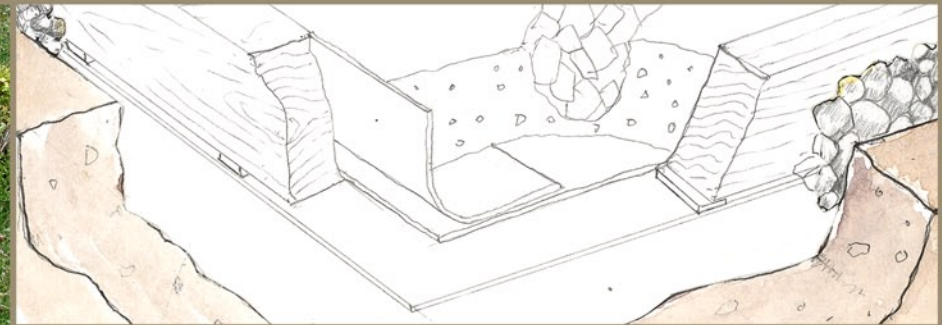


The
DIY
Guide
To

Green & Living Roofs



A Do It Yourself Guide for householders, small builders or landscaping contractors, along with community groups and all who want to enliven a roof with soils and plants



*Dusty Gedge
&
John Little*

With Full Illustrations & Tips

Dusty Gedge Urban Ecologist



Dusty is Mr Green Roof. He's passionate about putting vegetation on buildings and for the past 15 years has been one of the UK's foremost green roof advocates. Originally from a street theatre and entertainment background, his career turned full circle in 2006 when he appeared as a co-presenter alongside comedian Bill Bailey in the Channel 4 series 'Wild Thing I Love You' about saving wildlife.

He's put green roofs on Barclays Tower in the City and the Komodo Dragon House at London Zoo. He has travelled all over the world doing research on how to green-up our cities and buildings and has campaigned for the whole-scale adoption of green roofs in major developments in London and elsewhere in the UK.



In 2004, he co-founded the Living Roofs organisation that educates and advises on green roof development. Dusty now works as an advisor and consultant on urban nature conservation to various UK bodies. He is a consultant for the Green Roof Consultancy and is a professional ecologist and ornithologist, specialising in brownfield ecology.

"Getting Barclays to put a green roof on top of their tower in Canary Wharf was a highlight for me"

www.livingroofs.org

John Little Making Plants Work For People



John's life with green roofs started when he self built his own home in Essex. The green roof on John's new house consisted of the standard green roof structure, onto which he literally dumped soil from the foundations. That was 13 years ago and the roof is still growing strong.

He has since designed and built small green roofs buildings throughout South Essex and London, often combining the living roofs with habitat walls made of logs, bottles, crushed brick and tin cans. John has a particular interest in Art on green roofs.

John and his family often share their home and garden with the public in aid of local causes including The Essex Wildlife Trust.



In 2007 John's company was awarded Silver Gilt at the RHS Chelsea Flower Show for a garden based on the work they pioneer for the green spaces within social housing. John worked closely with the residents of the Clapton Park Estate, Hackney, in fact it was the first time a council estate had entered the show.

"Green where you would least expect, that's what makes living roofs so exciting"

www.grassroofcompany.co.uk

CREDITS

Jeff Sorril and Wendy Bussey at the Green Roof Centre for suggesting a DIY Guide.

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GREEN AND LIVING ROOFS

A Do It Yourself Guide For The Amateur, Small Building Or Landscaping Contractor, Community Group And All Who Want To Enliven A Roof With Soils And Plants

John Little [www.grassroofcompany.co.uk]

Dusty Gedge [www.livingroofs.org]

This guide is a response to the numerous emails and phone calls we have had over the last few years asking how to create a green roof, like the ones on our websites. The demand for information has increased with the concerns about climate change and people wanting to do something themselves to make a difference. Green roofs are certainly a way to make that difference. The purpose of this guide is to provide as much information for people to build a green roof for themselves or for small building or landscaping contractors to take the information and realise their client's aspirations.

There are a few suppliers providing good products for the 'small' market and on a commercial level green roofs are blossoming. With cities like London and Sheffield already introducing policies to encourage green roofs and other communities across the country promoting them, the commercial suppliers are busy installing green roofs on new developments on a large scale. Many people want to do it for themselves, after all it should cost less and they derive a great deal of pleasure from creating something unique and personal.

