Appendix 11
Sustainable design guidelines for the islands

Contents Page

1.0 Sustainable development and design

1.1 Concept of sustainable development

Sustainability is a key national issue. The government recognises that New Zealand's future prosperity depends on long-term sustainable strategies for the economy, society, culture and environment.

Sustainable development has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Report, 1987). This means achieving economic, social, cultural and ecological sustainability.

These four components of sustainablitity are briefly outlined below.

Economic sustainability

Is maintaining the economy into the long-term, it consists of economic growth, decreasing unemployment and addressing the inequalities in the distribution of income or wealth.

An example of economic sustainability for the islands is producing goods and services on the island, including tourism services, and maintaining employment opportunities.

Social sustainability

Is providing and sustaining the opportunity for all individuals to participate and belong to their local communities and the wider society. It requires the provision of opportunities for work and involvement in the community.

An example of social sustainability for the islands is maintaining social interaction within the community.

Cultural sustainability

Is maintaining and ensuring diversity and equity between different groups, and retaining and valuing the knowledge held by all groups.

An example of cultural sustainability for the islands is recognising and providing for tangata whenua as well as retaining their knowledge and history.

Ecological sustainability (also known as environmental sustainability)

Is maintaining and enhancing the capacity of our natural resources to supply environmental goods and services for people and nature.

An example of ecological sustainability for the islands is development that provides for human needs that does not impair the quantity or quality of non-renewable resources or the health of ecosystems.

1.2 Climate change

Climate change is another key national issue that highlights the importance of sustainability.

What is climate change?

Climate change is the recognition of changing climate patterns that are beyond natural climate variations observed over comparable time periods. There have been, and always will be, natural climate variations, however the changes over the past 10,000 years have generally been gradual thereby allowing people, plants and animals to adapt.

Over the past 50 - 100 years human activities and industrialism have begun to affect our natural climate balance. These activities are increasing the amount of greenhouse gases in our atmosphere which is contributing to the Earth heating up at an unprecedented rate. This effect known as “global warming” will affect our weather patterns and climatic conditions, hence we refer to it as climate change.

What are the threats to islands?

Climate change poses a serious threat to our collective environment, economy and well-being. One of the most significant potential effects of climate change is rising sea levels. The Hauraki Gulf islands are extremely vulnerable to an increase in sea levels.

Rising sea levels will have effects on fresh water supplies, agricultural and horticultural activities, and residential development and infrastructure near the coastline. Many of the islands’ infrastructure and buildings are concentrated on the coast, making them vulnerable to rising sea levels.

1.3 Contextual information

How we address sustainability at an international, national and local level will determine the reduction in the effects of climate change.

International context

The United Nations Framework Convention on Climate Change is an international treaty that sets an overall framework for international efforts to tackle the global challenge of climate change. As of June 2007, 191 countries have ratified the convention, including New Zealand.

The convention recognises that the climate system is a shared resource whose stability relies on all of us.

A number of nations, New Zealand included, approved an addition to the convention – the Kyoto Protocol – in 1997. The Kyoto Protocol established legally binding emissions targets for industrialised countries and created innovative mechanisms to assist these countries in meeting these targets. New Zealand’s emission target is zero (Kyoto Protocol Reference Manual on Accounting of Emissions and Assigned Amounts). This means that New Zealand is aiming to stabilise its greenhouse gas emissions to its levels in 1990 and this must be achieved, on average, over the period 2008-2012.

National context

As a nation we have made a commitment to reduce our greenhouse gas emissions back to 1990 levels over the period 2008 to 2012. The government has recognised that we have to look further ahead than this first commitment period of Kyoto Protocol so that New Zealand can have long term measures in place to ensure our country is sustainable.

There are numerous government initiatives which will have an effect on climate change, for example the:

- draft New Zealand Energy Strategy
- New Zealand Energy Efficiency and Conservation Strategy
- Building Code review
- Minimum energy performance standards
- EnergyWise home grants scheme
- Warm Homes programme
- Communities for Climate Protection – New Zealand.

Local context

Auckland City Council has a leadership role which is paramount to Auckland achieving sustainability. The council has incorporated sustainability into its plans, policies, frameworks and strategies through empowering people to take personal responsibility and influencing institutions and communities to 'do the right thing' and bring about the changes required to develop a sustainable city.

Auckland City Council produces its state of environment report every five years. Within this report there is a section addressing climate change, which looks at the council's objectives and vision, pressures and issues facing Auckland city and council's response.

Islands' context

The Hauraki Gulf islands are in a unique position where they have a number of existing sustainable practices and currently accomplish sustainable outcomes. Examples of these include rainwater collection, onsite wastewater management and solar heating.

The islands have the opportunity to become an exemplar of sustainability – a model to the rest of Auckland, and to have a significant impact on the wellbeing of the community, economy and environment.

To achieve sustainable development in the islands essential tools such as sustainable design need to be adopted by the council and the community.

1.3 Concept of sustainable design

Sustainable design is using technologies, materials and the natural environment to meet current needs while minimising the use of non-renewable resources and the impact of human activity and structures on the environment.

Sustainable design looks at various aspects of a development in terms of energy consumption, efficiency of buildings, water sources, disposal of stormwater and wastewater, visual aspects of design, and the carrying capacity in the environment. In a wider context, sustainable design can look at alternative energy supplies to service the islands such as wind farms.

1.4 Importance of sustainable design

There is growing awareness of the need to manage our environment in a way which has the least negative impact on natural systems and other living organisms as well as providing the best possible outcomes for communities now and in the future.

Creating sustainable design in our buildings will enable the islands to become more resilient to the effects of climate change and other national issues, and less reliant on non-renewable resources, generating a greater wellbeing for individuals and communities.

How does sustainable design relate to climate change?

Fossil fuels are common non-renewable resources that are traditionally relied on in our buildings for heating, electricity and building materials. Combustion of fossil fuels creates emissions of greenhouse gases and exacerbates global warming.

Sustainable design seeks to reduce non-renewable resource use to lessen the effects of global warming.

An example is using passive solar design to reduce the amount of energy required to heat a building. The reduction in energy consumption reduces the greenhouse gases which are emitted when forming energy.

2.0 About the guidelines

These guidelines include a range of methods for achieving sustainable building design and construction that will result in better economic and ecological outcomes.

The guidelines provide a basic understanding of the most common sustainable design features and technologies available in the market.

As a working document these guidelines introduce sustainability issues with the knowledge that this is a constantly changing field. These guidelines are not intended to be a sole source of sustainable design information and the user is encouraged to go beyond this document to obtain full, relevant and up to date information. The guidelines contain further information sources, which should be used to gain more extensive knowledge on the matter, if required.

The guidelines assist applicants in investigating sustainable building design by providing a list of matters to consider under each of the three principal resources – water, wastewater and energy.

The guidelines are also intended to provide some direction for applicants and council alike where sustainable design criteria are required to be addressed in an assessment of environmental effects (AEE) as part of a resource consent application – part 11.3 and part 10a.18.8.

Auckland City is particularly grateful to Waitakere City Council for the use of content from their Sustainable Homes Guidelines in the preparation of this appendix.

3.0 Sustainable design - starting out

One of the fundamental aspects of sustainable design is to ensure that sustainable design matters form part of the initial design brief to your architect or designer. It is much easier to achieve better environmental and economic results by integrating design features at the start of the process rather than retrofitting existing plans.

3.1 The design context

Research

- Talk to people, look at books and trade magazines and access internet resources to find out about new practices and materials which may reduce waste.
- Visit demolition yards - second hand materials and components may offer better quality and character than new ones.
- Consult third parties, such as the council, to keep up with new developments and make informed decisions, and make use of any resources they have available.

Consult the project team

- Involve the whole team in the design, the owner, the architect/designer, the builder and sub-contractors.
- Ensure that all parties are clearly briefed at the outset that sustainable design is a key component of a particular project.
- Consider whether the choices are practical.
- Consider how the design can be tuned to minimise waste.
- Consider what works and what does not.
- Involve everyone so problems are identified and solved at the outset - the more innovative the design, the more important it is that everyone understands the objectives and contributes accordingly.

Study the site and surroundings

- Study the site and surroundings with resource efficiency in mind.
- Understand the features and limitations of the building site.

- Record microclimates, wind directions, sun angles, slopes, vegetation, soil types etc.
- Study the wider surroundings, take note of neighbouring buildings, roads, trees, etc.
- Have the architect or designer make a number of visits to the site at different times of the day and week.
- Study the site at different times of the day - observe the movements of the sun and when and where shadowing occurs.
- Consider where the wind is strongest and how the building will funnel or diffuse the wind.
- Think about what will change with the seasons - the sun will be lower in the sky.
- Consider access to light or heat from the sun on certain parts of the site.
- Consider whether there is a need to limit the footprint of any buildings on the site due to vegetation or other natural features.

Consider the size of the building

- Consider how large the rooms need to be.
- Consider how many rooms are needed.
- Use rooms for more than one purpose such as office/guest-room, or garage/workshop.
- Smaller buildings use fewer resources so a reduction in floor space provides an opportunity to save money and redirect it to increase quality.

Design for the future - picture the building in 10, 20 and 50 years time

- Provide for the use of the building to change with the needs of family and consider future uses.
- Choose materials that will last.
- Choose materials that will not go out of fashion and that can be disassembled and reassembled easily without damage.
- Construct a flexible building with durable materials so the costs of future repairs, alterations or demolition are less likely.

REBRI programme

- Resource Efficiency in the Building and Related Industries (REBRI) membership programme aims to reduce resource use and waste by sharing information and experiences New Zealand wide. Member companies commit to reducing resource use and environmental impact. To find out more call the Auckland Regional Council.

3.2 During the design

Harmonise buildings and structures with the surroundings

- Plan the building to minimise vegetation clearing and earthworks.
- Locate so as to reduce driveway length and paved surfaces.
- Consider piles or poles, especially on sloping sites, to avoid excessive excavations. Reduced disturbance to the land reduces waste and resource use. It also reduces environmental damage and the cost of clearing - usually with expensive machinery.
- Choose external colours that have a low reflectivity value and pick up on the hues in the surrounding environment.

Consider module sizes in the design

- Design room dimensions to co-ordinate with the size of prefabricated or modular floor, roof and external cladding panels. In New Zealand multiples of 600mm are used to match maximum stud width. Standard wall panels are manufactured at 1200mm wide by either 2400 or 3000mm. Designing to this module will mean fewer panels need to be cut, they're easier to fit and there's less waste, therefore reducing the cost of the building.

- Arrange window and door spaces to co-ordinate with the layout of studs to eliminate the need for extra studs.

