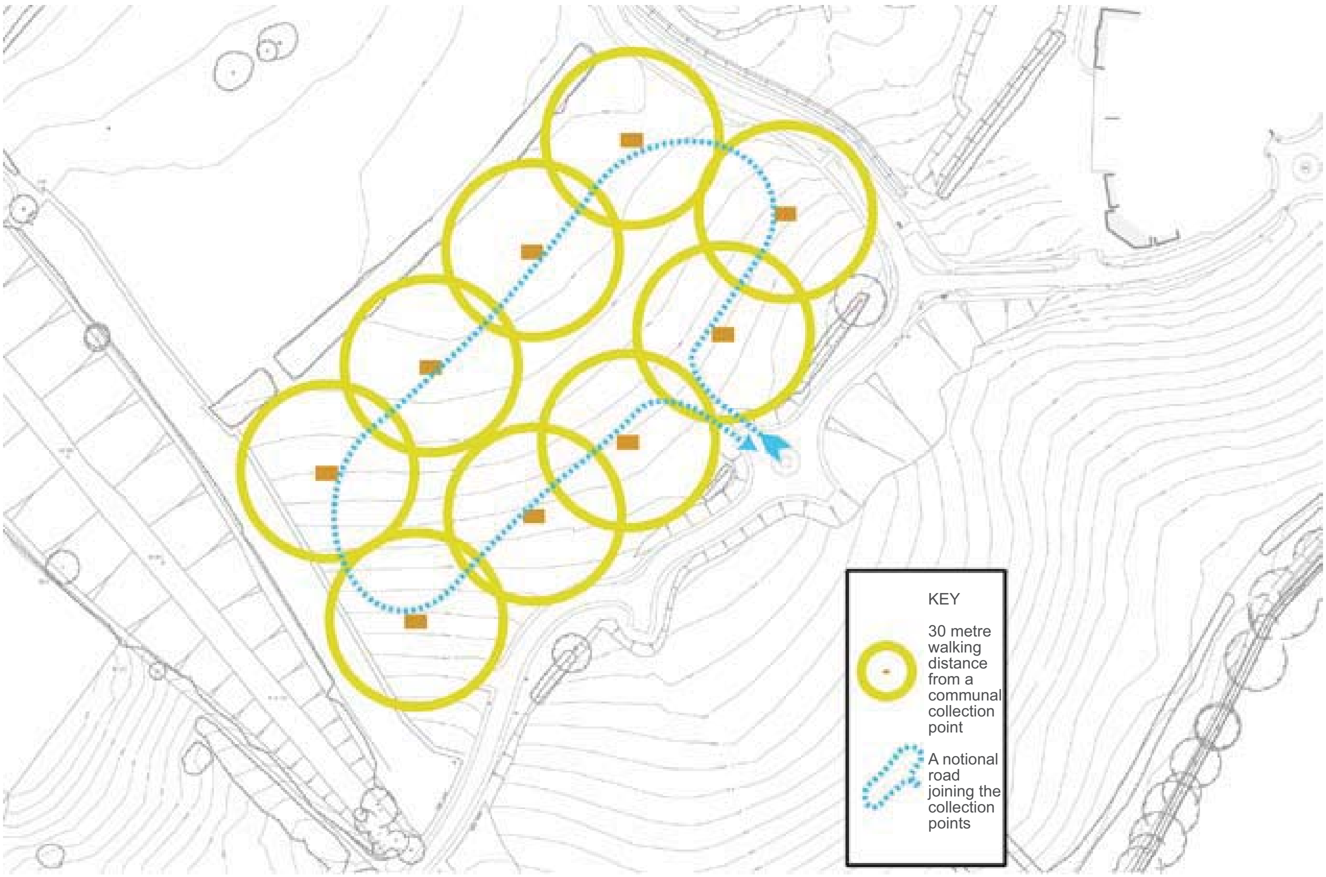


Figure 5.1.2: Notional 30 metre circles indicate the position of potential waste and recycling collection points, giving a parameter for how close to the boundary edge a loop road for refuse collection trucks may be

Middlemore: Operational Energy Strategy

To meet the Code for Sustainable Homes Level 5 energy target (100% reduction in “SAP regulated” energy), there are many options for developing this site with low carbon energy sources. The approach was to undertake an outline feasibility study that assessed both neighbourhood-wide technology options (“macro scale”) and technology options for individual units (“micro scale”).

The greater cost benefit technologies tend to be larger-scale technologies that make use of wind or hydro power for electricity and a communal heating system. On-site wind was discarded as the site was very small to accommodate both housing and large turbines. It would also have likely been considered “inappropriate” in town planning terms on this site. Hydro power was discarded as there is no local running water. Large- scale CHP was also discarded as it is not viable based on a development with this number of homes.

The **macro** scale strategy investigated was:

- a biomass district heating plant for heating
- photovoltaics on individual dwelling roofs for electricity

This option is based on the first development phase of 50 homes. Preliminary calculations estimated that a biomass boiler with a capacity of 150kW will be required, installed in an energy centre. For a future neighbourhood module alongside this phase, the network could be extended and connected to a second biomass boiler (around 150kW in size), located in the energy centre which is designed to be large enough for an additional boiler.

This is opposed to one large boiler (of the order of 300kW) that would serve both phases, as the capital costs make this prohibitive and until both phases are completed, the boiler would only be operating at a reduced load. The added benefit of having two boilers working in parallel is that if one suffers a technical failure the district heating system will still be able to operate. A gas-connected auxiliary back-up boiler also housed in the energy centre would provide a final back-up option.

The Energy Centre will be located near to the boundary of both phases and adjacent to a main road. This will allow easy access through a green corridor for the pipe-work and reduce the need for large fuel delivery trucks to pass through the whole neighbourhood (see figure 5.1.3).
The **micro** scale strategies feasible for neighbourhood development are more well-known. For this site, three options where the technologies are connected on an individual basis to each house were included for comparison. These were:

- **2.4 kWp of roof-mounted photovoltaics** (around 18m^2 of roof space) and a **6kW ground source heat pump** set below permeable paving
- **3.5 kWp of roof-mounted photovoltaics** (around 26m^2 of roof space) and a **5kW Air Source Heat Pump** (ASHP)
- A conventional **gas condensing boiler 2.75**, **kWp PV'**s (around 21m^2 of roof space) and **4m^2 of roof-mounted evacuated tube solar thermal panels**

All of these three options would meet the Code Level 5 benchmark for each single house.