The reasons for wanting a green roof vary considerably. Many just want a green roof, as long as it's green they are happy. Others are more specific, wanting to encourage wildlife or have a more horticultural interest and want the green roof to complement their garden.

Some want to be as sustainable as possible accessing plants, soils, substrates, waterproofing and other elements as near to their home as possible.

Another group of people who contact us have a desire for a green roof but don't really want to do the work themselves. Their building contractors may not be familiar with the concept or confident that they know what building methods to use, again this guide can help.

Green roofs are relatively simple things but if you've never created one before you may feel that there is some complex secret that is the preserve of the initiated. There are no secrets and we want this guide to show people that with basic skills and a little advice they can do it themselves.

However, we do recommend you read through the whole guide and thoroughly acquaint yourself with all the possible tasks and choices **before** you begin any construction.

WHY HAVE A LIVING ROOF?

REPLACES THE GREEN SPACE TAKEN UP BY THE BUILDING.

CREATES AN IDEAL HABITAT FOR INSECTS, BIRDS AND OTHER WILDLIFE.

REFLECTS YOUR COMMITMENT TO SUSTAINABILITY AND BIODIVERSITY.

INCREASES THE LIFE OF THE ROOF.

ABSORBS RAINWATER AND THEN RELEASES THE WATER SLOWLY FROM THE ROOF.

PROMOTES DISCUSSION AND INTEREST IN SUSTAINABLE ISSUES.

LOOKS GREAT!

THERE IS NO REASON WHY EVERY SHED, HOUSE EXTENSION, CONCRETE SUB STATION ROOF, BUS SHELTER, SCHOOL, BIKE SHED OR ANY BUILDING WITH A SUITABLE ROOF CAN'T BE GREEN. GREEN ROOFS TICK EVERY BOX WHEN IT COMES TO THE ENVIRONMENT.



Green where you least expect to see it. That's why living roofs are so exciting.

WHAT IS A GREEN ROOF?

A green roof is an intentional vegetated roof.

There are three main types;

- Extensive green roofs have a thin growing medium, require minimal maintenance and in general do not require irrigation. They are generally less costly to install than intensive green roofs.
- Semi intensive /semi extensive – these have deeper soils, allowing a greater range of plants. These also tend to plants that require minimal water. These roofs need more maintenance than extensive roofs and are best considered as Mediterranean in character.
- Intensive – these are deep soiled roofs which can have large shrubs, lawns and trees and require very intensive maintenance.

This guide will focus on extensive green roofs, the type that use shallow soils /substrates and are planted with drought and wind tolerant plants. An extensive green roof could be a grass roof, a flower rich roof and can be very decorative if you are willing to weed it regularly and keep it formal. It can also be left to do it's own thing, to be colonised naturally by plants within the locality. Why not add your own seed each year to change things? It can be whatever you want it to be within the parameters and limitations of the building and the system.



SO YOU WANT A GREEN ROOF?

In most cases a green roof won't be green all the time. It is important to understand that a green roof will vary through the seasons. In long hot dry summers no natural grassland will be green so don't expect your green roof to be. With the right approach it is possible to ensure that there is flowering from March through to October.

An instant green solution may not be the best solution in the long term. Patience is important. Some of our roofs have been around for a number of years and each year we look forward to seeing how they have changed. What new plants have arrived? What is going to flourish this year?

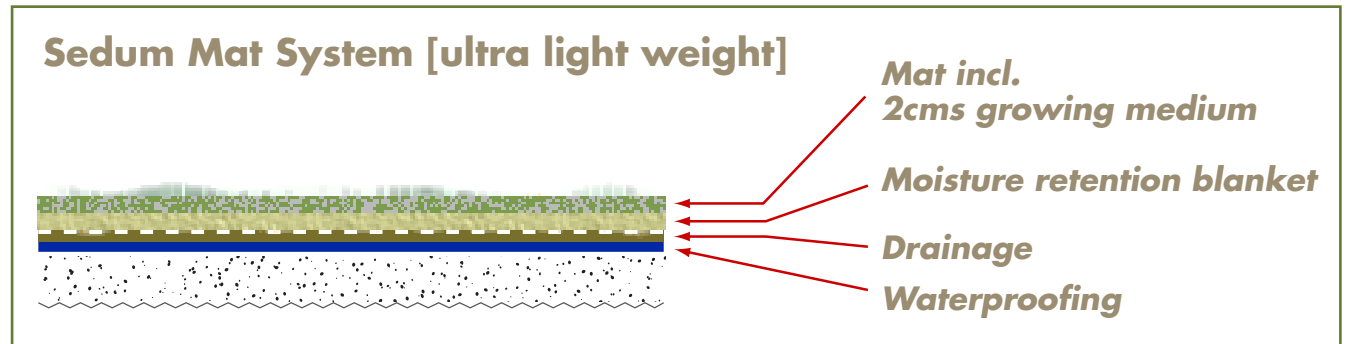
That is part of the joy of a green roof – the change