Service efficiency

- Group wet areas, ie kitchens, laundries and bathrooms - together and make the hot water cylinder central to this group. Reducing the length of pipework will result in savings in labour and materials.
- Plan efficient circuits for electrical and telephone cabling.

Use pre-fabricated and pre-cut components

- Pre-cut and pre-nailed wall framing and roof trusses mean faster construction, no waste is generated on site and resource use is potentially more efficient at the factory compared with a building site, where off-cuts are often dumped or burnt.

Simplicity

- Make the design simple and user friendly.
- Find low technology solutions. Options that require training should be avoided. Simple solutions are less likely to require maintenance, are simpler to use, cost less and use fewer resources.
- Simple solutions depend less on people increasing their knowledge and altering their behaviour.

Use fewer finishes

- Use materials which do not need paint or other finishes applied to them such as natural wood ceilings, bricks and tiles, pigmented concrete or plaster, or pre-coated roofing steel.
- Where fewer materials are used, less work is required finishing and maintaining them. Paints and varnishes can be toxic so reducing their use means fewer health and environmental risks.

Keep a record of the design - 'building book'

Keep records of the design and all details throughout the building process - include information about:

- the location of the drainage, water pipes, studs, electrical cables. Less waste is created trying to locate leaking pipes or faulty cables
- the type and amount of insulation
- the names of the contractors or firms who made the installations
- all guarantees and warranties. The five-year consumer guarantee is more enforceable if defects can be identified accurately.

In this way alterations and extensions can be planned more cost effectively. It also means that potential buyers know what they are buying, and the market value of the building may increase if good design features are included and well documented.

This is a simple way to ensure that knowledge and records about the building are accessible over the lifetime of the building. This record should remain with the building when ownership changes to make maintenance and changes to the building easier for future owners.

Design for green living

Design buildings in a way that will make 'green' living easy.

- Allow space for the storage of recyclables and a compost pile.
- Consider how the design can influence the lives and habits of occupants.
- Look for areas for fruit and vegetable gardens.

Waste minimisation

- Considering resource use and waste generation during the design phase of a building project reduces our impact on the environment and can save money.
- Huge reductions in waste can be achieved through a change of attitude. Often waste minimisation options cost nothing to implement and give benefits straight away with little or no effort.

3.3 Finding the right people

Good contractors can give advice about the products they use and the maintenance of the building - this information should go into the "building-book" with their information and guarantees on the work undertaken. Maintenance advice will help to increase the life-span of the building while guarantees and documentation of work will assist present and future owners.

- Negotiate waste minimisation issues before contracts are signed.
- Consider asking contractors to supply a waste management plan with their bid. REBRI member companies are trained and committed to reduce waste.

3.4 The building site

Keep it tidy:

- Keep the building site tidy. Provide a covered storage area.
- Waste that can not be reused should be separated and recycled.
- Consider asking suppliers to take back packaging.

A tidy site is good for a building firm's image plus materials are less likely to be damaged or lost and safety is improved.

Central cutting areas

- Materials should be cut and their off-cuts stored at a central location. This technique has reduced waste by 15 per cent.

Reuse temporary works

- Reuse formwork for concrete or scaffolding. This is particularly useful when constructing identical buildings.
- Select durable materials for temporary works, such as metal so waste can be avoided.
- Re-use packaging where possible. Crates are better than plastic or cardboard wrapping.

Ordering materials

- Estimate materials correctly and arrange for them to arrive just in time. Lots of materials are wasted because they are damaged during storage.
- Do not plan for 10 per cent wastage as is often advised. If materials are over-ordered there is no incentive for contractors to use resources efficiently.
- Tell suppliers that you are committed to reducing waste and request that they do not over-package materials. If suppliers are asked to provide less packaging they will eventually do it due to increased customer demand.

Waste management

- Ask the waste contractor if they will provide a discount if waste materials are pre-sorted for individual collection. Some contractors may supply several small bins to make sorting easier.
- Or consider using a company that sorts waste after collection and sells on recyclable and re-usable materials.

Documentation

- It is important that work is documented 'as built' in the 'building-book', with special attention to those details changed from the original plans. Photos will help.

3.5 Further information

The Green Homes Scheme instituted by BRANZ (The Building Research Association of New Zealand) aims to promote sustainable building by accrediting participating architects and assessing building designs for a range of environmental, health and safety issues. Find names of participating architects in this area by contacting BRANZ or the council, www.branz.co.nz.

The Hauraki Gulf Islands Section of the Auckland City Waste Management Plan 2000, www.aucklandcity.govt.nz/council/documents/waste/default.asp

Waste Minimisation Advisor, Auckland Regional Council.

Resource Efficiency in the Building and Related Industries (REBRI programme), or access via ARC website - www.arc.govt.nz

Building Biology and Ecology Institute of New Zealand, www.ecoprojects.co.nz

Guiding Principles of Sustainable Design, www.nps.gov/dsc/dsgncnstr/gpsd/

Reduce Your Rubbish, www.reducerubbish.govt.nz/

Waiheke Rubbish and Recycling Guide, available from the council

4.0 Earthworks

Sediment is the most significant water pollutant in the Auckland region. The islands have a relatively high proportion of coast in relation to the land mass which means there is a greater likelihood of soil being picked up by rain and carried, via water bodies and water courses, to the sea. An exposed earthworks site can generate a thousand times more silt than an undisturbed site. A single rainstorm can erode up to four truckloads of soil from a building site. New Zealand weather is changeable and difficult to forecast, and many of the clay soils of the islands, especially on steeper sites are particularly vulnerable to erosion.

The larger sediments may settle out in stormwater cesspits or streams, where they contribute to ongoing flooding problems. The finer clay particles common in island soils may stay in suspension for weeks or even months, causing dirty water in our streams and harbours. Not only does this look ugly and cause public complaint, but it smothers plant and animal life, and permanently effects fish feeding and breeding areas - both in streams and in the rich mangrove and shellfish beds of the harbours.

4.1 The requirements

Regardless of whether the level of earthworks being undertaken is permitted by the Plan, those carrying out earthworks are required to take measures to prevent soil loss and erosion. The Plan defines earthworks and incorporates rules for each of the land units and settlement areas. The level of permitted earthworks in any given land unit or settlement area varies according to the landform and potential to affect or be affected by hazards.

4.2 Erosion and sediment control guidelines

As long as erosion and sediment control measures are carried out as described in **appendix 16 - Erosion and sediment control guidelines for earthworks** (and summarised below), you can excavate up to the permitted level without obtaining resource consent.

All other earthworks that sit outside of these levels require resource consent from the council. For large scale earthworks you may also need a resource consent from the Auckland Regional Council (ARC). The ARC has comprehensive guidelines (Technical Publication No. 90) which are helpful for larger projects.

4.3 Further information

Erosion and Sediment Control Guidelines for Earthworks, Technical Publication No 90, Auckland Regional Council, www.arc.govt.nz

Environmental Impacts of Accelerated Erosion and Sedimentation, Technical Publication No 69, Auckland Regional Council

New Zealand Water and Wastes Association, www.nzwwa.org.nz

Sustainable Development For New Zealand Programme of Action, www.mfe.govt.nz/publications/sus-dev/sus-dev-programme-of-action-jan03.html

5.0 Energy

New Zealand's energy needs, while largely supported by renewable sources such as hydro-electricity and to a smaller extent windpower, are supplemented for peak flows by the burning of fossil fuels such as coal and oil. Reducing electricity use and converting to renewable energy sources reduces reliance on the use of carbon dioxide emitting fossil fuels for electricity generation.

By adopting sustainable energy sources such as solar and wind, it will enable the islands to become more self-sufficient and will help to reduce the effects of global warming.

Heating offers the greatest potential for energy saving in a business or home. The way most of us use electricity to heat is wasteful. Moreover home heating causes the highest peaks in electricity demand.

6.1 Building layout

The layout of the building can be designed for the sun, and results in the most cost-effective and environmentally friendly way to heat New Zealand buildings.

"Passive solar design" refers to the use of the sun's energy directly for the heating and cooling of living spaces. The building itself uses the natural characteristics of materials and air to take advantage of the sun's energy.

Light colours will reflect solar radiation while dark colours absorb. Transparent surfaces will transmit solar energy. The capacity of a surface to reflect, absorb or transmit solar energy depends upon its density and composition. Glass lets the sun's radiation pass straight through. When it hits a dark surface behind, the radiation is absorbed and converted into heat. The heat spreads to adjacent materials including the air, which is kept trapped inside by the glass. This is known as 'the greenhouse effect' - on a larger scale a similar thing happens with the earth's atmosphere.

Where heat or sunlight hits a solid surface, the thermal mass of the surface determines the rate as which the heat is absorbed and re-emitted. Heavy materials such as concrete, brick and tiling have high thermal masses that heat slowly and re-emit heat slowly. This has advantages for cooling slowly during the day and retaining heat in the evening as the air cools.

4.1 Laying out the building for the sun

- Check how much sun the building site gets. It is harder to design for the sun on south-facing slopes, areas exposed to winter winds, and low areas where cold air settles.
- Work out the path of the sun and plot the shadow patterns of trees and other obstructions on the site. The sun's path in winter is much shorter and lower than its summer path - midday sun in winter is about 30 degrees above the horizontal (see EECA's Energy Wise Design for the Sun)
- Think about the local micro-climate, especially the direction, strength, and frequency of prevailing winds, as this will affect the heating performance. Winds may be buffered or funnelled by local ridges and valleys - wind strength is highest at a saddle in a ridge.
- Design the building on an east-west axis so that there is a long north wall to catch plenty of sun.
- The north wall should have the most windows.
- The east side should also have plenty of windows for an early morning warm-up.
- On the west side, reduce the window area or use pergolas or trees to avoid late afternoon overheating.
- Think about how different rooms are used during the course of the day. For example the kitchen/ breakfast area may be located at the east end to catch early morning sun; living areas and family rooms to the north; lounge/dining at the west for afternoon and evening

light; and service rooms and garage to the south. Bedrooms need some winter sun to dry out moisture generated at night.

4.2 Gathering heat from the sun

The sun's heat can be captured in the building in three different ways:

Direct heat is gained by exposing rooms to direct sunlight, which warms up the air and also surfaces where the heat can be stored. This method is the most appropriate for much of New Zealand where there are no extremes of very hot days and cold nights. Living spaces should use north-facing windows, in combination with thermal mass and good insulation.

Indirect gain is useful in the situation where opening up living spaces to the north is not desired. The sun's radiation penetrates through insulating glass into a thermal mass, such as a concrete wall, which stores heat for re-radiation into the rooms behind it.

Isolated gain allows rooms to be heated at a distance from where the heat is collected and stored. The stored heat can be drawn through into the rooms by a variety of methods. A conservatory is an example of isolated gain.