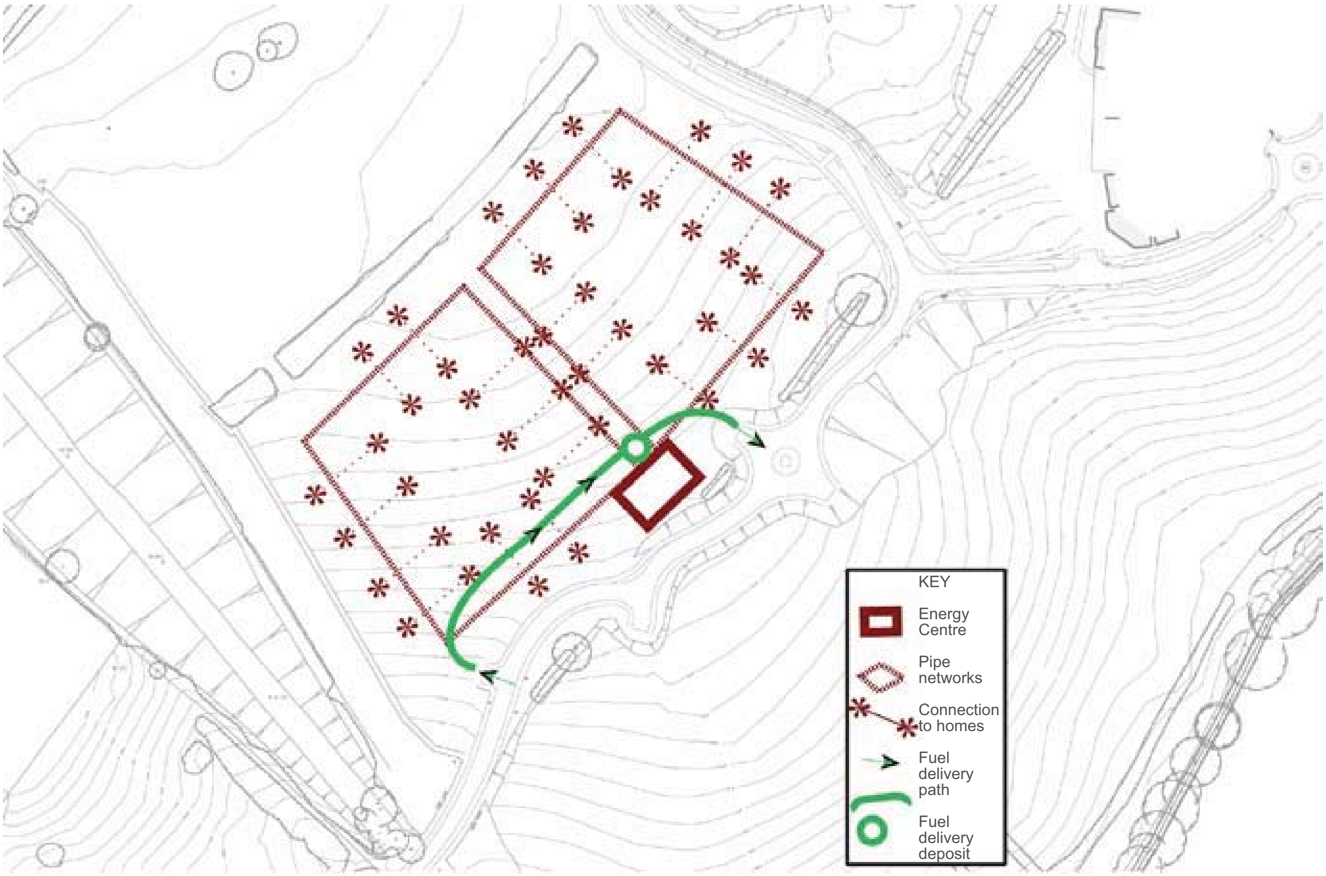


Figure 5.1.3: A potential location for the Energy Centre is shown located between the two site access points near the South of the site to avoid fuelling vehicles from needing to reverse or drive through the entire site. As the site slopes predominantly South, overshadowing for solar technology should be reasonably favourable.

Middlemore: urban design

Figure 5.1.5 shows the possible opportunities and constraints for the Middlemore site from an urban design standpoint. The site has the following features:

- primary "high value" views into and out of the site
- earthworks and railway cutting forming effective barriers to views into the site
- cold north-facing and warm south-facing slopes
- existing planting forming a potential screen and/or primary or secondary shelterbelts
- significant tree groups and hedgerows
- areas of landscape value and/or important wildlife habitats

Each unique site will have its own constraints and opportunities and the different proposals will have to meet different design criteria. Using this approach, urban design in outline was not begun until the parameters for the sustainable infrastructures were investigated.

Figure 5.1.6 therefore is an urban design approach overlaid above the water, waste and energy strategies. It shows in simple terms:

- a "site gateway"
- a green route through the site connecting the centre and the gateway
- ambitions for views out of the site
- potential edge conditions
- roads following a potential district heating system

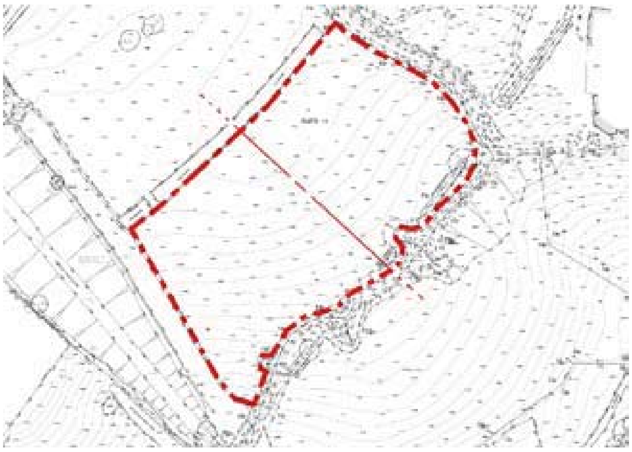


Figure 5.1.4 (above): Reviewing the topography shown in the plan will start to identify the natural slope of the existing land. The site can be notionally split into two to demonstrate two 50-unit neighbourhood modules