WHAT TYPE DO YOU WANT?

1. LIGHTWEIGHT SEDUM BLANKET

This is the minimum required for a living roof and is made from a very lightweight growing medium, which might consist of coir mat and a roll of turf made from sedum plants. This may require some proprietary drainage mat or similar if it is on a very shallow or flat pitch. This sort of roof will survive relatively harsh conditions and provide a living roof that will stay generally green and flower around June/July. Over the past few years this system has been generally specified as a "green" roof.



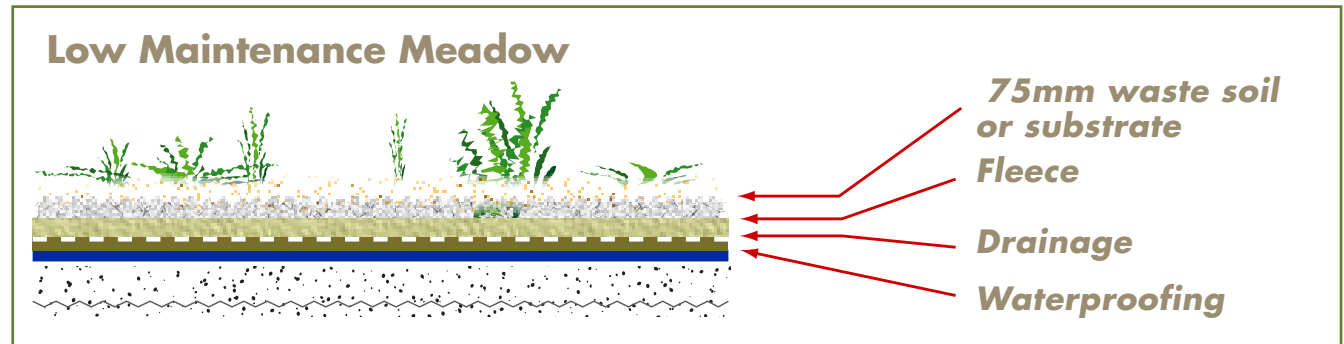
- ✓ *The lightest and maybe the only option on some existing roofs.*
- ✓ *Easy to install and would probably not mean any alterations to the roof structure.*
- ✗ *Relatively uninspiring.*
- ✗ *May tend to reduce in vigour and interest over the years.*
- ✗ *Can dry out in hot summers and fade.*
- ✗ *Looks pretty dull.*
- ✗ *Generally speaking, of lower ecological value.*



2. LOW MAINTENANCE MEADOW ROOF

This would be the next step on from the basic sedum/blanket roof. It requires a minimum of 75mm of waste soil, either from the construction of the building or brought in from a local source. As the substrate is deeper than lightweight sedum blanket it can support a greater diversity of plants. The greater the diversity of plants, the greater the diversity of wildlife attracted to it. With a 75mm substrate sedums, certain grasses and herb species will flourish.