Solar gain checklist

- Ensure that north windows will allow direct sun onto thermal mass for six hours on a sunny winter's day.
- The area of north-facing glazing should be about 10-20 per cent of the building's floor area (calculate the area using EECA's Energy Wise Design for the Sun manual to balance the rate of heat loss (dependent on insulation) with thermal mass and local climate).
- Windows on east or west walls would ideally be 2-5 per cent of total floor area.
- On a south wall windows should be the minimum necessary for adequate ventilation and light. Consider the use of clerestorey windows (above the roofline) to bring sun and light into south- facing rooms.
- For a complex building design, or on a south-facing slope, consider a mix of passive solar systems, using direct, indirect and isolated heat gain where each is appropriate.
- Eaves or other overhangs prevent overheating by the high summer sun. The average window works well with a 400-500mm overhang, while glass doors require 700-900mm depending on wall height and orientation.
- Be very careful with the design of a conservatory. It is likely to overheat in summer unless ventilation and shade are provided, and on winter nights it could leak considerable heat if it cannot be sealed off from the rest of the building. The value of a conservatory is in the quality of living space it offers - ensure that it is also thermally efficient, not a thermal drain.

4.3 Storing heat from the sun - thermal mass

Some materials can store large amounts of heat energy as they have a high thermal mass. Examples are concrete or earth floors (rather than timber). A dark surface (eg paint, tiles, slate) will help the absorption of heat into the thermal mass.

Buildings with little thermal mass rely on direct sunlight and warm air to achieve comfort. Air is a relatively inefficient heat store, so once the sun is gone and the air cools down, back-up heating to maintain the level of comfort may be required. If the floor and walls are cold a higher air temperature is required to achieve the same comfort level. Boosting the air temperature in this way costs more and results in dry stale air.

It is healthier and more economical to allow a lower air temperature and achieve the same feeling of warmth from the heat radiated by warm building surfaces.

Solar heat storage checklist

- Choose or create site conditions suitable for a solid concrete floor for solar heat storage. The floor offers the best opportunity for thermal and economic performance.
- A concrete floor slab should be at least 100mm thick, exposed to direct sunlight, dark in colour, and insulated underneath.

- A masonry wall (eg brick, concrete, block, etc) should be 100 to 150mm thick, and insulated on the outside.
- Avoid covering up thermal mass floors with carpet because it reduces the rate of heat absorption. Use moveable rugs in places that people sit.
- Avoid air cavities in thermal mass (eg fill concrete block cavities).
- Avoid thermal mass walls in shady areas unless they are well insulated. They lose heat to the outside without the benefit of absorbing the sun's heat.
- Internal thermal mass walls are better than external as they don't lose heat to the outside - however external walls will usually get more sun and offer the most practical solution.
- A thermal wall of half height will offer some thermal storage while still allowing a view.
- A thermal mass wall as a feature wall is a great option. Build it with ornamental stone, artistic earth or patterned bricks.

4.5 Moving the heat around checklist

Once the heat is in the building, it is important to think how the heat might be moved about, so that other heating sources are not required. This transfer of heat might be achieved through the use of a number of different methods:

- Direct the sun's heat to the areas of the building where it is most needed. It is not necessary or economical to heat all rooms to the same temperature. Design for the sun to heat floors at lower levels of the building so that the air can rise naturally to higher living areas.
- Think through the way heated air will travel from the ground floor to a mezzanine or first floor, and also from the high wind pressure side of the building to the low pressure side.
- Consider how natural air circulation loops can be controlled using vents, hatches, internal windows, doors, ducts or stairwells.
- With high ceilings use reversible ceiling fans to overcome the temperature stack effect by pushing warm air down in winter but drawing it up in summer.
- Avoid glass ceilings or sky lights. They tend to overheat in summer and lose heat badly in winter. Vertical windows like clerestories offer better performance, because they let in more of the low- angled winter sun than the unwanted summer sun. If a skylight is necessary for light, fit it with ventilation, shading and double glazing to improve its thermal performance.
- If a back-up heating stove is required, locate it near the centre of the building and direct its heat into rooms that have no direct access to the sun.
- A thermo-siphoning collector panel applies the thermal chimney effect to generate heat-balancing convection and radiation in a window space. It is only applicable where light or a view is not desired.

Fresh air ventilation checklist:

- Opening windows and doors should make up at least 4-8 per cent of external wall areas to provide for ventilation.
- Ventilation openings for internal walls need be only half the above percentages.
- Consider the use of a heat recovery ventilation unit to warm incoming air.
- To reduce condensation on windows use joinery with permanent or manually controlled ventilation built in, or alternatively, double glazing.
- Consider thermostatically controlled ventilation for living areas.

A heating plan

The most energy efficient heating is by passive solar design (see **4.0 Designing for the sun**) and the most energy efficient cooling is by designing for natural ventilation. In the Auckland climate it is possible to design a building that can achieve comfort with little or no need for supplementary heating.

- Aim for different temperature zones in the building.

- Cater to different requirements - ie heat the study not the laundry.
- Heat the bed not the bedroom - unless it is for an asthma sufferer.
- Place the main heating source in the centre of the room/building - not against an outside wall where heat is likely to leak straight out.

A central position will reduce heat loss, store heat in the floor and walls, and circulate warmth more effectively throughout the building.

Heat will move naturally from a lower room in the building to a higher room. With a high ceiling use a reversible ceiling fan to push the warm layer of air back down to people level (and in summer it can help keep the room cool).

4.6 Generating your own electricity

There are many options for renewable energy generation, which help to reduce your contribution to global warming and reduce energy costs.

Photovoltaic (PV) systems

Photovoltaics (PV) are solar panels that generate electricity. A PV system uses solar panels, which contain a semi-conductor material that creates an electrical current when the sun shines on it. Photovoltaic systems can either be connected to the local lines system giving a backup supply for when the sunlight hours are not enough and gives the opportunity to sell electricity back to your power retailer at times when you generate more than you need; or run as a standalone system. (Smarter Homes)

Wind turbines

A wind turbine is worthwhile if the wind is reasonably strong and steady. The amount of power generated from a wind turbine depends on the system, the location and the average wind speed.

A small 1kW wind generator can produce about 12kWh per day in high average wind speeds of 10 metres per second, and just 0.7kWh per day on sites with low average wind speeds of 3 metres per second. The average New Zealand household uses about 27.5kWh per day.

A backup system such as photovoltaics is needed for when the wind is not blowing.

Wind turbines are more suitable for non-urban areas due to the space they take up, the noise they create and the higher wind speed out in the open without effects of turbulence caused by obstructions. (Smarter Homes)

Micro-hydro systems

A micro-hydro system is an environmentally friendly alternative to local lines. It is only suitable for rural properties that have a stream with a reliable flow and works best if:

- the stream runs all year
- the stream doesn't flood
- the slope is reasonably steep
- there is a reasonable static head.

Static head is the vertical distance (in metres) between the water level at the intake and discharge point.

A micro-hydro system can generate 1kw - 10kw which is generally sufficient to power a single property depending on the power usage patterns.

Building and resource consents may be needed for water use and any structures built.

Further Information

Smarter Homes, www.smarterhomes.org.nz/energy/generating-your-own-electricity/

6.3 Landscaping

The use of landscaping will assist in cooling the building in summer. This is a more sustainable way in managing the temperature of the building as opposed to automatic controls.

Using shade and breezes - site planning checklist:

- Use existing natural elements, and take advantage of the varying characteristics of shrubs and trees, to modify the micro-climate of the site.
- Plant deciduous trees to the north to give shade in summer and sun in winter.
- Consider the timing of the leaf season to coincide with the heating season, and also the density of branches and how that may affect sun and wind shelter.
- Select and locate plants carefully and consider the shadow that will be cast when the tree reaches its full height and canopy spread.
- Avoid a building shape that shades itself on the north side.
- Protect the building from the cold south-westerly, but open it up to the cooling effect of the warmer north-easterlies. These are Auckland's prevailing winds, but check how local hills and vegetation may change the prevailing wind for the site.
- Cluster evergreens to the south of the building for year-round wind shelter. A garage, which doesn't need sun, may also offer wind protection from the south.
- A diffusing screen (like a hedge) will give better wind shelter than a solid one like a wall, which causes turbulence and gusting.
- Create outdoor areas that provide shelter from different wind directions. Aim for a choice of shade in summer and sun in winter.
- Think about glare and reflected heat from sealed outside surfaces like driveways. Can the sealed area be reduced? Would the surface cooling effect of a pond or moist vegetation help?
- Where solar panels are used for generation or water heating, make sure they will always have full sun.
- Use large eaves that provide shade and cooling in summer when the sun is overhead, but allow the lower winter sun to heat internal surfaces.
- Base the landscaping plan on good design principles and a respect for the local ecology (see Greening Our Gulf Islands by Don Chapple et al.).

10.0 Building materials

Choosing a building material involves a number of sustainability issues:

- Will its end use be energy efficient?
- Is it a good insulator?
- How much energy went into its production?
- Does its production cause pollution or damage to the environment?
- What are the visual impacts of its production and processing?
- At the end of its life can it be disposed of safely or recycled?
- Is it a health risk in your building - does it release gases?
- Will it contribute to a healthy allergen-free indoor environment?

10.1 Timber

Timber is the primary building material in New Zealand. It is relatively cheap and the building code makes designing with timber easy. Although other materials are now more commonly used for some building components (aluminium for window frames, fibrous cement for cladding) the bulk and the structure of most of our dwellings are still timber.

- Timber is a renewable resource, produced by solar energy.
- In New Zealand structural timbers are supplied from plantations occupying less than five per cent of our land area.

Because the process of growing a tree soaks up carbon dioxide, timber is the only building material that has a beneficial rather than negative impact on the greenhouse gases in the earth's atmosphere providing that forested areas are replanted after logging.

Each year an acre of healthy growing forest produces up to 7 tonnes of new wood, releases about 8 tonnes of fresh oxygen, and consumes about 10 tonnes of carbon dioxide.

From a sustainability perspective, consideration needs to be given to:

- Where does the timber come from?
- How is it preserved?

Timbers grown in New Zealand plantations require less energy input to get to the building site, and you can be more confident of their origin. Sustainably produced tropical timber is now available through some New Zealand timber merchants; look for certification from the Imported Tropical Timber Group (ITTG) - a partnership of industry and non-governmental organisations.

As consumers we now have a greater choice of sustainable plantation timbers that do not require chemical treatments before use.