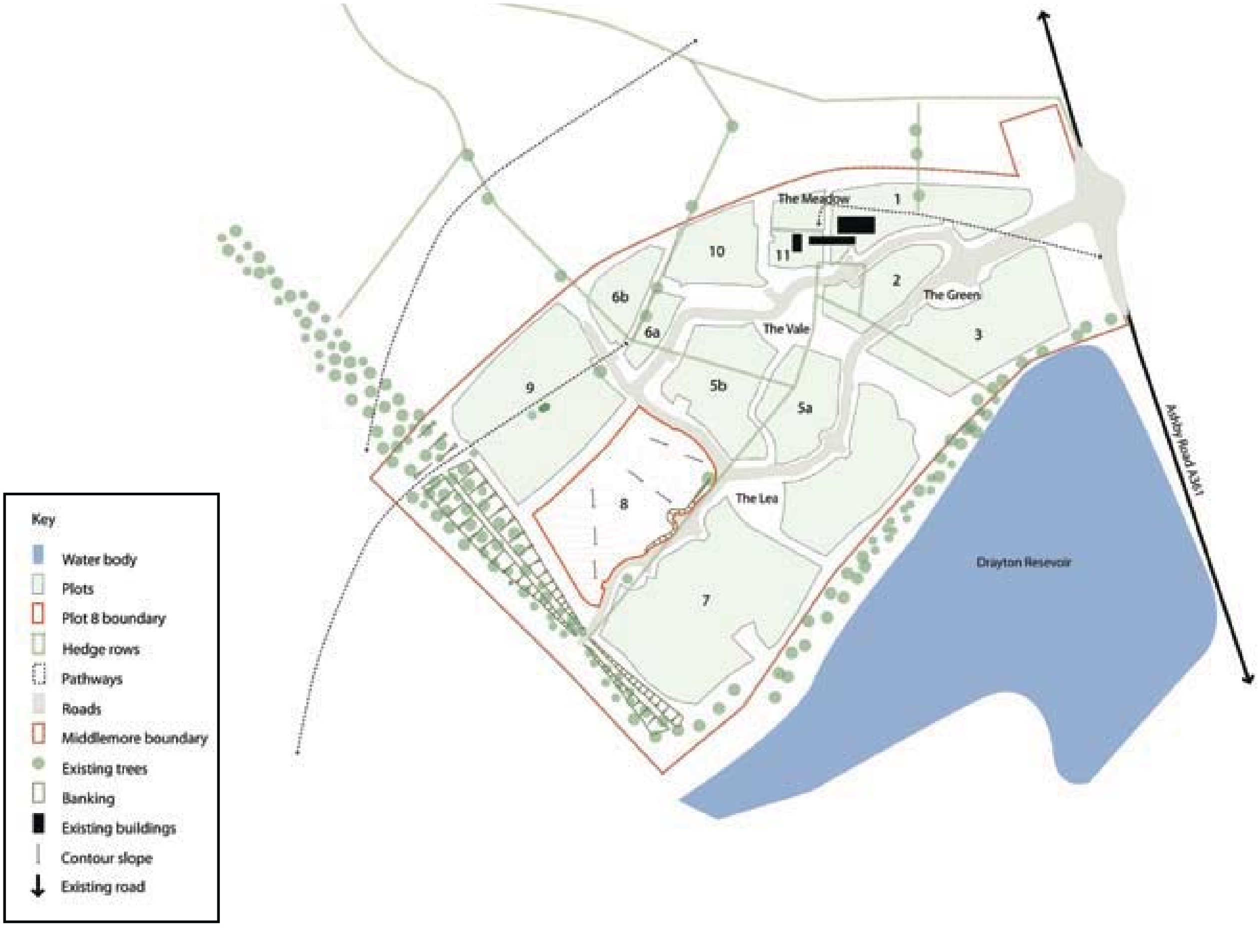


Figure 5.1.5: Urban design - site opportunities and constraints

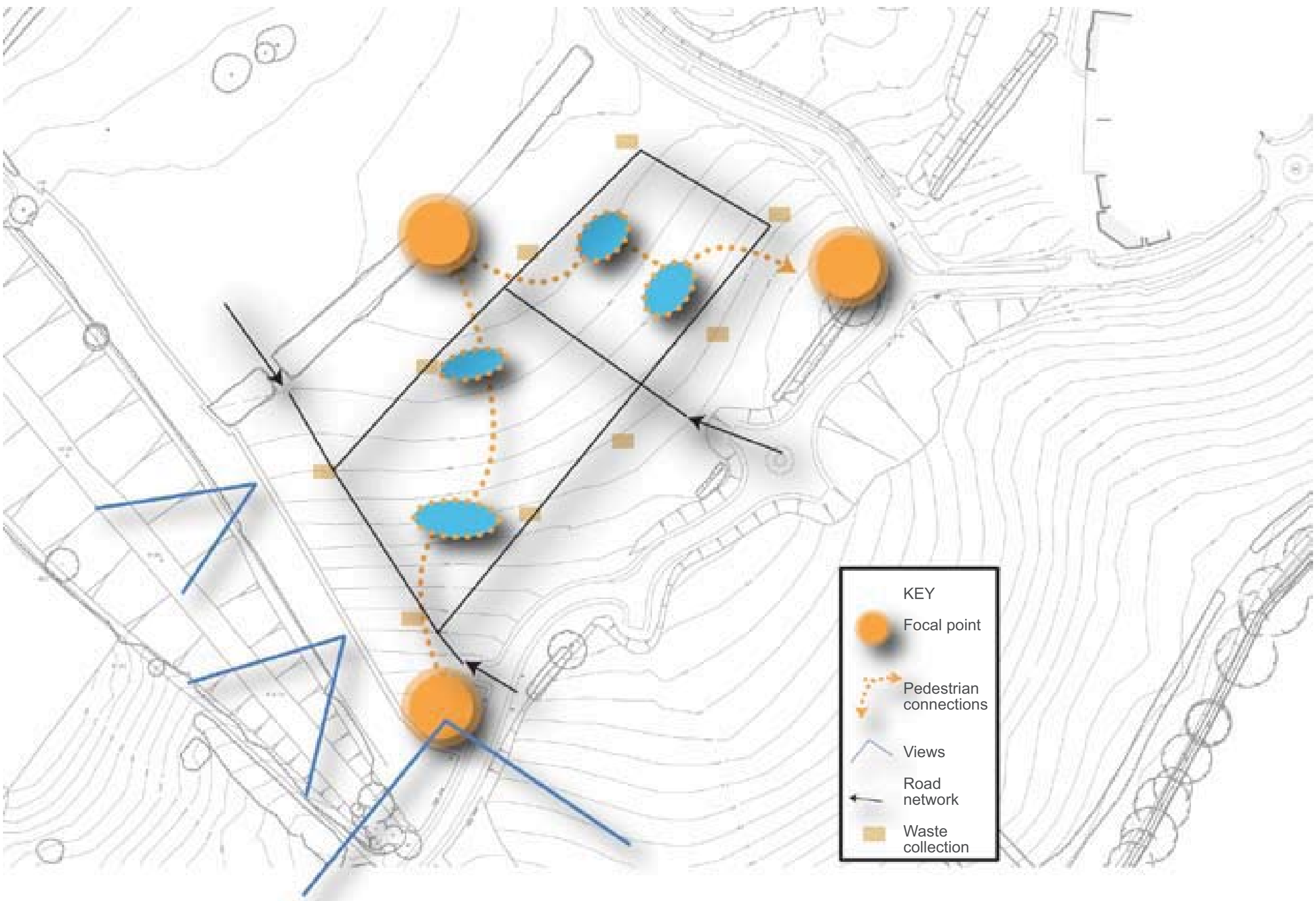


Figure 5.1.6: Urban design laid over the water and energy infrastructures, accounting for the waste management strategy for communal refuse and recycling points

Figure 5.1.7: An image of the housing units, illustrating the integration of the three infrastructures. These units could equally be an apartment block at a higher density

Figure 5.1.8 binds together the strategies and illustrates a possible neighbourhood layout for one phase. This layout was the result of an iterative method within the design team, balancing the needs of the SUDS scheme, the communal waste points, and the need to provide on-site energy. It demonstrates one possible neighbourhood design that could achieve a Code for Sustainable Homes Level 5 rating using a site-wide approach. It also demonstrates that a future second neighbourhood module could be plugged in alongside in a complementary manner using a similar or completely different approach.

The following objectives can be achieved:

- A full SUDS scheme with source, site and regional control features can be accommodated
- District energy infrastructure can be a solution, with pipework aligned with roads emanating from an on-site energy centre. Equally, the three micro strategies for energy could be accommodated
- Communal waste and recycling points can be integrated with SUDS features and reduce hardstanding

Notwithstanding the above, the following further objectives can also be met:

- Medium to high density layouts can be developed
- The site can be divided into two modules, each independent of the other
- The new neighbourhood can be designed to meet urban design standards, e.g. CABE standards, Building for Life standards etc..

Figure 5.1.8: An option for a masterplan that binds together the three infrastructures

Comparing the costs of the strategies

Vital to the perceived benefits of adopting this approach, this site-wide neighbourhood design option was tested against other methods of achieving the same objectives. These are described below and each are placed in a table of comparative capital costs on the opposite page. These are outline costs intended as a guide only. Final costs will vary in different projects in different development contexts. More detail of the table to the right is provided in appendix 7.6.

Surface water

Figures 5.1.8 - 5.1.11 (following pages) illustrate in more detail two other options for controlling surface water instead of a full SUDS scheme as shown on Figure 5.1.9 for the same site layout.

Figure 5.1.10 shows a "traditional solution" of gullies and pipes, but incorporating the necessary storm water attenuation within oversized drainage pipes or below ground crates.

Figure 5.1.11 shows an "end of pipe" solution, whereby traditional gullies and pipes are partially replaced by an element of permeable paving, with the main attenuation capacity being provided by oversized pipes with detention ponds at the end of the system. This is a partial SUDS scheme. The cost comparison table shows that the lowest capital cost is for the full SUDS scheme which is fully integrated within the site layout, and which uses the least number of hard features. This does not include for the added benefit of a "pond premium" that SUDS schemes can offer - i.e. the extra capital value on the price of the housing units due to the attractive green environment.

Residential waste

Planning waste infrastructure provides benefits for both residents and the collection authority if undertaken correctly, however the developer can also benefit from reduced build costs. The inclusion of communal recycling bins reduces the need for the more extensive road system required to service individual bins by a refuse collection vehicle.

This allows a significant reduction of road construction on the whole site and represents a saving of approximately £43,500 to the developer. It is assumed that individual bins would occupy 20m^2 per house and that there would be free issue of bins for either scheme. The maintenance of the communal bin storage units would be the responsibility of whoever adopted them, being either a facilities management company or Local Authority.

Communal greywater recycling systems should provide a cost saving of approximately £5000 over the installation of individual units. The ongoing maintenance cost of a communal system would have to be borne by the residents through a financial arrangement with a facilities management company. Individual systems would be installed inside houses and therefore the responsibility for maintenance and associated costs would be the homeowners.

The installation of water recycling technologies may not appear beneficial to the developer at the present time but increasing pressure to attain higher Code Levels will make the inclusion of such technologies more desirable.

Operational energy

The four energy options were reviewed for the same neighbourhood layout:

(1) a biomass district heating plant for heating with 1.2kWp roof-mounted photovoltaics on individual dwelling roofs for electricity (the **macro** scale strategy)

(2) individual home 2.4 kWp of roof-mounted photovoltaics (around 18m^2 of roof space) and a 6kW under-permeable-paving ground source heat pump (a **micro** strategy)

(3) individual home 3.5 kWp of roof-mounted photovoltaics (around 26m^2 of roof space) and a 5kW Air Source Heat Pump (ASHP) (a **micro** strategy)

(4) individual home conventional gas condensing boiler 2.75 kWp PV's (around 21m^2 of roof space) and 4m^2 of roof-mounted evacuated tube solar thermal panels (a **micro** strategy)

Costs

The cost table shows the varying capital costs differences, demonstrating that the **least expensive** is the gas condensing boiler with PV and solar thermal (option 4), then the macro strategy of district heating with PV (option 1) followed by the air source heat pump with PV (option 3). Finally, the **most expensive** was the ground source heat pump with PV (option 3).

Figure 5.1.8: Middlemore masterplan - cost comparison

WATER	Total Capital Cost (£)	Cost per Dwelling (£)
"Full SUDS"	171,000.00	3,420.00
Traditional Drainage solution	175,000.00	3,500.00
Semi Engineered SUDS - "End of pipe"	238,000.00	4,760.00

WASTE	Total Capital Cost (£)	Cost per Dwelling (£)
Individual bins (including additional road construction	75,000	1,500.00
Communal bins	31,500	630.00
Grey water re-cycling - individual	40,000	800.00
Grey water re-cycling - communal	35,000	700.00