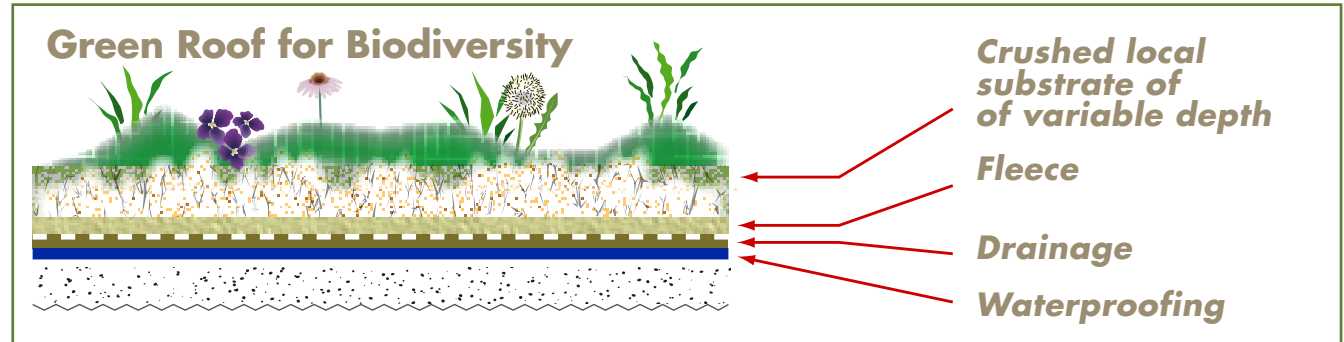
Again, if your roof is flat or has a shallow pitch, you may require some drainage but generally above a couple of degrees, it is not strictly necessary.



- ✓ *Very low environmental impact.*
- ✓ *Generally low energy used in construction.*
- ✓ *Maintenance is very low to zero.*
- ✓ *Changes through the season and year to year.*
- ✓ *Tends to adapt naturally to the plants that suit the habitat.*
- ✓ *One of the cheapest options.*
- ✓ *The occasional appearance of a new species that may dominate for a season or a year.*
- ✗ *Heavier than a sedum blanket therefore the construction would need to be more substantial.*
- ✗ *Pretty scruffy through the winter.*
- ✗ *As the soils are thin can tend to brown off at some stage during the summer months.*
- ✗ *Will not have a garden border feel or look.*
- ✗ *If you haven't got a good local source of sub soil or green roof aggregate will need to buy from further afield.*

3. BIODIVERSE ROOF

One way to achieve a more diverse roof is to vary both the materials and the depth. Try to think of a natural habitat at ground level moved to the roof. It is not only the substrates and plants that make the difference, temporary pools, log piles and hemp rope can be incorporated into the design. In fact anything that gives visual and physical variety can be used. It makes sense to use as much waste material for the construction as possible. This would mean some waste soil from the construction, maybe crushed brick or concrete, off cuts from the waterproof liner to create a temporary pool or the creation of piles of timber or bricks. These are good places for certain invertebrate species. It is also worth thinking about collecting and using local seeds, but be responsible and follow the countryside codes [Wildlife and Countryside Act 1981].



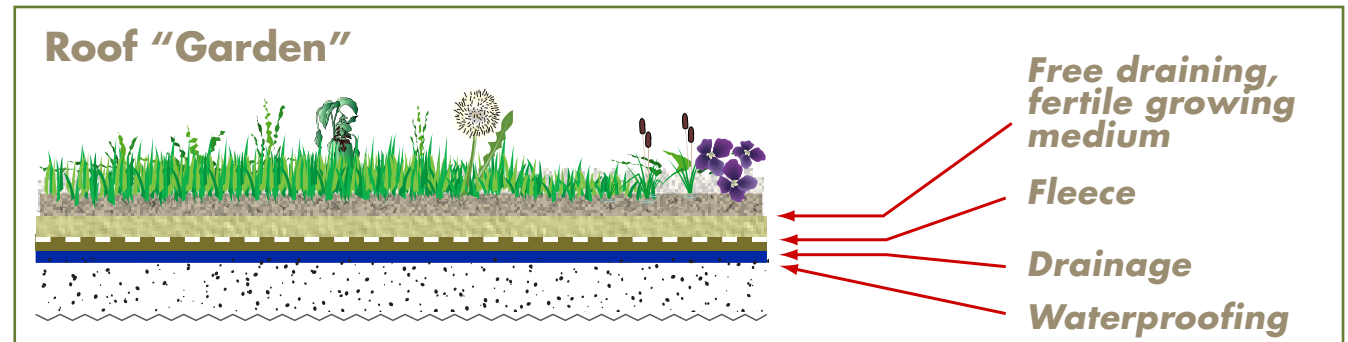
- ✓ *The ultimate green roof habitat.*
- ✓ *A contrast to the orderly garden at ground level.*
- ✓ *By using waste materials you are creating a mini *brownfield site.*
- ✓ *You are creating the diversity to encourage a very wide range of flora and fauna.*
- ✓ *Gives you a chance to add a lot more depth of substrate over supporting walls but use much thinner depth, say, in the centre of the roof span.*
- ✓ *Varied substrates and depths let you use plants that require more moisture and richer substrate together with plants that tolerate much harsher conditions.*
- ✓ *Maintenance should be very low.*
- ✓ *Your neighbour will definitely not have one!*
- ✗ *It might take time to develop and evolve.*
- ✗ *Access to the necessary waste materials.*
- ✗ *Relatively heavy.*