Table 4: Sustainable plantation timbers suitable for various end uses

Uses	Suitable timbers	Comments
Exterior joinery and weatherboards	Cypresses and NZ redwood, radiata pine (H3 treated)	All heartwood
Decking	Cypresses, stringy bark eucalypts and eastern blue gums, radiata pine (H3 treated)	All heartwood
Structural (protected)	Cypresses, douglas fir, radiata pine (H1 treated)	All heartwood
Engineering (external beams and cross arms)	Stringy bark eucalypts and eastern blue gums	
Roundwood	Stringy bark eucalypts and eastern blue gums, radiata pine (H4 - H5 treated)	
Garden uses	Stringy bark eucalypts and eastern blue gums, radiata pine	15 - 20 year life
Furniture	Cypresses and radiata pine, all nominated eucalypts, blackwood, black walnut	Moderately soft timbers, choose colour, high quality
Veneer	Same species as furniture	
Turnery	All nominated eucalypt species, blackwood, radiata pine	

Timber preservation

Rot (a process of fungal decay) and attack by insects or vermin pose problems for timber construction. As the softwood, radiata pine, became our dominant timber species however, we became reliant on heavy chemical treatment of the timber to prevent rot. Per capita, the use of treated timber in New Zealand is the highest in the world. There are, however, alternatives to chemical treatment.

Natural resins: Some timbers have a high resin content and thus are resistant to vermin and rot - for example totara, which was traditionally used in New Zealand for piles. Commonly available plantation grown timbers include (with progressively greater natural protection from rot): Douglas fir, eucalypts, Lawson cypress and macrocarpa.

Kiln drying: The organisms that cause decay in timber depend on a certain level of moisture. That's why pinus radiata rots quickly when it is in permanent contact with the ground. An alternative to chemical treatment is to sterilise and stabilise the timber by kiln drying. When kiln-dried to the appropriate moisture level radiata pine can then be used as a framing timber without the need for chemical treatment. It must be kept dry in transport and storage, and the walls can be closed in as soon as the frame is up. This saving in time - especially in winter - often outweighs the extra cost of kiln-dried timber.

Heartwood is more resistant to rot than sapwood. Another recent innovation is the development of a process that forces plant-based starch into radiata pine, converting it essentially from a softwood to a hardwood, harder than teak. The process increases the density, hardness, strength, stability, and machining properties of the timber, so it becomes suitable for traditional tongue and groove flooring.

Sheet materials: The most common flooring material these days is particleboard, mainly composed of wood chips. However the binder, which normally uses urea formaldehyde, causes health concerns because of the way it continues to give off volatile solvents.

Low formaldehyde products are becoming available in NZ - kitchen cupboards and furniture, though disguised by veneers, upholstery and other surface finishes, are also widely based on variants of particleboard such as MDF.

Another useful wood-based sheet material is plywood, which offers qualities of stability and strength unachievable in plain timber of the same dimensions. Ply veneers come from a myriad of forest sources (though radiata pine is the most common) and the glues that bind them also vary depending on the intended use.

Chemical treatment: The aim of chemical treatment is to coat or saturate the timber with a poison that kills any fungus or insects that may live on it. There are many different chemicals used for timber treatment - aimed at producing timber for different end uses. The treatment regime and chemicals are chosen to be appropriate to the intended end use, so it is important that they are used only for that purpose.

The Building Code identifies six hazard levels of moisture that timber may be subjected to. The appropriate treatment process depends not only on the hazard level, but on the nature, durability, treatability and condition of the timber itself. In the past there was a tendency to over-specify timber treatment to a level unnecessary for the situation.

CCA: The most common timber preservation in NZ is CCA (Copper Chrome Arsenic) commonly known as tanalised timber, it has a distinctive greenish colouration. CCA is a mixture of metallic salts composed of arsenic, copper and chromium, which protect wood from decay by microbes, fungi and wood-feeding insects. The treatment chemical is highly toxic but once chemically fixed to the timber it is inert.

Be wary of timber that shows surface wetness from excess chemicals or which has crystalline chemical deposits on it - buying timber with the Timber Preservation Authority's "Woodmark" brand guarantees that it has been processed in a modern treatment plant to the standards of MP360.

Typical uses for CCA treated timber include fenceposts, decking, playground equipment, and structural timber used where it will be in contact with concrete or the ground.

LOSP (light organic solvents preservative), is less toxic than CCA which commonly uses chlordane, permethrin and tributyltin oxide as fungicides and digestive insecticides. It is typically used for the H3 situation - timber which may be exposed to weather, but not ground contact, so it would be suitable for window joinery and weatherboards.

Boric treatment, used for H1 situations like wall framing, is relatively benign to humans although highly toxic to plants. Furthermore it does not chemically fix to the timber - but then it is blocked off inside the walls, until disposed of. It also acts as a fire retardant.

The use of treated timber raises more concerns about the beginning and end-points of the product life cycle than the period over which it is a component of your building.

Modern timber treatment often involves placing the wood in sealed pressure vessels where it is immersed in preservative and then subjected to applied pressure. The excess chemical is vacuumed from the vessel before the treated wood is removed.

Older plants though are far less sophisticated and toxic chemicals often enter the soil. There are hundreds of such sites around New Zealand, which are now virtually unusable for anything else, and cause ongoing problems of toxic chemicals leaching into groundwater.

The disposal of off-cuts and demolition timber is also an issue for some treated timbers. Exposed to organic acids (in swampy ground or soil with high humus levels, for instance) CCA treated wood will leach readily. CCA treated wood should therefore, be disposed of only in a landfill able to accept toxic waste. Never burn it, especially on a barbecue.

Table 5: Treated timber and alternative solutions

Common use of treated timber	Alternative Options
CCA - H4 tanalised poles and piles, etc (in ground contact)	• Use concrete piles or strip foundation. • Use recycled hardwood, eg Jarrah telephone poles. • Use concrete block retaining wall.
LOSP treated H3 weather boards, (exposed to weather)	• Use macrocarpa or eucalyptus. • Treat boards with low impact finish (CD50). • Paint and maintain boards with Telarc Certified Environmental Choice Paints.
Boric treated H1 timber framing (protected from weather)	• Use Douglas fir, Lawson cypress or similar species with natural resins. • Use kiln dried pinus radiata.

10.2 Plastics

Plastics are durable, inexpensive and lightweight and thus have become a popular building material.

There has been much debate in recent years, over the environmental cost of plastics. However, much of this is associated with the packaging industry and it should be kept in mind that the issues for buildings are quite different from those of packaging. Plastic building materials are not generally throw-away products, but last a long time, so the energy and environmental implications of using plastic in a building can be quite different from its use in packaging. At the same time, there are suitable, more sustainable materials available for many building applications and their use should be considered. The increasing trend towards the packaging of building materials should be resisted where this is possible.

Theoretically, plastics can be made from renewable resources such as casein (a milk product) or cellulose. In reality plastics are generally made from mineral oil - a finite and non-renewable resource - because it is cheap and readily available. One in ten litres of all refined oil is used in the plastics industry. The basis of all plastics is a high molecular weight polymer, which is inert and non-hazardous.

However, by itself this is unsuitable for structural purposes so additives such as antioxidants, ultraviolet light stabilisers, moulding and plasticizer compounds and fillers are added. It is these additives that might include toxic substances.

Plastics are generally very durable and will not break down naturally, although research into biodegradable plastics has begun. Some plastics can be recycled, but this requires considerable energy input and composite products (products made from more than one material) cannot be recycled.

Different plastics have different environmental impacts. Plastics are often made up from many different compounds, and additives are used to achieve the desired properties. Generally the more simple plastics - those with only one polymer and few or no additives - can be recycled more easily (PET, or polyethylene terephthalate, is an example of a plastic with a very simple structure. It has been suggested that theoretically it could be recycled indefinitely).

PVC

PVC, or polyvinyl chloride, was introduced in 1913. By the 1960s it had become the most important mass-produced synthetic material used. The monomer used to produce PVC is vinyl chloride, a highly toxic substance that is a recognised human carcinogen (causes cancer). All PVC articles will probably contain minute traces of free vinyl chloride. Like other plastics, PVC is combined with various additives to change its properties. In fact, PVC by itself is unstable and stabilisers are needed to make it usable. One common group of additives are plasticisers to make it more flexible. Concerns have been raised over the long-term health effects of some of these additives, although scientific evidence seems inconclusive. Building materials are also less likely to be chewed than children's toys, which have been the focus of much of the health concern over PVC.

Consider the beginning and end of PVC life cycle. Concerns have been voiced over the environmental effects of the production process of PVC, with risks of toxic waste generation, water and air pollution. Vinyl chloride is made from chlorine gas and ethylene (a fossil fuel product). Chlorine gas is highly toxic and ethylene dichloride is thought to be a carcinogen. The two are combined to make ethylene dichloride, then vinyl chloride, which is polymerized to make PVC.

When PVC burns, such as in a fire or during waste incineration, dioxins and furans can be released into the air. Dioxins and furans are some of the most toxic substances known. In Europe, concerns have been raised about the toxic smoke generated when PVC burns and particularly it's effect on rescue services, such as fire-fighters.

Polyethylene, polypropylene and polybutylene

The production of the plastics, polyethylene, polypropylene and polybutylene does not involve the use of chlorine as a base material. Chlorine is the component in PVC manufacture that causes most concern to some organisations and individuals. Therefore these alternative plastics are often suggested as environmentally friendlier alternatives to PVC.

Alternatives to PVC

If the preferred option is not to use PVC in the building there are alternatives:

Table 6: Alternatives to PVC

Purpose	Suggested material
Guttering and down pipes	Polyethylene, colour steel, copper
Water pipes	Polyethylene, polybutylene, polypropylene, copper
Waste water pipes	Polyethylene, polypropylene, clay, concrete
Drainage pipes	Polyethylene, clay, concrete
Drainage pipes	Polyethylene, clay, concrete
Electrical cables	Polyethylene, thermal plastic, rubber, nylon
Vinyl flooring	Linoleum, cork, tiles, concrete, timber
Blinds and curtains	Timber blinds, natural fabric (cotton)
Wallpaper	Ordinary paper
Cladding timber	Fibre cement, plaster

10.3 Paint

Many surfaces in the average building are painted - furniture, walls, ceilings, wooden floors, exterior cladding, roofs. Paints have been used for centuries to make surfaces more attractive, easier to maintain, or to protect them from the elements. Paints and finishes can extend the lifetime of some materials, such as weatherboards, dramatically.

On the other hand paint is often not needed to prolong the life of a material. Plaster, concrete, galvanised steel, brick, even many timbers in the right circumstances, do not necessarily need a protective coating. With good design such materials can look attractive in their natural state as well as reducing resource use and maintenance.