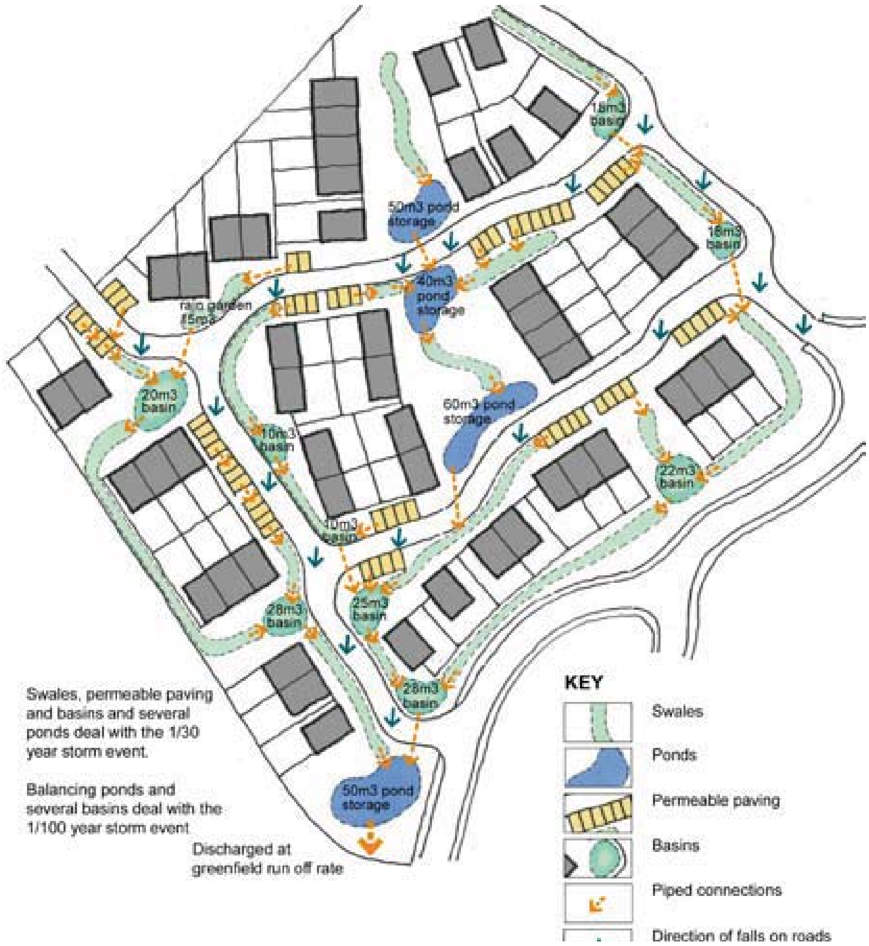
ENERGY	Total Capital Cost (£)	Cost per Dwelling (£)
Macro- biomass district heating plant with 1.6kWp Photovoltaics on dwelling roofs (12m^2 of roof space per dwelling)	889,000.00	17,780.00
2.4 kWp Photovoltaics (18m^2 of roof space) + permeable paving (94m^2 of paving) + Ground Source Heat pump	1,267,000.00	25,340.00
3.5 kWp Photovoltaics (26m^2 of roof space) + c. 5kW Air Source Heat pump	950,000.00	19,000.00
Conventional Gas condensing boiler + PV + 2.75 kWp Photovoltaics (22m^2 of roof space) + 4m^2 solar thermal panels	827,500.00	16,550.00

5.1 Design Options: Middlemore

Middlemore:
Various surface water strategies for comparing the SUDS strategy adopted against two other options

Figure 5.1.8: The masterplan shown as micro energy options, i.e. without an energy centre

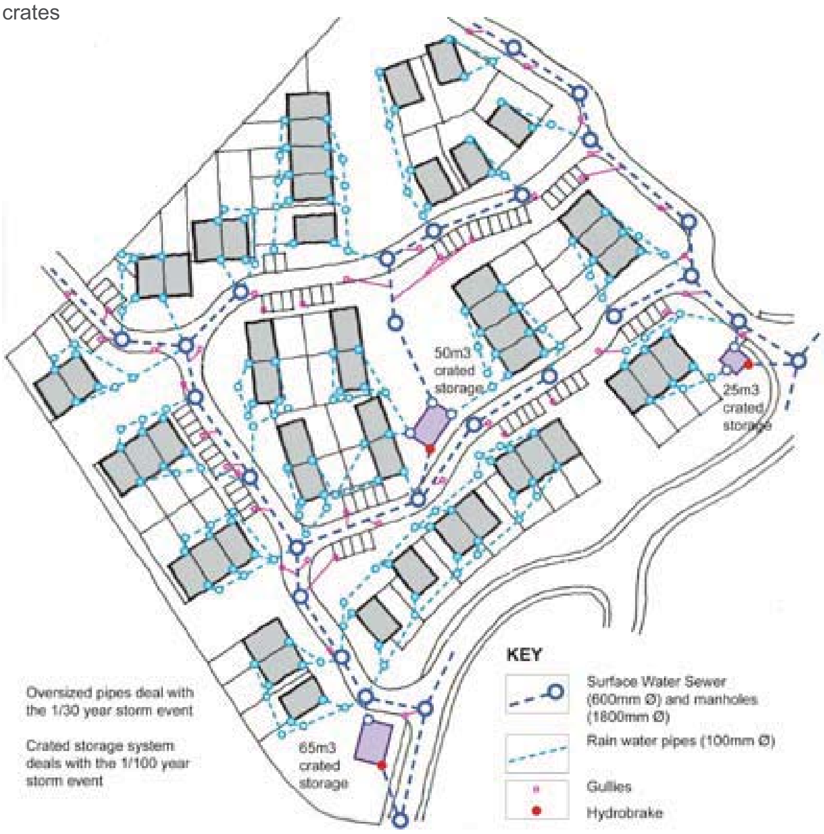
Figure 5.1.9: The designed full SUDS scheme



Full SUDS Solution

1 in 30 year event	
Rain garden	15m^3 storage
Permeable paving	120m^3 storage
Basins	135m^3 storage
Ponds	90m^3 storage
Total:	**360m^3**
1 in 100 year event	
Basins	40m^3 storage
Ponds	100m^3 storage
Total:	**500m^3**

Figure 5.1.10 A “traditional solution” of gullies and pipes, but incorporating the necessary storm water attenuation within oversized drainage pipes or below ground crates



Traditional Drainage Solution

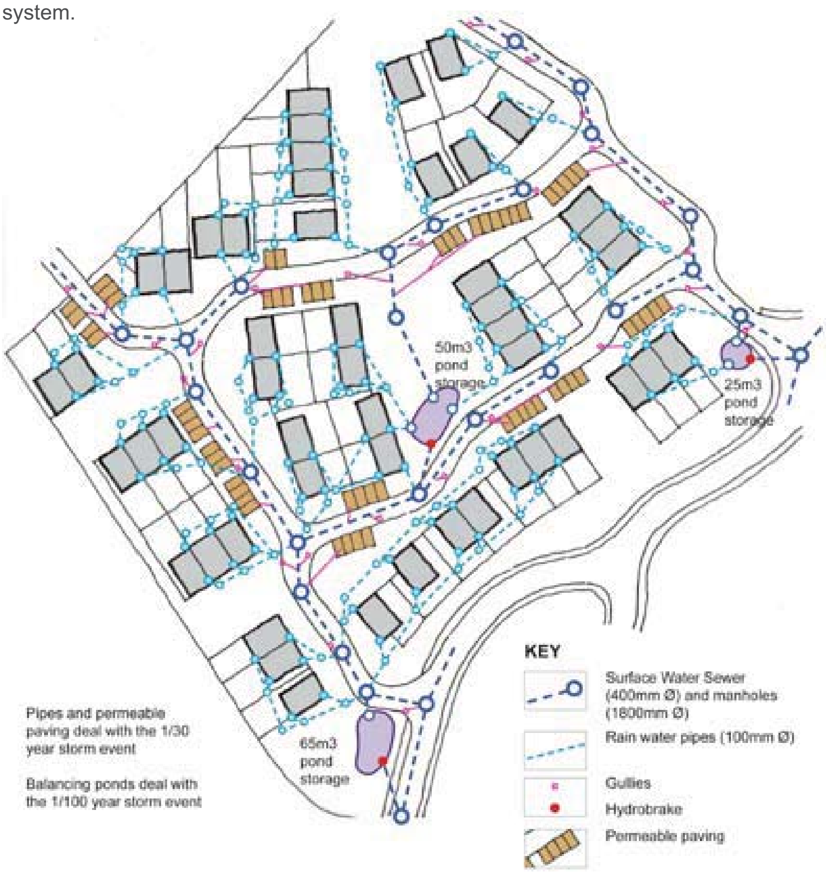
1 in 30 year event

Pipes (600mm diameter)	360m^3 storage
Total:	**360m^3**

1 in 100 year event

Crates	140m^3 storage
Total:	**500m^3**

Figure 5.1.11 An “end of pipe” solution, whereby traditional gullies and pipes are partially replaced by an element of permeable paving, with the main attenuation capacity being provided by oversized pipes with detention ponds at the end of the system.



Engineered SUDS Solution - ‘End of Pipe’

1 in 30 year event

Pipes (400mm diameter)	240m^3 storage
Permeable paving	120m^3 storage
Total:	**360m^3**

1 in 100 year event

Ponds	140m^3 storage
Total:	**500m^3**

5.2 Design Options: Shirebrook

In this section, the Shirebrook site is tested using the same integrated approach. This site is much larger than Middlemore, and hence a number of (say five) “modular neighbourhoods” could be plugged in a phased development of approximately 250 homes.

Shirebrook: Surface Water Strategy

As the Shirebrook site is currently a green field that has varying topography, it is useful to begin with the surface water strategy, as this can begin to define the urban layout and minimise costly groundworks by not attempting to heavily redefine the shape of the land.

As described in Section 2, best practice would be to create a sustainable drainage system for this site that mimics nature in the way that surface water can be accommodated. Water will obviously flow downwards with gravity. Hence the approach is to allow this direction of water flow to occur in a natural way, with controls at source, site and regional levels.

Figure 5.2.1 shows a possible SUDS strategy for the Shirebrook site. It shows how the site can be divided into several “sub-catchments”, each with a system of source control, e.g. permeable paving and green roofs, site control, e.g. ponds, basin, swales, and regional controls, e.g. ponds, basins and wetlands. From the regional control features, possibly in the form of a “central spine” North South through the centre of the site there will be a discharge to storm sewers after the larger or longer storms.