**brownfield site*

These are old industrial areas that have proved to be very important places for biodiversity. Such habitats are being built on throughout the country, and even small areas of green roofs can have a significant benefit for species associated with these habitats.

4. ROOF "GARDEN"

An extension of your garden, with flower borders, shrubbery etc. with all the aesthetic potential but also high maintenance associated with a garden. You can, if you make access simple, look after your roof with the same care as you might your garden. For this type of roof you may wish to consider irrigation and a more fertile, yet free draining, growing medium, but avoid the use of peat.



- ✓ A gardeners delight.
- ✓ It would give you more growing space and a chance to experiment with plants.
- ✓ Aesthetically, it would have a more traditional garden feel.
- ✗ Far higher maintenance issues.
- ✗ Minimum of 150-200mm of substrate, therefore the roof would need to be much stronger.
- ✗ Higher energy and water input.
- ✗ The roof would need to be designed to allow easy access and would obviously need to be flat or have a very shallow pitch.
- ✗ Handrails and perimeter fencing would be necessary from a health and safety point of view.
- ✗ A more expensive alternative.

ALL OF THE STYLES ARE INTERCHANGEABLE.

You may feel you would like to have a roof "garden" on the lower edge and be more bio-diverse on the remaining section of roof. In the same way, you may feel the mix of substrates and habitats for the bio-diverse roof can be improved and added to with more maintenance.

THE BUILDING

Lets forget the green element for a moment and consider the building.

It sounds obvious but a roof:

- Must not leak.
- Must allow excess rainfall to escape.
- Must not collapse!

The first two are waterproofing and drainage issues but the last is the deciding factor in terms of what kind of green roof you can have.

What loads are possible without the roof collapsing?

LOADS

Loads of various green roof systems:

- *Sedum blanket [20mm] 55 kg/m²
- *Sedum blanket [40mm] 80–90 kg/m²
- *Substrate based system [80mm] 120 kg/m²
- *Substrate based system [100–120mm] 140–170 kg/m²

*These are ball park figures based on commercial systems

If you are retrofitting a green roof onto an existing roof you need to know what the roof can support as this will dictate the type of system you might be able to install.

On a new shed or house extension you can decide what system you would like and then design the roof to suit.

DRAINAGE

Although green roofs hold water, thus reducing run off, excess water must be able to drain away from the roof. That is why so many systems have a drainage layer. If the roof has a pitch then water should drain away without this layer. On a flat or very shallow pitched roof, a drainage element can help to move the water more quickly.

When designing your green roof always keep in mind where the water will eventually escape.

WATERPROOFING

A roof must not leak. On simple small builds a butyl liner is adequate. In the detailed section of the guide we will discuss waterproofing in more depth.

However, one thing to note is that waterproofing must be protected from root penetration. If you are retrofitting onto existing waterproofing then a double layer of 300-micron damp proof polythene can be used to protect the waterproofing from root penetration.

Butyl Liners and high end waterproofing can come root protected.