10.4 Earth building

There are now hundreds of earth buildings in New Zealand. Building with earth materials can be a way of helping with sustainable management of the earth's resources. Earth buildings avoid deforestation and pollution, and can achieve low energy costs throughout their lifetime - in the initial manufacture and construction, in their use as homes, and eventually in their recycling back to the earth.

Earth building is more time consuming than conventional design and construction, but for those who are providing their own labour, the time involved in earth construction may be less significant than the monetary cost of modern materials. Many people also value earth construction for its aesthetic qualities.

10.5 Further information on building materials

New Zealand Building Code, contained in the First Schedule to the Regulations, Department of Building and Housing website, www.building.govt.nz

Landcare Research, Sustainable Indigenous Forestry, www.landcareresearch.co.nz/research/biodiversity/forest/sust_forestry.asp

New Zealand Forest Owners Association, www.nzfoa.org.nz/file_libraries/sustainable_forest_management

Scion Research, www.scionresearch.com, see sustainable consumer products

Good Wood Guide FOE (NZ), www.converge.org.nz/gwg/

NZS 3604: 1999 Timber Frame Buildings, Standards New Zealand

BRANZ Bulletin 347: Using Kiln-dried MSG Radiata Pine Framing, Building Research Association of New Zealand

Properties and Utilisation of Exotic Specialty Timbers Grown in New Zealand, FRI Bulletin 119, Forest Research Institute

Properties and Uses of New Zealand Radiata Pine, Forest Research Institute

NZ Timbers: Indigenous and Imported - The Complete Guide, NC Clifton (GP Books, 1989)

Earth Building - Sustainable Home Guidelines, Waitakere City Council website www.waitakere.govt.nz

Earth Building Standards, Standards Association of New Zealand

NZS 4297: 1998 Engineering Design of Earth Buildings

NZS 4298: 1998 Materials and Workmanship for Earth Buildings

NZS 4299: 1998 Earth Buildings Not Requiring Specific Design

BBE manual No 9, Earth Building

Miles Allen, Out of the Ground: Earthbuilding in New Zealand

The Earth Building Association of New Zealand (EBANZ), www.earthbuilding.org.nz/

4.7 Further information

Energy Efficiency and Conservation Authority, www.eeca.govt.nz/

BRANZ - Building and Research Association of New Zealand, www.branz.org.nz

Building Biology and Ecology Institute of New Zealand, www.ecoprojects.co.nz

New Zealand Urban Design Protocol, Ministry for the Environment, www.mfe.govt.nz/publications/urban/design-protocol-mar05/html/index.html

Sustainable Development For New Zealand Programme of Action, www.mfe.govt.nz/publications/sus-dev/sus-dev-programme-of-action-jan03.html

Consumer Build, Passive Design for Energy Efficiency, www.consumerbuild.org.nz/publish/materials/materials-passive.php

Thermal Design Guide for New Zealand Houses, Conference Paper number 51, 1998, see 'Free Information / Publications', www.branz.co.nz

Glazed windows

Windows have a function of transmitting and retaining heat energy in our buildings. Glazing windows can have both beneficial and unfavourable effects on the vision and the quality of light we receive, depending on the type.

6 mm clear glazing (float glass) allows most of the visible light (87 per cent) to pass through, along with most of the radiant heat (83 per cent). However, it keeps most of the ultraviolet light out.

Tinted glass decreases light and radiant heat transmission. However long-term work behind tinted glass is a likely factor in "sick building syndrome". It can cause depression, a measurable loss of muscle strength, lowered resistance to colds and flu, and physiological disturbance.

Vertical blinds are useful where excessive light or glare is a problem, use them in conjunction with clear glass. This is more cost effective than tinted glass and more controllable by individuals.

Toughened glass will provide security where required. Laminated glazing will increase security further and will also allow for different glazing layers to further reduce both light transmission (as low as 7 per cent) and radiant heat transmission (down to 18 per cent).

Double and triple glazing allow maximum light transmission while dealing with the high conductive heat loss through a window by insulating with layers of air.

Further information:

Energy-wise Technologies: Improving Lighting and Reducing Energy Costs, Energy Efficiency and Conservation Authority

Light, Colour and Sound, BBE manual No 17, Building Biology and Ecology Institute, NZ)

Lighting up your Home: Your Guide to better Home Lighting, Philips

5.1 Insulation

Insulating the building will save energy and provide a healthier and more comfortable indoor environment.

How does it work?

Most insulation works by trapping air in cavities. The smaller the cavities of trapped air, the better the insulation material will perform. We can insulate our buildings by providing cavities of still air, such as in wall insulation or double-glazing. This reduces heat transfer because air is a poor conductor of heat. Another method is to use surfaces that reflect heat, such as silver foil behind radiators.

Where to insulate

- Unless the hot water cylinder has an 'A' rating, insulate it - 40 per cent of the energy bill is taken up by water heating.
- Insulating the first metre of the hot water pipes (closest to the cylinder) is helpful.
- Most heat in a building is lost through the ceiling (42 per cent).
- Walls also lose a significant amount of heat.
- Floors only lose 10 per cent of heat, but they are easy and cheap to insulate with foil so this is worth doing.

- Windows are the biggest heat drain for their size. They can be fitted with thermal drapes, but it is important that the curtains are well fitted and that pelmets are provided.
- A concrete floor used for heat storage needs to have the insulation underneath, not on top.

R-Values

The ability of a material to insulate is measured as thermal resistance, or R-value. The higher the R-value the better is the insulation. K- value is another measure sometimes used - this is the thermal conductivity of a material. The R-value increases with the thickness of a material, but the K-value doesn't. R = x/K (where x is the thickness of the material in metres)

- Insulate to higher R-values than those which are currently (2006) prescribed in the building code and NZS 4218:2004. For example it will be more efficient to use the standard for Climate zone 3 (Central North Island and South Island) when building in zone 1 (Auckland).

Construction R-values - list the R-value of the finished wall, ceiling or floor including the construction materials used. The BRANZ House Insulation Guide outlines methods of achieving R- values. Insulation suppliers should also be able to provide this information.

The following tables contain suggestions for new homes in the Auckland climate. The three columns list different options to allow compensation for lower wall insulation by installing higher ceiling insulation.

Table 1:

R values for non-solid construction (such as timber frame)			
Roof	2.5	2.9	2.3
Non-solid wall	1.9	1.6	2.2
Floor	1.3	1.3	1.3
Glazing	0.18	0.18	0.18

Table 2:

R values for solid construction (such as concrete block or earth)			
Roof	3.0	2.3	1.9
Solid wall	1.0	1.2	1.5
Floor	1.3	1.3	1.3
Glazing	0.18	0.18	0.18

It is easier to fit insulation during initial construction than put it in later. Increasing the R-value at the time of construction is relatively cheap and the difference between the bare minimum and the above values is often minimal for insulating the entire building.

When retrofitting, choose a product of at least 2.0 R-value for the ceiling - the higher the R-value the better. For under-floor insulation foil is generally the most economical solution - even though the R-values are not that high it offers good value for money.

Installing insulation

- Fit insulation carefully so heat does not escape. To avoid air gaps cut batts slightly larger than the space they are to be fitted into. Staple to the framing or floor joists where there is the possibility of movement.
- Roll blanket type insulation over the ceiling framing, this has the benefit of covering the framing, reducing thermal bridging. When it is used in walls or under the floor it has to be stapled to the framing.
- Insulate under an existing timber frame floor by stapling insulation foil to the underside of floor joists. This creates a cavity of still air for insulation, and the silver foil reflects heat back

up. Mark the position of wires and pipes on the underside of the foil with a permanent marker pen so they can be easily located for future maintenance.

- To achieve higher R-values for under floor insulation, staple batts or blanket type insulation to the floor joists and then cover it with sheeting materials such as fibre cement boards or plywood.
- Concrete floor slabs need to be insulated at the time of construction by placing a layer of insulation before the concrete is poured on top. Suitable materials for this are pumice or polystyrene.
- Concrete block walls can be insulated. Place the insulation near the outer side of concrete walls and floors to take advantage of the heat storing capacity of concrete.

Insulation materials

There are several insulation materials on the market. The ones discussed here are the most commonly available. All R-values quoted below and estimates. Obtain the exact R-value for the product from the supplier.

Fibreglass (and rockwool) (approximately R 2.4 for 100mm thickness)

Fibreglass:

- is the most commonly used insulation material
- outperforms most other materials in terms of R-values
- does not burn, but it can melt in a fire
- is generally cheaper than other options
- is a non-renewable resource
- can cause irritation of the skin and respiratory tract - wear full protective clothing and a mask during installation
- is available as batts, blankets and loose fill insulation.

Concerns have been raised about health impacts for installers and occupants.

Wool and wool blends (approximately R 2.5 for 100 mm of loose fill - less for batts and blankets)

Wool:

- does not perform as well as fibreglass
- is a natural renewable New Zealand resource
- is pleasant to handle
- is 10 to 20 per cent more expensive than fibreglass
- is treated to discourage mould and pests
- will burn if it comes into direct contact with a flame, but will not ignite through heat or aid a fire to spread.

There are two different types of wool products available. Some are sprayed with a resin to bind the fibres and provide strength, while others are blended with polyester. Wool is cheaper as loose fill insulation - comparable to fibreglass.

Polyester (approximately R 2.0 for 100mm blanket or batt)

Polyester:

- does not perform as well as fibreglass
- is a non-renewable resource (made from mineral oil)
- is more expensive than fibreglass
- does not present the same health concerns associated with fibreglass
- will not burn easily, but it will give off dense smoke

- is available as batts and blankets.

Recycled paper (approximately R 2.2 for 100mm loose fill)

Recycled paper:

- is treated with a fire retardant and can be used as loose fill insulation in ceilings
- is very competitively priced
- is a renewable resource often made from recycled materials.

As this is loose fill material, the performance depends on the quality of installation.

The ceiling cavity must be dry, as wet paper will sink and the R-value will be reduced.

Polystyrene (approximately R 1.4 for 50 mm sheet)

Polystyrene:

- has excellent insulation properties
- can be used in sheets on framing and then plastered, or under concrete floors. Hollow polystyrene blocks filled with reinforced concrete give very good R-values
- is a product of the petro-chemical industry and therefore a non-renewable resource
- gives off toxic fumes in a fire (except when under a floor slab).

Pumice (approximately R 1.4 for 100mm)

Pumice:

- is great for use under concrete floors
- is a naturally occurring material and has good insulating properties
- is an economical option where pumice is locally available
- may serve joint purpose when fill is required under a slab.

Foil (R value dependent on air gap)

Foil:

- is effective and economical under-floor insulation
- is generally comprised of paper coated in bitumen and aluminium foil
- can be used behind heaters to reflect heat back into the room.