Shirebrook: Residential Waste Strategy

Similarly to the Middlemore site, the approach is to provide communal bins for multiple properties, housed in units at street level. Recycling units for the houses/flats are to be shared between properties, situated as near roads as possible allowing for step-free access for ease of bin crew movements and to reduce noise of bin servicing for residents. If possible, green roofs can be put on the units to ameliorate the runoff from the hard standing taken up by the bins. Quick and quiet removal of recycling and rubbish is possible if there is no need for a refuse truck to reverse.

The second element of the waste strategy is to incorporate a community composter, to make use of the food waste from the 250 homes. The location of the composter on site would not be critical but it would be advantageous if it were sited to give access to other existing housing to encourage community engagement from outside of the development. Food waste would be collected in caddies supplied to the residents, the caddies would be lined with compostable bags and when full the bags would be put out for collection.

A 10 by 10 metre unit to house for the composter should also incorporate bike storage for community use so encouraging sustainable travel to the site. A permanent secure storage space for trailer bikes or a similar load lugger could be owned by the community scheme operator and used for the local collection of food waste, the frequency of which would be determined by the community scheme itself. Carbon is required for the process and this could be supplied by the Local Authority in the form of wood chip from grounds maintenance. It would be stored within the building and added as required to the food waste mix.

Alternatively, green waste could also be collected to be used as a mix for composting. This would require some sort of community vehicle for collecting the green waste and may require a larger composting machine.

Figure 5.2.2 shows a possible waste strategy for the Shirebrook site.

Figure 5.2.1: Outline options for SUDS on this site

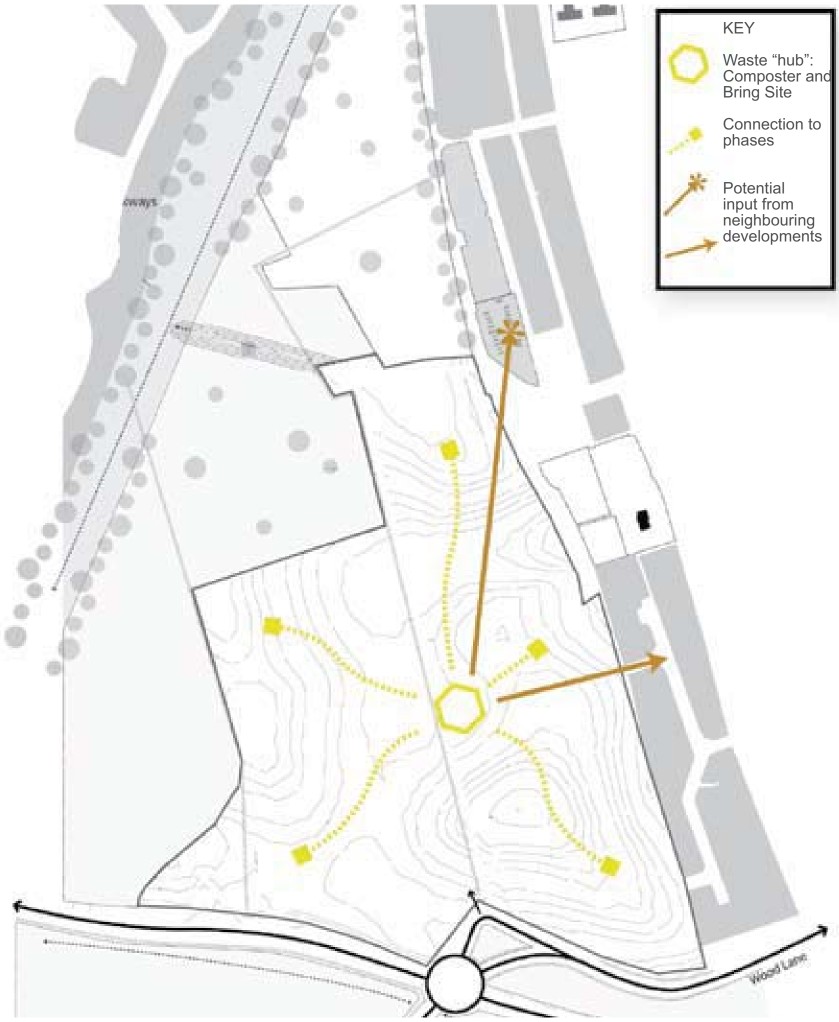


Figure 5.2.2: Outline options for waste management on this site. As the site is large enough, a community composter and bring site could be potentially incorporated. Ideally these would be central to the scheme and pedestrian and cycle accessible to the existing local community

Shirebrook: Operational Energy Strategy

The macro scale approach for this site becomes more viable due to the number of properties requiring heating. A biomass district heating system can feed five phases of 50 homes. One option could be adopted if the first phase of development included two 50 home modules. In this case, a 300kW biomass boiler could be installed in a central energy centre, again with the biomass boiler connected to a network of pre-insulated buried pipe-work.

The Energy Centre needs to be approximately 30 metres by 20 metres within the site to allow for all of the plant for future phases. Space within the energy centre's footprint will be required for the storage of wood chips/pellets that will provide the fuel source for the boiler, appropriately landscaped, with access for large vehicles that will deliver the wood pellets.

An energy services company (or similar body) will be required to manage the district heating system, and will need regular access for maintenance.

Installing a number of boilers working in parallel, to satisfy the first and future phases means that if one of them suffers a technical failure the district heating system will still be able to function.

A 300kW auxiliary gas boiler would be installed to provide backup heating during maintenance periods or any unforeseen breakdowns, adding security for the developer and management company operating the biomass plant, thus reducing financial risk in the future.

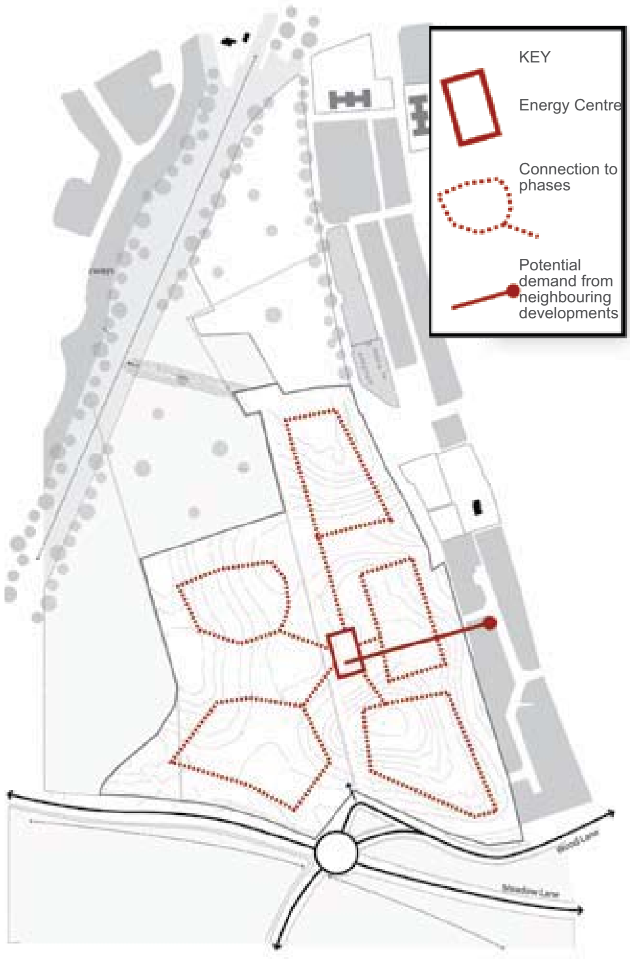


Figure 5.2.3a: A central energy centre for the whole site

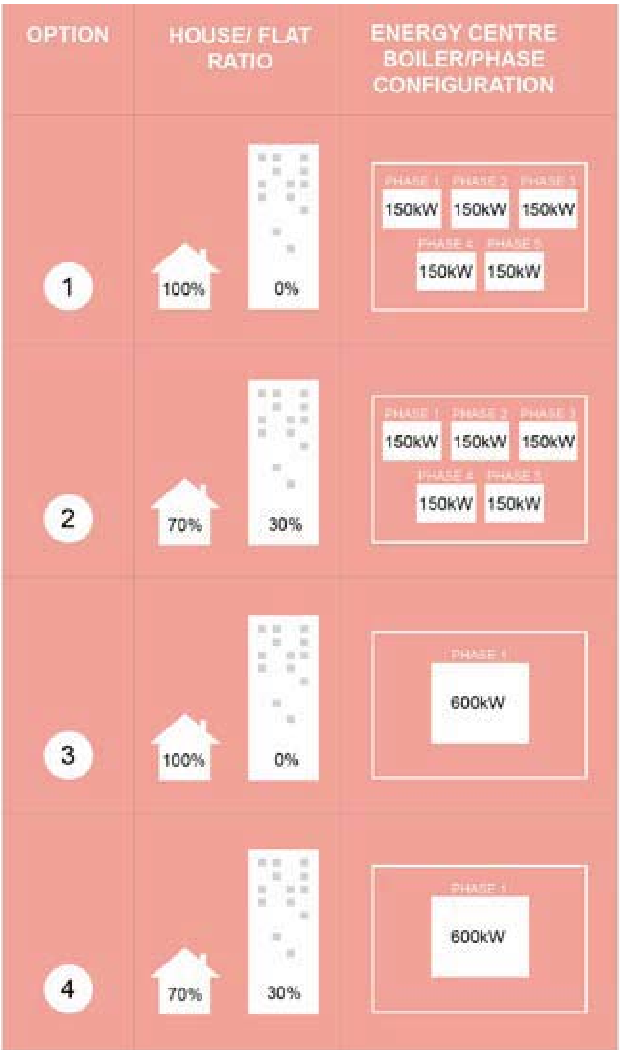


Figure 5.2.3b: Various options for the energy centre

In terms of potential phasing, there are a number of options. These include building one energy centre and district scheme per phase, or one large central energy centre that can incorporate several boilers that are installed in the future when new phases are developed.