THE BASICS

THE GREEN ROOF ELEMENT

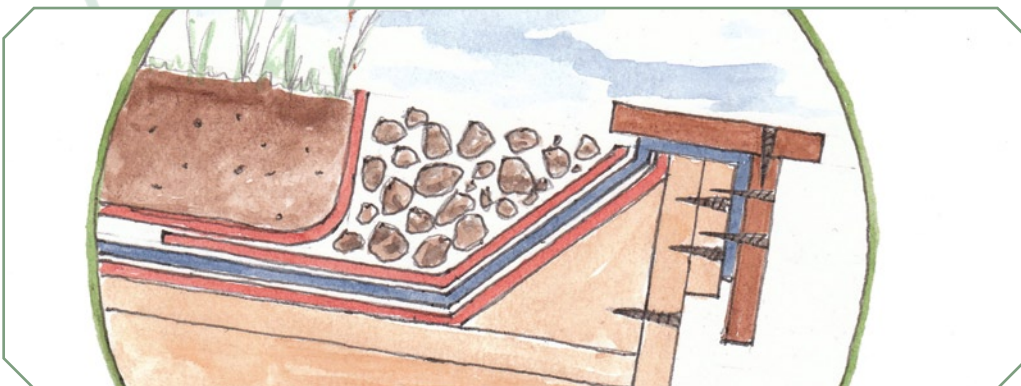
The green roof element is in many ways just a large hanging flower basket. It follows the same principles. They have some kind of moisture retention system, they have soil, they have plants and the water can drain from the basket.

The basic principles are that whatever the plants, they will need:

- Nutrients
- Water
- Aeration

How much of each will dictate the type of vegetation. The shallower the soil the less nutrients and the less water the substrate will be able to retain.

For the sake of this guide we will refer to soil [garden soil] and substrate [either a blend of good lightweight aggregates with soil or just aggregate]. It can be confusing when looking at green roof products and websites as sometimes this element is referred to as the green roof soil or the green roof substrate or the growing medium.



THE CONSTRUCTION GUIDE

PART 1a - RETROFITTING ONTO SHEDS AND OTHER SMALL GARDEN BUILDINGS

THERE IS NO REASON WHY AN EXISTING BUILDING CAN'T BE EASILY STRENGTHENED SO YOU ARE NOT LIMITED TO A SEDUM BLANKET ROOF. WITH A STRONGER ROOF YOU HAVE THE FLEXIBILITY TO EXPLORE MANY MORE PLANTING AND SUBSTRATE CHOICES. REMEMBER, THIS IS ONLY A GUIDE. YOU SHOULD CHECK WITH ARCHITECT OR STRUCTURAL ENGINEER IF IN ANY DOUBT.

WALLS

Most garden buildings are built with stud walls using 65mm x 32mm timber spaced at say 800mm apart. Fine for the existing design but a little weak if you want a more interesting living roof. Here we have listed some of our suggestions to increase the strength of your building. Each step increases the weight loading capacity of your roof, so you can match the strength of the building to your choice of roof.

To adapt your 'standard' shed wall

1. Get some timber to match the existing uprights. Add these into the stud wall so instead of 1 every 800 mm you now have 1 every 400mm. **See photo 1**
2. Attach 12-18mm shuttering ply to the wall fixing to each upright and the top and bottom plates using 5mm x 50 mm screws or equivalent. **See photo 2**



The plywood not only gives you the extra strength for the roof it also 'braces' the building, and if you use 18mm, allows you to fix anywhere on the wall without hunting for the uprights.

Bracing the building either with plywood or timber diagonals is important when adding a green roof to a building. The extra weight on the roof means it's more important for the building to be rigid.



To adapt your 'standard' shed wall

1. On the walls with windows you may need to add a beam across the top to act as a lintel. Fix the beam approximately 100mm x 50mm to the uprights tight under the roof joists. **See photo 3**
2. Then if necessary secure new uprights inline with the existing timbers that divide the windows and up under the new beam. These new studs need to sit on a new bottom plate of the same dimensions. **See photo 4**



THE CONSTRUCTION GUIDE

PART 1b - RETROFITTING ONTO SHEDS AND OTHER SMALL GARDEN BUILDINGS

ROOF

The roofs on garden buildings are either shallow mono pitch or a traditional pitched roof.

MONO PITCH

These roofs normally have a shallow pitch, ideal for green roofs, but they often slope back from the entrance and are inherently weaker roofs having a longer span.

To adapt your roof:

1. Get some roof joists the same size as the existing.
2. Add these in to give you no more than say 250mm spacing instead of the 700–800mm usually fitted.

TRADITIONAL PITCH ROOF

To adapt your roof:

1. If possible add more joists to the roof as described above.
2. Fix a beam across the roof under the centre of the rafters. You may have to beam through.
3. Support this beam each end with timbers. **See photo 5**

OPTIONAL

To increase the weight your roof can take you could now cover the complete roof by fixing 18mm ply on top of your existing felt roof, securing through the felt and into the joists below and finishing flush with the roof edge.