Foam products (R value varies but similar to polystyrene)

Foam:

- is injected into cavities and expands
- is often propelled by CFCs and HCFCs, which deplete the ozone layer
- some foams, such as urea formaldehyde and polyurethane, can release small amounts of toxic substances.

When choosing a product ask for an independent test report (such as that from BRANZ or the BIA) and for a guarantee.

Further information

Look at the websites of those companies you are considering purchasing products from. Many have extensive information about their products available online.

NZS 4214:2006 Methods of determining the total thermal resistance of parts of buildings, NZS 4218:2004 Energy efficiency - Small building envelope, and SNZ/PAS 4244:2003 Insulation of lightweight-framed and solid timber houses. Standards are available for purchase online at www.standards.co.nz

Building Biology and Ecology Institute of New Zealand, www.ecoprojects.co.nz/

Consumer, www.consumer.org.nz - see 'home and DIY', also see 'appliances'

Ministry of Economic Development, New Zealand Energy Policy Framework, www.med.govt.nz

Ministry of Economic Development, New Zealand Energy Outlook to 2025, November 2003, www.med.govt.nz

National Energy Efficiency and Conservation Strategy, www.eeca.govt.nz

National Institute of Weather and Atmosphere, NIWA science, www.niwascience.co.nz/ncces

New Zealand Building Code, contained in the First Schedule to the Regulations, Department of Building and Housing website, www.building.govt.nz

New Zealand Climate Change Office, Climate Change Policy in New Zealand, www.climatechange.govt.nz - policy/initiatives

5.4 Sustainable heaters and heating systems

Look for the Star Energy Rating label. It features an arc of 1 to 6 stars. The more stars it displays the more energy efficient it is relative to conventional heaters of the same type.

The following is a list of the more common heaters and heating systems available. Each system is discussed in relation to its energy efficiency.

Heat pump

Heat pumps operate on the same principle as a fridge - only in reverse. Refrigerant circulates through an external evaporator panel, extracting energy from the outside and re-emitting it inside. Ensure that the heatpump uses an ozone friendly refrigerant, such as R410A.

- Heat pumps use about one third of the electricity an equivalent heater uses.
- The initial outlay may be recovered in as little as four years from the savings produced.
- The system can be reversed to act as a cooling and air conditioning system in summer. With a well designed building, cooling need only be used sparingly.
- Can be customised to the space that needs heating.

Convection heaters

- Convection heaters are relatively inefficient - they focus on warming the air.
- They are best for quick-response short-term heating in a small area that isn't occupied for long.

Low temperature electric radiators

- Low temperature electric radiators, usually oil-based, offer an efficient, comfortable and healthy heat source with a reasonable response time.
- They can be freestanding and mobile, or mounted on a wall.
- The wall-mounted type can be connected to a hotwater supply instead of using oil as their thermal mass.
- They do not scorch dust particles in the air.

Radiant floor heating

- Theoretically this is the ideal source of radiant heat.
- Based on warm water pipes set in a concrete floor slab, it runs on a low temperature of 40 - 50 degrees.
- It creates a very comfortable warmth, especially round the feet.
- The long response times mean this form of heating is better where temperatures remain cold for long periods.
- It can utilise solar panels as a heating source.

Ceiling mounted heaters

- Heat remains in the ceiling unless it is blown down with a ceiling-mounted fan.

- Infra-red globes are a cheap and effective way to heat a bathroom.

Traditional HVAC (heating, ventilation and air conditioning) systems

- These consume large amounts of energy.
- They are used mainly for commercial and public buildings, but residential use may be appropriate in some circumstances for health reasons.
- These systems aim to control indoor climate, regulating air humidity, air temperature and indoor air quality.
- They must be designed, operated and maintained to required standards (ASHRAE) as they can otherwise create unbalanced and polluted indoor air.

Heat exchange systems, such as heat recovery ventilation

- Heat exchange systems work on the principle of extracting heat from stale air that is being vented to the outside and using it to warm up fresh air that is being brought in.
- The process can be reversed for cooling in summer (so long as the outside air temperature is lower).
- These systems can be very efficient, especially if they draw warmth down from spaces where it is usually wasted.
- They do need to be designed to fit appropriately into the particular building.
- In Auckland's climate the natural dehumidification provided with the heat recovery ventilation process improves indoor air quality. Moisture, mould, dust mites and other asthma-causing allergens are reduced.

Open fireplace

- An open fireplace is relatively inefficient, with most of the heat going up the chimney.

Modern wood-burning stoves

Modern wood-burning stoves:

- are the best option where electricity is not available
- depend on a good supply of clean dry untreated firewood
- use natural heating principles together with modern technology to create an energy efficient, double combustion heat source
- offer the opportunity of combining space heating with water heating, cooking and baking
- heat space directly by radiation or indirectly by running water through wall radiators or underfloor pipes
- may be used in conjunction with solar panels to provide a year-round hotwater supply
- can be considered carbon-neutral as the wood consumed is a renewable resource.

Gas and oil-fired heaters

Gas and oil-fired heaters:

- depend on a non-renewable resource
- must be vented to the outside of the building to avoid condensation and pollution of indoor air by oxides of carbon, nitrogen and sulphur.

Further information

The Asthma and Respiratory Foundation of New Zealand, www.asthmanz.co.nz/keeping_your_home_warm.php

Proposed Emission Design Standard for Wood and Coal Burning Appliances, www.mfe.govt.nz/publications/air/emission-design-standard/emission-design.html

Auckland Regional Council Regional Air Land and Water Plan, www.arc.govt.nz

Home Heating Association, www.homeheat.co.nz/articles.php

New Zealand Climate Change Office, www.climatechange.govt.nz/

Communities for Climate Protection, www.iclei.org/index.php?id=3920

5.5 Water heating systems

Water heating is likely to account for 45 per cent of the annual energy use. Most of us have electric storage hot water systems, which are often inefficient and wasteful. Poorly insulated cylinders, long pipes without lagging, and inadequate appliances and fittings all waste energy. Inefficient layout and design of the system can create huge losses too

The standard New Zealand hot water cylinder uses an electric element to heat water, which is then stored until needed inside the insulated cylinder. When a hot tap is turned on, water is drawn off from the top of the cylinder and cold water enters at the bottom of the cylinder to replace it and be heated up ready for use.

When building a new building or replacing a hot water cylinder think about the best system for the needs of occupants. A building should be designed so that the hot water cylinder is in a central position with relatively short pipe runs to the points where hot water is most frequently used.

Most people install a large capacity mains-pressure cylinder with a powerful electric element, and often a booster element at the top for quick daytime re-heating. It can also open up energy-saving opportunities by enabling low-flow fittings and tempering valves to work efficiently, and its extra capacity enables best night rates for electricity to be taken advantage of for heating water.

There are other options for heating water most of which use alternative energy sources.

Solar water heater

Heat energy from the sun can produce large quantities of hot water to supplement the use of electricity. A square metre of north-facing roof in Auckland can generate 4kW of renewable non-polluting energy. In summer solar can generally provide all the hot water needs, but a winter backup from electricity or a wetback may be required.

Solar collectors are usually mounted on a sloping roof facing north. The best angle is 35 degrees from horizontal. The most effective systems absorb over 90 per cent of the available solar radiation and provide two-thirds of the annual water heating requirement for an average home. They comprise copper tube bonded to aluminium heat absorbing fins and covered with an optically efficient selective surface. At the other end of the spectrum are home-made systems using coiled black plastic tubing.

Heat pump

A heat pump operates on the same principle as a fridge - only in reverse. Like a solar system it has tubing up on the roof, but the liquid inside is a refrigerant that extracts molecular energy from its surroundings as it evaporates. Back at the hot water cylinder a compressor condenses it back to a liquid, thus releasing the heat into the water.

This system doesn't need a supplementary electric element because it works night and day, year round. Electricity - about a third of what a normal hotwater cylinder would use - is needed only for the compressor pump. The payback period can be as little as four years, depending on the initial cost of the system.

Instantaneous or continuous hot water system

In an instantaneous system the water is heated up - by a very powerful heat source - only when it is needed. This system is far more efficient than the standard storage systems, because it does not lose heat from hot water sitting around in the cylinder and pipe work. Consider this option where:

- the hot water is needed at a point remote from the main cylinder
- the use is small and infrequent - the guest wing of a building for instance, or a church hall.

Solid fuel wetback

If using a solid fuel heater, install a wetback to heat hot water at the same time. This works particularly well when combined with a solar system, which can heat the water through the summer, while the wetback will take it through the winter.

The wetback, burner and the pipework must be designed and sized to work efficiently together or there is a risk that the cold water will reduce temperatures in the burning chamber too low, preventing double combustion of the flue gases, and resulting in air pollution and inefficiency.

Using modern combustion technology that is highly insulated a solid fuel water heater is most cost effective when the wood is readily available and large quantities of hot water are being brewed (as when it is also used for central heating).

Further information:

Making the most of your hot water system, Energy Efficiency and Conservation Authority, 1995
www.eeca.govt.nz

6.0 Water

Island residents are ahead of the rest of Auckland City in the sustainable use of water. As there is no reticulated water supply, water consumption is limited by local water availability. Residential, commercial and rural development is necessarily constrained by water availability and disposal options.

Around 95 per cent of island residents use collected rainwater as their primary water source. However 30 per cent of the population supplement this water source with water from bores - 45,000m^3 is taken by water carriers each year.

Rainwater collection is the most sustainable water use option for the islands, as seen in the water use hierarchy in figure 1. Expert advice offered by manufacturers of rainwater tanks should be utilised when planning a rainwater collection system to ensure the size of the system will adequately service the water use requirements. This will reduce the use of other water sources such as aquifers.

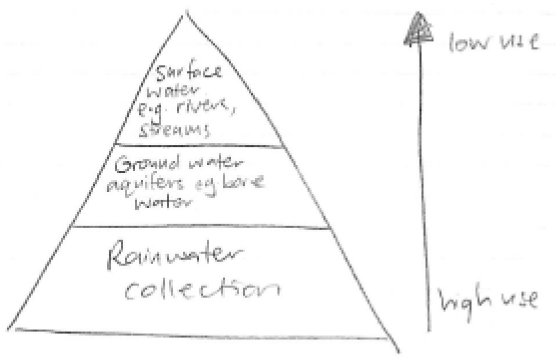

Figure 1: Water use hierarchy

All aquifers on Waiheke Island have been identified as ‘high use aquifer management areas’ in the Proposed Auckland Regional Plan: Air, Land and Water. Aquifers are not only important sources of water supply but are also major contributors to the base flow of many streams and therefore contribute to the overall quality and diversity of surface water bodies.