Four scenarios were tested that incorporated a single energy centre with various different numbers and sizes of boilers, against different ratios of houses and flats. These could then be reviewed alongside the Middlemore scenario where there is a single energy centre for one phase of development. The four options investigated are:

- Option 1 - 1 no. 150KW boiler installed for each phase with the Energy Centre built in Phase 1 to accommodate 5 separate boilers. All residential units are houses
- Option 2 - 1 no. 150KW boiler installed for each phase with the Energy Centre built in Phase 1 to accommodate 5 separate boilers. Each phase has a combination of 35 houses and 15 apartment units
- Option 3 - 1 no. 600 kW boiler installed in phase 1. All residential units are houses
- Option 4 - 1 no. 600 kW boiler installed in phase 1. Each phase has a combination of 35 houses and 15 apartment units

All of the above options are tested with 1.6kWp rooftop photovoltaics for electricity (needing 12m^2 of roof space for each home.

Shirebrook: urban design

Figure 5.2.4 shows the possible opportunities and constraints for the Shirebrook site from an urban design standpoint. In principle, there are:

- Attractive views to the South
- Existing residential houses on the Eastern boundary in close proximity to the site
- Fields to the West not earmarked for development
- Site access from the South and potentially through the existing neighbourhood to the East
- A train station approximately 20 minutes walk away North-east
- Two existing schools to the North of the site
- Existing hedgerows forming a biodiversity corridor through the site

Figure 5.2.5 shows the various “layers” of infrastructure strategies and an urban design approach overlaid. This loosely shows that the site can be developed in a large number of ways, informed by the infrastructure parameters.

The following objectives can be achieved:

- A full SUDS scheme with source, site and regional control features can be accommodated
- District energy infrastructure can be a solution, with pipework aligned with roads emanating from an on-site energy centre
- Communal waste and recycling points can be integrated with SUDS features and reduce hardstanding. A community composter would be a focal point of the five modular neighbourhoods near the energy centre

Notwithstanding the above, the following further objectives can also be met:

- Medium to high density layouts can still be developed
- The site can be divided into five modules, each independent of each other, but connected by the overall SUDS strategy
- The new neighbourhood can be designed to meet urban design standards, e.g. CABE standards, Building for Life standards etc...

Figure 5.2.4: Opportunities and constraints for the Shirebrook site

Figure 5.2.5: An urban design option overlaid above the infrastructure parameters

Shirebrook: urban design

Figure 5.2.7 binds together the strategies and illustrates a possible neighbourhood layout for the site, shown in five potential phases (figure 5.2.6). The phasing of the site broadly follows the outline of the water sub-catchments for the site, hence simplifying the SUDS strategy.
This layout was the result of an iterative method within the design team, balancing the needs of the SUDS scheme, the communal waste points, the need to provide on-site energy and the urban design requirements. It demonstrates one possible neighbourhood design that could achieve a Code for Sustainable Homes Level 5 rating using a site-wide approach. It also demonstrates a flexibility in the phasing and density of the site, as the site could comfortably accommodate 350+ homes.

As with the Middlemore design, a single phase of the Shirebrook site (phase 1) was designed in more detail to test the feasibility (figure 5.2.8).

Figure 5.2.6: Potential phasing of the site

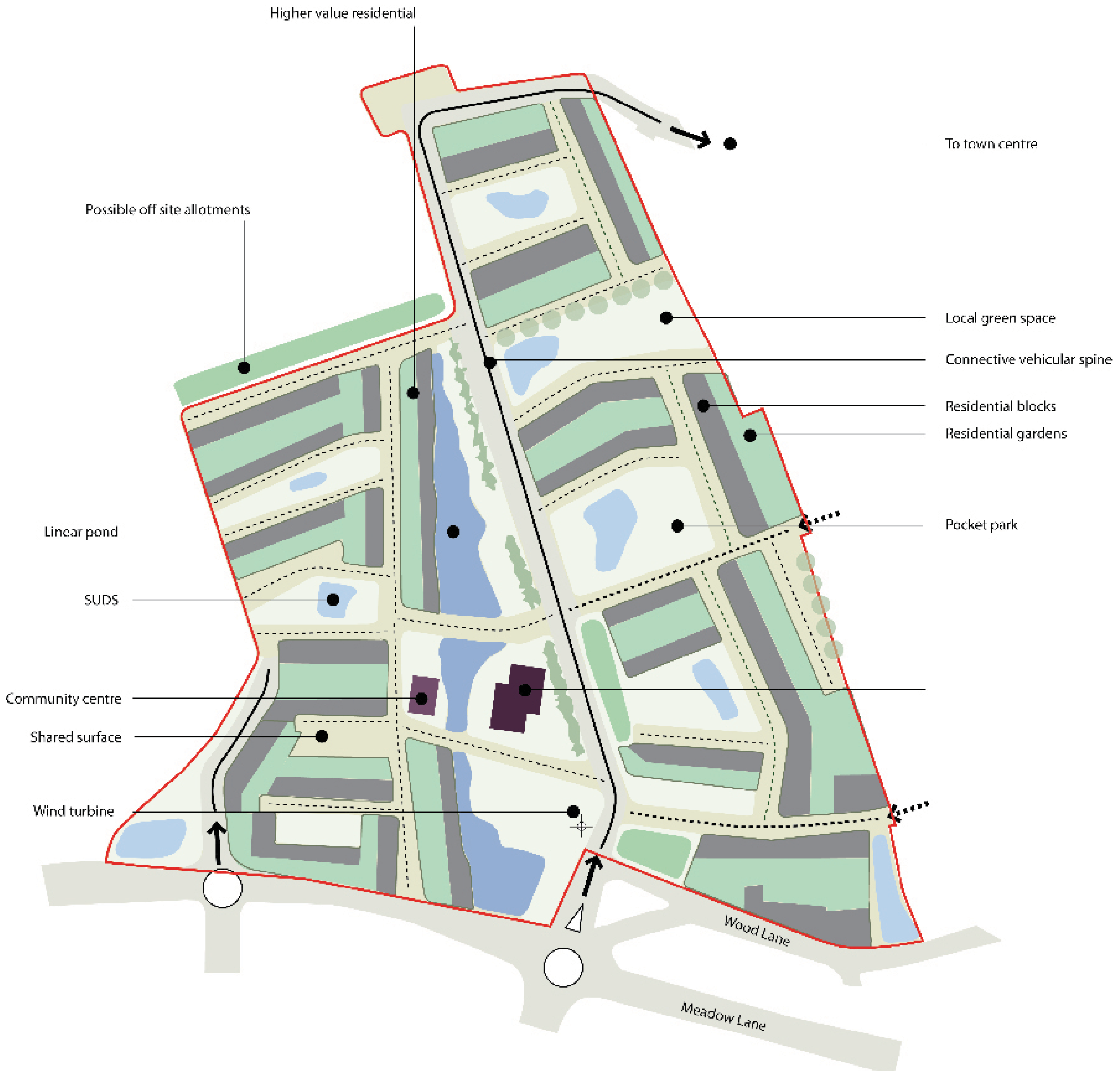


Figure 5.2.7: A possible masterplan layout for the site

Figure 5.2.8: Phase 1 in detail - illustrating that it is possible to be flexible in the detailed design without damaging the overall infrastructure concept. In this case, the SUDS features changed position from the outline masterplan, whilst maintaining the necessary source and site features