THE CONSTRUCTION GUIDE

PART 1c - RETROFITTING ONTO SHEDS AND OTHER SMALL GARDEN BUILDINGS

BASIC LINER/FASCIA DETAIL

1. Remove any existing fascia and roof trim.
2. Lay geotextile felt on top of the ply or existing felt, flush with the roof edge.
3. Lay your waterproof membrane on, overlapping by 100mm all round.
4. Lay another geotextile layer on top to protect the liner.
5. Fix a new fascia on the sloping edge of the roof approximately 32mm thick trapping the liner. The fascia needs to be deep enough to fix into the joists and extend up 75mm above the liner. Finish this fascia approximately 20mm below the lower edge of your roof to allow the water to escape.
6. Now fix fascias to the lower edge of the roof to join both sides of your roof. This should give you a minimum of 20mm gap for the rain to drip off. **See photo 6**
7. To support this fascia fix a timber from the centre of the lower fascia up to the top of the ridge, do the same for the other side and fix together at the ridge. **See photo 7**. This part of the roof structure sits on top of the geotextile that protects the liner. You may need to add more of these supports depending on the length of the roof.
8. On roofs below 15 degrees add a noggin fixed between each timber support 30mm back from the bottom fascia. If the roof pitch is over 15 degrees you can add more noggins between the timber supports that go up and over the roof. See photo 8. This will stop any slump in the substrate. Fix these noggins so there is a minimum 5mm gap below so water can effectively drain. See Diagram [a]
9. Once these are in place add some stones up against the lower noggin to act as drainage. This will allow the water to drain. Lay an off cut of geotextile or terram between the big stones and where the green roof substrate is to go. This will stop the fine material leaving the roof. Fill the roof with your chosen substrate. See photo 8
10. Add seeds and plants as discussed later in the guide.

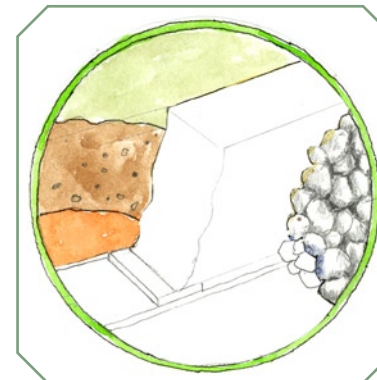


Diagram [a]

THE CONSTRUCTION GUIDE

PART 2 - NEW BUILDS

HERE IS A BRIEF RUN THROUGH OF THE ROOF BUILD FROM THE JOIST UP.
EACH SECTION OF THE BUILD IS DEALT WITH IN MORE DETAIL LATER.

If your building is enclosed you will need to consider a vapour barrier or ventilation layer according to building regulations. This is standard practice on any roof structure and prevents water condensing on the under side of the waterproof liner.

1. Fit joists of size and spacing to suit weight loading including supporting beams and walls.
2. Fix roof deck to joists. Insure deck boards/ planking is flush or slightly back from the edges of the joists.
3. Fix triangular 'arris rail' flush with the edge of the joists all round the roof.
4. Fix fascia say 20mm below end of chamfered roof joist and just above top edge of arris rail.
5. Fix 75mm x 20mm spacer flush with the top of the fascia.
6. Drill outlet through the roof deck.
7. Lay geotextile membrane. Don't overlap top of fascia.
8. Fit waterproof liner. Pull pipe sleeve through outlet and then position liner to overlap roof edge.
9. Fix 100mm X 20mm capping piece flush with the top of the fascia trapping the liner.
10. Fix the 75mm x 20mm top cap only fix through the top of the 100mm x 20mm side cap, not through the liner!
11. Lay in tougher geotextile or equivalent 'greener' material.
12. Install drainage layer if necessary and cover with separate filter layer.
13. Substrate layer; bring up your choice of growing medium.
14. Fit drainage chains or down pipe.
15. Relax.



Photo Right: Roof cross section



Photo Far Right: Joists showing chamfered ends

THE CONSTRUCTION GUIDE

DETAILED GUIDE TO CONSTRUCTING A SMALL SCALE BUILDING WITH A GREEN ROOF

THIS IS ONLY A GUIDE. YOU MUST CHECK WITH A STRUCTURAL ENGINEER OR ARCHITECT IF YOU ARE IN ANY DOUBT.
BEFORE STARTING YOU MUST DECIDE WHAT TYPE OF GREEN ROOF YOU WANT AND THEN THE LOAD YOU WILL NEED TO SUPPORT IT.