In order to continue to meet existing and future water abstraction demands and to provide base flow for surface streams, water taken from these aquifers needs to be well managed. There is a great opportunity for Waiheke Island to reduce its use of bore water by having an adequately sized rainwater collection system.

There are short term and long term benefits of sustainable water use to current and future generations as well as other living organisms.

6.1 Water efficient technology

6.2 Tuning up your plumbing system

Reducing the flow

Check the flow rates from your taps and showers by holding a 1 litre jug under them and timing how long it takes to fill. If it fills in less than six and a half seconds you are using more water than you need.

- When buying new fittings choose taps and shower heads with built in flow restrictors.
- There are a variety of devices you can fit to existing or new shower-heads and taps to reduce the flow. Flow restrictors generally ensure that temperature and flow fluctuations are controlled - they are cheap and easy to fit. Some companies offer good package deals to retrofit an old building with water efficient fittings.
- Use single lever taps and mixers - you have greater control over the water flow.
- Aerators improve the "quality" of the water stream and by mixing the water with air they also result in a lower flow. They can be easily fitted to many kitchen and bathroom taps.

Talk to a plumber prior to making any changes. The whole system needs to be considered where there are substantial differences in cold and hot water pressure

6.3 Building water efficiency into a new building

Minimise the distance between the hot water cylinder and the point of use as:

- less water (and time) is wasted waiting for the water to reach the desired temperature
- less pipe is used, saving money and labour - insulating the hot water pipes will help a little to save energy but distance is generally the greater problem.
- while mains pressure is now more common in new buildings and is considered more convenient, low pressure systems are cheaper and use less water.

See also **5.5 Heating water.**

Septic tanks can fail when high volumes of water are discharged to them. Water saving is extremely important with a septic tank; it will reduce the risk of failure and consequential environmental pollution.

Composting toilets are a great option where reticulated sewage is not available - although they do require some change in the behaviour in the user. Also available are several other options that use very little water, separate solid and liquid waste, and offer water recycling options. See **7.0 Wastewater** for details.

Washing machines often overload septic tanks by discharging large amounts of water suddenly - space washes out over time rather than to do several loads in one day. The best option is to collect the water from your washing machine in a storage tank and re-use it.

Water efficiency rating scheme

The AAA water efficiency rating scheme is an independent labelling system, administered by Standards Australia, for appliances and fittings. The more 'As" the less water is used, the labels should be displayed at retailers - if they are not, ask.

In-sink waste disposal units are inefficient and will cause the septic tank to fill up quickly. They also waste the valuable nutrients contained in organic waste, which can be composted and used in your garden.

Dual flush systems

The dual-flush system reduces water volumes in the toilets and adds greatly to the overall water savings of a household. An average single-flush toilet uses 11 litres per flush. In comparison, an average dual-flush toilet uses 3 or 6 litres per flush, which is considerably less. You will need a plumber to replace or install the toilet cistern.

Front loading machines

The average top-loading washing machine uses 200 litres of water per wash – a front loading machine uses half that amount. When purchasing a machine choose a front loading model and look for the 'A' rating – the more A's the more water efficient.

Flow restrictors

Check the flow rates of your taps and showers by holding a one litre jug under them and timing how long it takes to fill. If it fills in less than six and a half seconds you are using more water than you need.

There are a variety of devices you can fit to existing or new shower-heads and taps to reduce the flow. Flow restrictors generally ensure that temperature and flow fluctuations are controlled – they are cheap and easy to fit. These restrictors come in different flow rates from four litres per minute to 16 litres per minute. Six to 10 litres per minute is suitable for showers.

Urinals (in commercial buildings)

Urinals can waste a huge amount of water. The traditional form of control is that the cistern automatically empties every time it fills up. Waterless urinals are now available as are flow restrictors for traditional urinals

Taps

Depending on the situation, sensors or taps that will turn off automatically can be installed.

Toilet systems

The following list covers the most common on-site wastewater systems that reduce the volume of water used:

The **long drop** is a simple hole in the ground in a separate building from the building, away from water tables.

The **ventilated privy** has a similar set-up to the long drop, with the addition of a vent pipe to help reduce odours. Another variation (aqua privy) contains the waste in a water tank. This will prevent seepage into the water table but does not solve the problem of anaerobic storage.

The **incinerator toilet** uses combustion and venting to resolve odour and contamination problems, but it does not return matter to nature in any valuable form and uses significant energy.

The **electric toilet** mixes and aerates the effluent on a rotating disc, then heats and evaporates the liquids by venting through an automatic air extraction system. This reduces the original waste volume by 90 per cent to dry turf, which can be composted. This is an ecological solution with relatively high running costs.

The **aerated composting toilet** is a true composting toilet with an aerated storage tank. The waste is mixed by gravity, while venting and aeration is achieved by the thermo-syphon principle. The tank requires space to install below the bathroom.

The **solar compost toilet** is a simple natural solution, allowing for composting, heating by solar radiation, and venting by thermo-syphon. Solids and liquids are separated and flies and odours are controlled by a perforated tray. The compost is removed by swapping buckets.

The **biological toilet** is an environmentally friendly system, which requires some electrical energy input to keep the waste rotating, heated and vented.

Solid/fluid separation systems are mechanical equivalents to the solar composting toilet, separating solid and liquid effluent, while providing a conventional flush toilet. The solids are composted with the help of worms, while the liquid is disposed of after further treatment. Some systems allow for the reuse of the cleaned effluent for toilet flushing and other uses. The system can be placed underneath the toilet or outside in a shed or underground.

6.5 Further information:

BBE NO10 Water, Building Biology and Ecology Institute

The Healthy House, Sydney and Joan Baggs, 1996, Harper Collins Publishers

The Natural House Book, David Pearson

Green Architecture, Brenda and Robert Vale, 1991, Thames and Hudson Ltd, London

7.0 Wastewater

Wastewater is the water we dispose of from our homes, offices and industry. It comes from toilets, sinks, showers, washing machines and industrial processes and was historically called sewage. Wastewater can be divided into two subclasses: grey water and black water. Wastewater is increasingly being recognised as a valuable resource.

Black water is wastewater from toilets. It contains human waste and can be a public health risk if not treated properly. **Grey water** (sullage) is a lesser health risk, because it does not contain human waste. It is the wastewater from the kitchen and bathroom sinks, baths, showers and laundry.

Stormwater is the rainwater that flows to drains and then to the nearest stream, lake, pond or coastline.

It is important that wastewater and storm water are kept separate, because stormwater infiltration into wastewater systems can cause sewage overflows and environmental damage. Keeping grey water and stormwater separate from blackwater can further reduce pressure on the treatment system (on-site as well as reticulated systems). Wastewater can be treated to high quality and used for irrigation, while the solids can be composted.

Stormwater and greywater can also be used to water gardens and for some industrial and domestic purposes. This might become more common as increasing population puts more pressure on water resources.

7.2 Wastewater disposal and re-use in the islands

The majority of properties within the islands contain on-site waste water systems. However there are areas within the islands where on-site systems are unable to cope with the waste produced. Some commercial properties in Oneroa are connected to a centralised wastewater system that takes the waste to the Owhanake wastewater treatment plan. Treated water is discharged to the Owhanake wetland.

Residents outside the serviced area have on-site disposal systems. The responsibility lies with the resident to make sure their on-site system works and does not pollute the environment. These systems, when working well, avoid the problem of concentrating all of the island's waste at one location. When they do fail the problems are generally (but not always) local as opposed to regional in scale.

Many older septic tank systems were poorly designed and sited, or designed for a use that has changed over time. For instance a bach on water front property may become permanently occupied along with modern appliances that greatly increase the water discharged into the septic tank. Septic tank problems also arise when the disposal field (where the effluent soaks into the ground) is inadequately constructed for islands clay soils, which do not absorb water well.

7.3 Keep pollutants out of natural systems

Controlling pollutants individually at the source is relatively easy, while treating them at the outflow is expensive and doesn't happen in most places.

- Think about where pollutants will emerge from the drainage system.
- Reduce the release of any pollutants into the environment where ever possible: oil leaking from the car, lead from vehicle exhausts, dust from brake linings and rust.
- Reducing car use reduces pollution - you can car-pool, use public transport or walk or cycle instead. Don't spill or pour cleaners, oils and garden sprays into domestic or other drains.
- Reduce detergent use and choose biodegradable brands.
- Don't clean your paintbrushes into the stormwater drain.

- Wash your car on the grass, so dirty water and detergents can be absorbed before draining into the storm water system or use a car wash that handles the wastewater correctly.
- Be aware of potential erosion when landscaping and building.
- Use permeable surfaces such as gravel or hollow blocks around your building, instead of hard surfaces, such as concrete or bitumen.
- Make sure your septic tank works well - malfunctioning septic tanks are likely to pollute ground water.

7.4 Wastewater systems

Looking after an existing septic tank

Looking after an on-site system is important to ensure that it will not pollute the environment or endanger your health. A malfunctioning septic tank is likely to pollute the ground water.

- Fit the septic tank with effluent filters to stop solids from entering the disposal field.
- If necessary alter the effluent disposal method.
- Contact the council for advice on how to improve the system.

Installing a new on-site system

For an on-site wastewater system to work well, it has to be suited to the individual site. Soil conditions, the size of the section and number of occupants, slopes and ground water levels are all important factors. The location and size of the system is also important.

The manufacturer's instructions must be followed and a maintenance programme must be put in place to ensure that the health and environment of both family and neighbours are protected. If you are considering a new system contact the council and ask to speak to a building or wastewater officer who specialises in septic tanks.

The following describes common treatment systems:

The **septic tank** pre-treats domestic wastewater before it enters the disposal field where natural processes are expected to take care of the final treatment. In the tank solids settle to the bottom and form a layer of sludge. The council requires a pumpout of sludge every three years.

Lighter waste such as grease and fats float to the top forming the scum layer. This layer prevents some of the offensive odour from escaping. Anaerobic breakdown (using bacteria that can live without oxygen) treats the waste in the tank to a certain extent. Each time new waste is discharged into the tank, the same amount of pre-treated effluent flows out into the disposal bed where it is exposed to the air and broken down further.

Well-designed and sited septic tanks can work satisfactorily but the owner needs to care for them.

- Ensure the tank is the correct size for your building.
- Ensure that the area you have chosen for the tank has suitable drainage and topography.

Failures can result from poorly sized and sited tanks, inadequate disposal fields, extreme weather and ground conditions (such as clay soils or high ground water levels) and inappropriate occupant behaviour and lifestyles (large water use from modern appliances, use of toxic chemicals, etc). Failure of septic tanks can result in widespread environmental damage such as pollution. This is why they are now seldom installed as the sole treatment system.