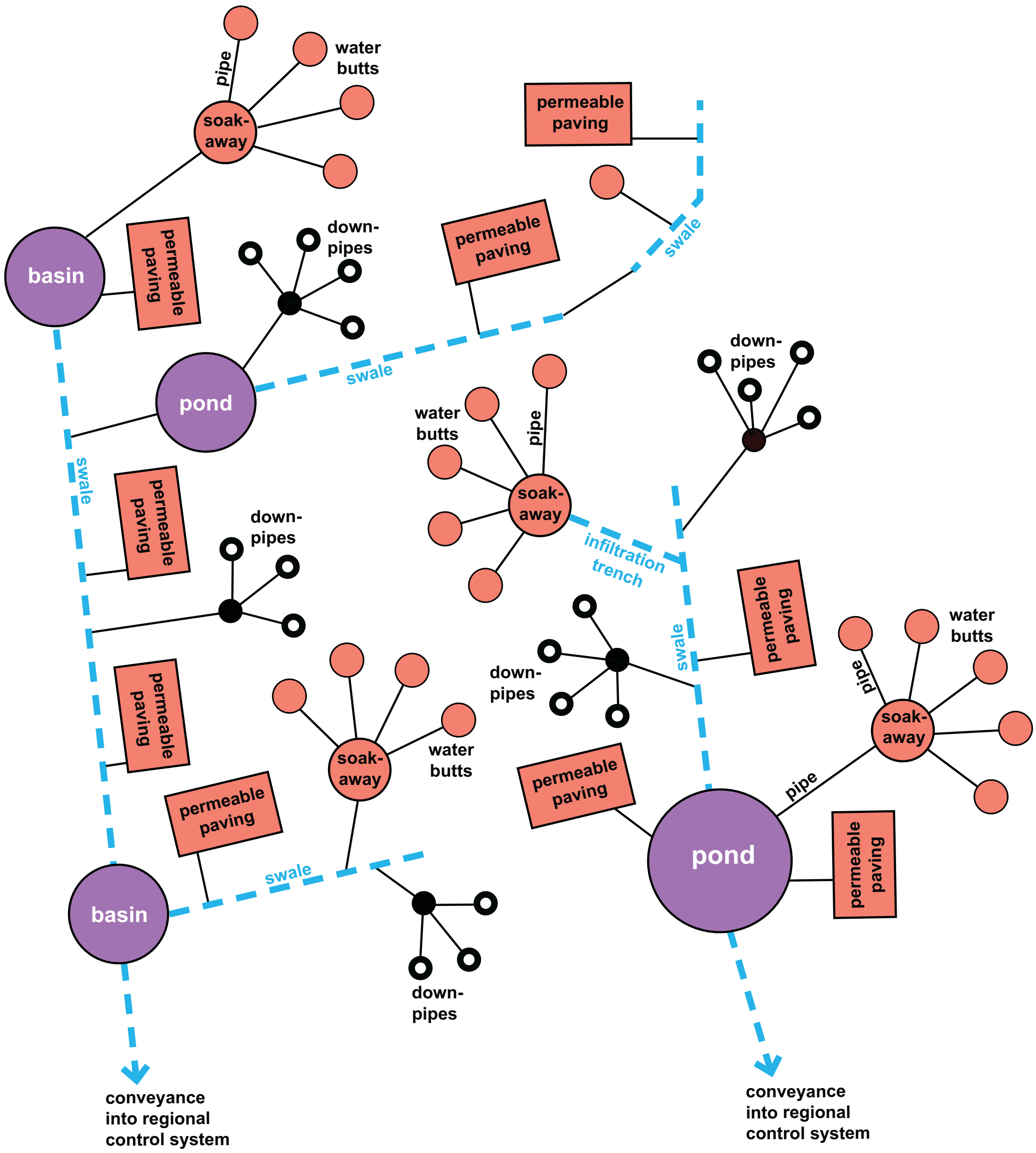


Figure 5.2.9: Shirebrook Phase 1 SUDS strategy in diagrammatic terms

Comparing the costs of the strategies

Vital to the perceived benefits of adopting this approach, this site-wide neighbourhood design option was tested against other methods of achieving the same objectives. These are described below and each are placed in a table of comparative capital costs (Figure 5.2.10).

Surface water

As with the Middlemore site, the SUDS strategy is cheaper to build than the other two options. The single phase investigated in more detail (phase 1) in figure 5.2.8 shows the intended flow directions of surface water into the two ornamental water stores. This strategy allows this 50-home module to attenuate water in swales before conveyance to the regional control features further to the South of the Shirebrook site down the central spine of regional SUDS control.

Residential waste

As with the Middlemore site, the main capital cost difference was the balancing of communal collection storage facilities and the addition or reduction of hardstanding.

In addition to this, the small scale in-vessel composter was added for the whole development. This could be implemented early on or could be added in a future phase. Three further elements have been costed:

- A Bring Site
- Grey water recycling units for individual housing units
- A communal grey water recycling unit

The strategy for waste collection for Shirebrook the same as that for Middlemore site and the ratio of cost is the same i.e. five times the cost of Middlemore, and therefore the saving of a communal bin system over traditional individual bins is approximately £217,500. There is however the addition of a “bring” site and in-vessel composter on the larger site.

With a larger site the inclusion of a “bring” site is feasible and would represent an initial cost of £3000 but there would be no further maintenance costs as the bins would be supplied by the Local Authority, waste management company or third sector organisation responsible for the collection of recyclables.
Inclusion of an in-vessel composter would cost approximately £19,000. This cost includes the composting unit housed in a secure building with connection to electricity and water. The ongoing costs would be the responsibility of either the community group managing the facility, a Local Authority or facility management company. Ongoing running costs could be reduced by using renewable energy, rainwater harvesting and potential income from the sale of compost.

The inclusion of communal greywater recycling on the Shirebrook site would provide a cost saving of £25,000 in comparison with the installation of individual units in houses. Costs given include a central storage and treatment plant and supply to individual houses. At Shirebrook, five units would be used rather than one larger unit, as manufacturers are not currently recommending one single system to serve all 250 dwellings due to maintenance issues. There would be a possible reduction in costs if orders for recycling units were placed for all five phases from the outset.

Operational energy

The district energy strategy was tested for a number of variations in terms of phasing, the mix between houses and flats, and boiler size to demonstrate the difference in capital costs. In summary, the greater the number of flats, the higher the density of development, i.e. the higher the density the lesser the distance of pipes and trenches required. Hence, the higher density development should be cheaper than many detached dispersed homes.
All options assume 5 phases of 50 units in the six options that were reviewed.

- Options 1-4 show the various energy centre boilers scenarios. These show that the cost per dwelling inevitably reduced compared to the Middlemore district heating (which cost £17,780 per dwelling) as there was only one energy centre required
- Option 5 shows the micro option that was tested to illustrate a comparison against the district heating. It comprises Conventional Gas condensing boiler + PV + 2.75 kWp Photovoltaics (22m^2 of roof space) + 4m^2 solar thermal panels, and was more expensive than the macro options overall
- Option 6 shows the result of building one energy centre per phase of development. This was clearly the most expensive option due to the cost of the energy centre buildings

Figure 5.2.10: A cost comparison

WATER	Total Capital Cost (£)	Cost per Dwelling (£)
"Full SUDS"	855,000	3,420
Traditional Drainage solution	875,000	3,500
Semi Engineered SUDS - "End of pipe"	1,190,000	4,760

WASTE	Total Capital Cost (£)	Cost per Dwelling (£)
Individual bins (including additional road construction	375,000	1,500
Communal bins	157,500	630
Small scale In-vessel composter (installation cost & enclosure only)	19,000	76
Bring Site	3,000	12
Grey water recycling - individual	200,000	800
Grey water recycling - communal	175,000	700

ENERGY	Total Capital Cost (£)	Cost per Dwelling (£)
Option 1 - 250 units (Houses) - 5 nr. 150kW Boilers + 1.6kWp PV per unit	3,945,000	15,780
Option 2 - 250 units (Houses - 70%/ Flats - 30%) - 5 nr. 150kW Boilers + 1.6kWp PV per unit	3,593,250	14,373
Option 3 - 250 units (Houses) - 1 nr. 600kW Boilers + 1.6kWp PV per unit	3,795,000	15,180
Option 4 - 250 units (Houses - 70%/ Flats - 30%) - 1 nr. 600kW Boilers + 1.6kWp PV per unit	3,443,250	13,773
Option 5 - Gas condensing boiler + 2.75 kWp Photovoltaics (22m^2 of roof space) + 4m^2 solar thermal panels	4,137,500	16,550
Option 6 - Five separate energy centres and district heating systems (one per phase / neighbourhood module)	4,445,000	17,780

6.0
Why do it?

6.1 Benefits and challenges

Sustainable neighbourhood developments provide more attractive places to live, which is often reflected in the sale prices of new homes in those neighbourhoods. High quality environments simply attract higher house prices, and this has been demonstrated in many developments in the UK and abroad. In social and cultural terms, new approaches to sustainable infrastructures often means community hubs are created, which can provide significant educational benefits.

The approach integrating water, waste and energy will result in a more holistic solution for the developer, and should create potential cost and time savings from having a co-ordinated team. The methodology for developers undertaking these sites proposed is to:

i. Define the vision and aims of each member of the project team

ii. Foster an environment for inspiration and creative thinking. Each party will have many valuable experiences to bring to the projectCreative thinking should be informed by - but not constrained by - wider legislation such as the Code for Sustainable Homes

iii. Carry out analyses of the site(s), appraising opportunities and constraints. This should include reviewing the "baseline" data for sites, which will involve the wider review of energy, waste and water infrastructure.

iv. Develop a "matrix" of solutions which should cover the three infrastructures and their outline costs.

v. On developing a short-list of design options, the solutions should be re-tested in more depth to consider a broader range of concerns. These would include: discussions on site capacity, density and phasing; streetscapes and place; and of course deliverability in practical and cost terms.

vi. Once preferred solutions are chosen, work through them with relevant support.

A key benefit in adopting a sustainable approach is that it demonstrates to the local planning authority that delivering a high quality place is the driver essential to the planning process. Sustainable developments become positively received and therefore marketable case studies - key to the process in bidding for future projects.

In terms of surface water, these guidelines have shown how important it is in design terms to consider water issues early, and in doing so open up capital cost benefits. The financial benefits shown here don't include the extra factor colloquially known as the "pond premium" for properties in or near water environments. While there are clearly no hard and fast rules, various research has shown that a premium of 5% up to 30% was possible for homes with a view of a well designed pond or wetland, with an average premium of about 10%. The premium also appears to hold up well upon reselling.

Figure 6.0.1: The "pond premium" in Freiburg, Germany

In terms of waste management, there are significant achievable savings through the inclusion of communal recycling collection systems on both small and large scale sites. Provision of a bring site and an in-vessel composter does not provide a financial saving to the developer but greatly improves the sustainability of the development and inclusion may benefit planning applications where such issues are taken into account. In this masterplan the investigation included a bring site and composting facility on the Shirebrook site, because it is assumed that these sites can be developed adjoining another development or an existing community who can benefit from their inclusion. Therefore it may be applicable to include a bring site or composter at a housing density much lower than 250 houses.

The stakeholder benefits are shown in figure 6.0.2 and the advantages, challenges and system requirements for each waste management option are shown in figure 6.0.3.

Stakeholder	Benefits
Developers	• Improved reputation through acknowledgement of sustainable design and satisfaction of residents • Code for Sustainable Homes credits met
Local Authority (planning)	• Improved ability to see the context of the development in terms of sustainability facilitating assessment against criteria
Local Authority (waste management)	• Improved efficiency of waste collection and increased recycling rates • Reduction of amount of organic waste to collect • Improved ability to increase number of waste fractions collected in the future without resident disapproval • Better health and safety for collection crews
Residents	• Improved satisfaction with service provision • Improved amenity and safety • Increased willingness to recycle/ compost • Community initiative to get involved in (Participation/education/training/experience) • Reduced water use and reduced water bills
Wider community	• Better waste recycling facilities • Community scheme to get involved with (Participation/education/training/experience) • Improved aesthetics
Environment	• Increased recovery of resources (recyclables) • Better contribution to wider agenda on waste management through improved contribution the waste hierarchy • Facilitation of waste taken to be used for EFW where possible with associated benefits (CHP) • Reduction in water use and therefore reliance on centralised water management infrastructure

Figure 6.0.2: Stakeholder benefits for each waste management option

Figure 6.0.3: The advantages, challenges and system requirements for each waste management option

Management option	Advantages	Challenges	System requirements
Communal bin storage	Reduces footprint required for bin storage areas by reducing the amount of bins required Allows more efficient collection of waste and recycling Improves amenity by providing good design appropriate to environment Simple and easy to use system for disposal and recycling Adaptable for different collection systems Encourages participation in recycling through co-location of recycling bins with residual bins	Noise from bins being used disturbing neighbours Possibility of vandalism to storage units Individuals not using the recycling system appropriately so preventing other from doing so Limiting refuse truck access can limit residential private vehicle access and this needs consideration in the strategy	Design storage areas for easy access for residents and collection crews Use plastic bins not metal Road layout to reduce collection vehicle movements Designed to enable efficient collection of bins Design enclosure to reduce noise through use Use materials that are not easy to vandalise and make the units secure and well lit Position along desire lines (where people would naturally walk or go to the shops etc...) and where natural surveillance can be achieved Ensure there is adequate capacity for recyclate and residual to avoid contamination and side waste issues and to fulfil Code requirements Ensure the Local Authority will support the system and get their input at initial design stage
Bring site	Allows residents to recycle more materials than they can through kerbside collection Provides an amenity for wider community	Noise from bins being used disturbing neighbours Possibility of vandalism to storage units	Position area for convenient use by residents in new and established communities and in an area convenient for collection vehicle Position facilities so not to cause disturbance to residents Ensure that area is designed in keeping with local aesthetics and only use receptacles of good design
Automated systems	Provides a convenient waste collection system reducing the need for bins or dedicated storage areas Provides a bulking up of materials so taking collection vehicles away from residential areas Aesthetically appealing design with minimal intrusion into the development Encourages source segregation of recyclable materials	Possibility of vandalism to system Blockages may be difficult to remove and would stop the system being used where present No way of identifying who is recycling and who is not so making targeted promotional campaigns difficult	Convenient positioning of recycling points for residents Installation of significant underground infrastructure during development Ensure the Local Authority will support the system and get their input at initial design stage
In-vessel composting using a community composting scheme	Reduces the amount of green and food waste being collected by Local Authority Provides a community focus on waste and possible third sector involvement Produces a soil improver for the community or a saleable compost	Odour control where process is not being used properly Community not wanting to be sufficiently involved Competition with established Local Authority green waste collection systems	Well positioned composting centre which is close enough to houses to allow easy collection of waste but far enough away that the operations do not disturb residents A secure building with water and electricity Integration with Local Authority collection systems from the outset
Grey water recycling	Reduces volume of water used by householders Reduces water bills for usage and sewage Reduces the communities reliance on centralised water provision	Can be expensive to install and maintain Biological systems require specialist engineers Land take large for biological systems reducing available land for development	Plant needs separate piping system which must not contaminate potable water Communal plant requires convenient location on development and a management company to take control once in use Biological system requires appropriate land for treatment

Figure 6.0.4: The benefits of the Feed in Tariff and Renewable Heat Incentive for each option

ENERGY OPTION	Capital Cost per Dwelling (£)	Annual Benefits (£) *FiT and RHI*
Middlemore MACRO (50 houses)		
Option 1 – PV and biomass district heating	17,780	647.70
Middlemore MICRO (50 houses)		
Option 2 – PV and ground source heat pump	25,340	879.80
Option 3 – PV and air source heat pump	19,000	1,186.90
Option 4 – Gas, PV and solar thermal	16,550	1,086.56
Shirebrook MACRO (250 houses)		
5 x 150kW boilers and PV (Option 1)	15,780	487.32
1 x 600 kW boiler and PV (Option 3)	15,180	487.32
Shirebrook MACRO (250 units – 70% houses/30% flats)		
5 x 150kW boilers and PV (Option 2)	14,373	487.32
1 x 600 kW boiler and PV (Option 4)	13,773	487.32
Shirebrook MICRO (250 units – any mixture of houses / flats)		
e.g. PV and ground source heat pump	22,808	879.80

In terms of sustainable energy, a district approach may well be more cost-effective than many “micro approaches”. Even for the options that resulted in the higher capital costs, e.g. the synergy between ground source heat pumps below permeable paving, there is clearly a potential benefit of higher densities as the SUDS and the energy issues are addressed together.

A big driver for step change in sustainable energy generation is the Feed in Tariff (FiT). A model where the developer wishes to keep the price of homes as low as possible, is for them to consider installing sustainable electricity generation technology, funding the capital costs themselves but then benefiting from a guaranteed income stream to produce a return on their investment. The renewable Heat Incentive (RHI) set to be active in April 2011 should have a similar effect on sustainable heating supply.

Income streams for each of the energy options illustrated on the two sites have been calculated in principle and are shown in figure 6.0.4.

Summary:

There are a growing number of challenging policy drivers, and those that do not adapt to changing legislation or make use of the appropriate technical expertise will soon be at a disadvantage. As the deadline of 2016 approaches for “Zero Carbon” homes, this document aims to support the developer by describing some of the options available that can help comply with changing legislation, whilst potentially offering capital cost savings.

These guidelines have demonstrated that different approaches do exist for creating sustainable neighbourhoods, and that considering these can bring multiple benefits for all involved in new developments. One of the key challenges is to appraise the entire development process - from design to occupation and maintenance. The other is to achieve buy-in from all parties. Once those are achieved, it will be straightforward to see that sustainable neighbourhoods are the future.

7.0
Lessons Learnt

The aim of these guidelines was to demonstrate the benefits of integrating site-wide sustainable infrastructure by illustrating flexible solutions to develop innovative, small-scale residential development sites that are sustainable in all senses - cost-effective and deliverable. The approach encouraged is that of interdisciplinary working, and the emphasis must be on collaboration to undertake this challenging task. Isolated design work cannot result in good design, hence the methodology should integrate all members of the design team from the beginning.

One challenge faced was integrating flexibility and wider applicability whilst ensuring that the quality of “place” in its context is respected and essentially enhanced. Low-carbon design is possible on the individual house scale and this document shows that in design terms, low-carbon, high-quality, commercially-viable construction is possible at this neighbourhood scale.

The next challenge is to test this approach against full private sector market conditions and to address the issues of design, delivery and maintenance during occupation using new models of development management.