The **dual chamber septic tank** is similar to the septic tank, but has two chambers. Only toilet and kitchen wastewaters pass through the first chamber. Wastewater from the bathroom and laundry is added at the second chamber. This design avoids some of the problems of single chamber septic tanks, because large discharges from the laundry will not result in untreated toilet waste flowing into the disposal field.

Aerobic treatment plants offer a mechanical solution to wastewater treatment in an aerobic treatment tank with drip irrigation onto the garden. The wastewater is aerated which allows aerobic bacteria to break down the waste. These systems require energy and ongoing maintenance.

The **sand filtration system** uses various grain sizes of sand and gravel. It will take out some pollutants from black and grey water, but not chemicals or sludge, which should be dealt with beforehand in a retention tank. The final effluent can be used for garden irrigation.

Evapo-transpiration systems use sub-surface soakage and evapo-transpiration from selected plants. The plants absorb effluent into their root system and then release water to the atmosphere through their leaves. Aerobic soakage beds are a similar system using shallower narrower beds. The effluent is also dosed so that a larger amount can be released into the system at one time.

Compensated dripper-lines are covered with bark or mulch and discharge the effluent to the ground They are laid around bush and landscaped areas (not vegetable gardens) and can be used as irrigation

Wetland flow systems can be either sub surface or surface operated In the former, the effluent is percolated over several days through gravel beds and aquatic reeds, on top of impermeable clay soils. A surface system needs a slow surface flow of 10-20m per day through aquatic reeds. These systems purify water in a very natural way, but because of the need to design and size them correctly to avoid pollution of waterways, Auckland Regional Council approval has to be obtained.

In an **oxidation pond system** the effluent is disposed into the centre of a shallow pond, where wind, oxidation and algae allow for aerobic treatment. Auckland Regional Council approval has to be obtained for this system

7.5 Grey water recycling

Consider re-using water from the washing machine, bath and shower to flush the toilet. The water must be stored in a tank and treated to stop bacteria breeding and avoid odours developing.

Grey water can also be used on the garden, but it needs to be free of contamination. The rinse water from washing machines is generally safe for non-food plants.

The minimum treatment requirements include a secondary treatment system and a chlorine disinfection system in accordance with the Auckland Regional Council's Techinical Publication No. 58 - On-site wastewater systems: design and management manual (3rd edition 2004).

Due to the risk to human health and the environment approval must be gained from the Auckland Regional Public Health Services and the Auckland Regional Council.

7.6 Evapo-transpiration fields

Section **8.0 Low impact design**, outlines a number of species that can be used in moist environments and evapo-transpiration fields, and are useful not just for wastewater fields but also for rain- gardens and stormwater management.

8.0 Low impact design

You can reduce your stormwater and recycled water run-off by increasing plant cover and reducing the amount of impermeable surface (eg concrete) on your site. More water then soaks into the ground and is absorbed by plants. Water is also cleansed when it is filtered by vegetation.

It is not known how much water people in the islands apply to their gardens. In Auckland it accounts for about 10 per cent of the total water use. Most of it is used in the dry periods of the year when water is scarce. Our water supplies must be managed for those peak summer demand periods, so a reduction in water used on gardens will have a significant effect on the need to find new sources of water supply.

Too much water on the garden can become a problem. In winter the soil becomes water-logged and plants may rot and die. When water soaks into the ground or filters through plants it is cleansed of sediment and pollutants.

Surfaces that do not absorb water, such as concrete driveways, patios and roofs, often direct these pollutants straight to drains, streams and watercourses. Whatever we can do to reduce this run-off will improve the condition of our streams and harbours.

8.1Water loving plants

Plants absorb water through their roots, and later release it back into the air (transpiration). They act as a storage facility for water and reduce flooding while holding onto the moisture. This is why dense forests are damp. Plants with large leaves lose more water into the air and are useful in boggy areas. Planting the wetter areas with water tolerant species - work with nature to make the most of your specific conditions. Planting is a far better option than draining

Table 3 outlines a number of species that can be used in moist environments including evapo-transpiration fields and raingardens.

Table 3

Native plants suitable for moist environments (ecologically suitable for the islands)		
Native grasses	*Carex flagerllifera, carex maorica, carex virgata, carex lessoniata*	
Toetoe	*Cortaderia fulvida*	Not the Argentinian pampas
Hanghange	*Geniostoma rupestre*	
Flax	*Phormium tenax*	Good food for birds
Panakenake	*Pratia angulata*	Attractive ground cover
Karamu	*Coprosma robusta*	Food for birds
Gahnia	*Gahnia xanthocarpa*	
Rushes	*Juncus gregiflorus, juncus planifolius*	
Manuka	*Leptospermum scoparium*	Attractive flowers
NZ (native) broom	*Carmichaelia aligera*	Attractive flowers
Swamp coprosma	*Coprosma tenuicaulis*	
Kiekie	*Freycinetia bankskii*	
Pukupuku	*Doodia media*	Fern
Kahikatea	*Podocarpus dacrydioides*	

The council encourages residents to plant natives and supports the publication 'Greening the Gulf Islands' (see references) which gives detailed information on the diverse original plant communities and ecosystems in the islands.

8.2 Stormwater management practices

Raingardens

Raingardens are scoria filled pits covered with a layer of sandy soil in low depressions that are planted, preferably with indigenous plants. They are located to collect, infiltrate and filter rain that falls on hard surfaces such as driveways. The layers of scoria and sand naturally filter the stormwater and therefore act as a pre-treatment device.

Less impermeable surfaces

Stormwater is not reticulated on the islands and therefore it must be disposed of on site. Permeable surfaces are required on site to absorb and retain stormwater. Intensely planted areas absorb a lot more water than a lawn area.

Ways of reducing stormwater runoff include:

- Minimise the length and width of driveways.

- Use permeable paving such as turf blocks or similar systems. These allow grass or other ground-cover to grow on your driveway, while providing structural support. Permeable paving is still less permeable than planted areas.
- Use permeable path and walkway options such as pebbles, stepping stones or bark.
- Create winding paths on steep slopes that divert run-off into planted areas at the sides.

Diversion channels, dams and ponds

Divert water along channels from areas where it is not needed to ponds. These features might be on a large scale on a farm, or quite small in a suburban backyard. Channels need to be fairly impermeable, perhaps with a clay base, if the aim is to collect the water rather than allow it to soak into the ground. Shape channels and plant them to appear like natural streams. This will encourage wildlife, prevent erosion and look more pleasant. If you are be undertaking works within or around an existing watercourse or water system, resource consent is usually required. Seek advice from the council before undertaking any works.

Ponds can be constructed by using plastic liners or clay. Other cheap options for small storage ponds are old bathtubs or laundry basins. Ponds should be planted to encourage wildlife, discourage mosquito breeding and also to avoid their becoming anaerobic and smelly.

Swales

Swales are wide, gently sloping, vegetated channels or ditches. They capture the water and allow it to filter into the soil. Water loving plants can then be grown on the edge of the swale.

Flowforms

Flow forms are designed to replicate the natural flow patterns in streams, aerating and cleansing the water. The water flows in a figure-eight path, lengthening the time in which pollutants can be broken down by natural processes and oxygen can be taken up from the air. A natural stream, with its great variety of water conditions and plant life is preferable.

8.3 Further information:

New Zealand Indigenous Plant Species Selector, Selection Tool, Manaaki Whenua Landcare Research, www.landcareresearch.co.nz/research/biodiversity/greentoolbox/index.asp

Pest Plants, Manaaki Whenua Landcare Research, www.landcareresearch.co.nz/education/pestplants.asp

Greening our Gulf Islands - A Manual for Native Revegetation with special Reference to Waiheke , By Don Chapple, Rachel Ebbett, Ivan Kitson, 2000

Sustainable Wastewater Management - A Handbook for Smaller Communities, www.mfe.govt.nz/publications/waste/wastewater-mgmt-jun03/html/

Wastewater Disposal Systems for Domestic Households, Ian Gunn, Waiheke Island Seminar, 1991

Technical Publication 58 (TP58), Auckland Regional Council

Auckland Regional Council, Proposed Auckland Regional Plan - Air Land and Water, www.arta.co.nz/arc/publications/regional-policy-and-plans/proposed-arp-alw.cfm

Composting toilets, Maanaki Whenua Landcare Research www.landcareresearch.co.nz/about/tamaki/composting_toilets.asp

Re-using Greywater, Smarter Homes, www.smarterhomes.org.nz/water/re-using-greywater/

9.0 Building in the bush

The islands are home to a wide variety of animal and plant species.

There are measures in place to ensure the most significant areas of bush with high ecological values are left to regenerate, and to encourage the use of indigenous plants.

This guide is intended to assist in determining ways in which to minimise the impact of development on the bush environs.

The following design features can improve the sustainability of buildings in the bush:

- Minimise the clearance of vegetation to that which is only required for the building and driveway.
- Utilise any already cleared areas on the site (for the building, driveway etc).
- Design the building location to be a good distance from significant trees on the site (the general rule is for any structures to be well clear of driplines).
- Make allowances for continued growth of trees, especially those which are located closer to the building.

9.3 Design features to maximise benefits of bush living

- Maximise light, sun and warmth in the building.
- Minimise problems such as dampness.
- Orient the building to the sun so that sunlight penetration is maximised.
- Design living areas (both indoor and outdoor) in the north facing parts of the building or property to take advantage of the sun.
- Clerestory windows and, to a lesser extent, skylights are a good idea for allowing increased light overall in the building.
- Double glaze skylights so heat does not escape and be aware that they can overheat the building if they are not shaded.
- Good insulation is very important in helping to reduce heat-loss and preventing dampness, especially in buildings with pile foundations where air can circulate beneath the floor.
- Insulate walls, roofs and under floors. Ensure that drapes are fully fitted to a pelmet to reduce heat loss.
- Make sure gas heaters, clothes dryers, bathrooms, and stoves are vented to the outside of the building to prevent dampness.
- Minimise building footprint and make use of cantilever or tall buildings where there is a mature canopy.
- Double-glazing will also help, especially on south facing windows but is quite expensive

9.5 Further information

Biodiversity and Ecosystem Processes, Manaaki Whenua Landcare Research, www.landcareresearch.co.nz/research/biodiversity/

Greening our Gulf Islands - A Manual for Native Revegetation with special Reference to Waiheke - By Don Chapple, Rachel Ebbett, Ivan Kitson, 2000

New Zealand Indigenous Plant Species Selector, Selection Tool, Manaaki Whenua Landcare Research, www.landcareresearch.co.nz/research/biodiversity/greentoolbox/ index.asp
Auckland Regional Council

10.0 General sustainability information

Add links here for information on sustainability that is general.