1. Fit Joists

Weight loading:

As we discussed earlier this really dictates the type of living roof you can have. A stronger roof provides for a greater choice of substrates and plants and in turn the greater the diversity of wildlife.

A rough guide to joist size and span is shown below:

Around 75mm of substrate means a weight loading of say 100kg/m²

For this weight:

Joist	Span
100mm x 50mm	1.75m
150mm x 50mm	2.96m
200mm x 50mm	4.0m

This also assumes joists spaced at 400mm centres and allows for the extra weight from snow and access for maintenance.

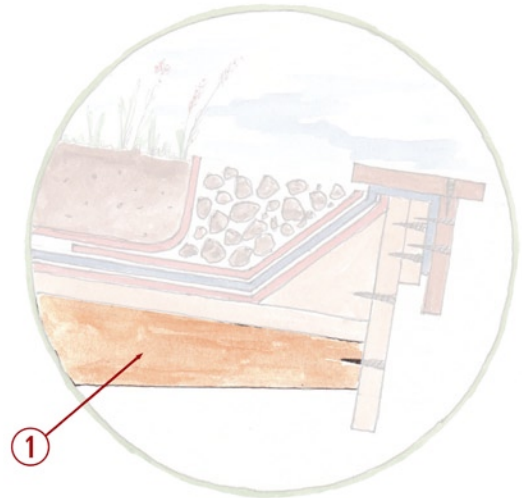
If you just fix a fascia to the ends of the joists without a chamfered cut your roof will look heavy and out of scale. Make a chamfered cut as *Photo 1*

We would suggest an overhang of at least 400mm from the wall edge, or better still 600mm.

Cut the joists to length. There is no need to make a plumb cut as you would with a conventional roof, simply use a square cut to the joist.

Cut the chamfer from about 50mm outside the wall edge to 50mm down from the top of the joist end. **See photo right**

Fix your joists to the walls, 400mm to 600mm apart depending on your weight loading and joist size. It's a good idea to set your joists to suit the sheet material you are using. for example a standard plywood sheet is 2440mm long so try to fix a joist at 1220mm and 2440mm centres along your joist run. The 1220mm centre allows you to stagger the joints in your roof deck.



chamfered joists



2. Fix Roof Deck

Your roof deck can now be fixed. If you need to enclose your roof space now is the time to fix noggins between your joists above the wall using the off cuts from the joists.

The main thing to remember when installing your roof deck is to fix flush or just back from the joist edges, this makes the alignment of the fascia much easier later (See Diagram 2).

What you choose to fix to your joists to support your roof, as with most of the construction, will depend on your taste.

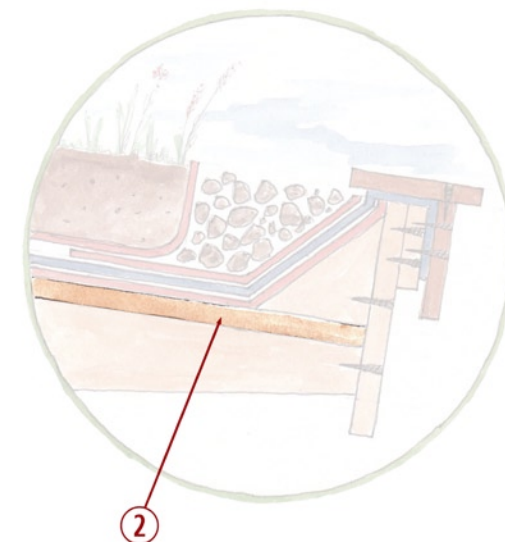
It will depend on:

- how sustainable you want the material
- will the underside be on view

Here are a few choices:

- 18mm WBP (waterproof plywood) preferably FSC (<http://www.fsc.org/en>) certified. There are some interesting ply's available. Plywood also has the advantage of helping to brace your building and is often essential on an open sided timber structure. Best to paint or add a finish on the underside before fixing.
- 18mm strand board. *See photo below.* Slightly more 'fragile' especially the edges but an interesting finish and relatively cheap material. Will again help to brace the building if needed
- Rigid recycled plastic sheets. See <http://www.filcris.co.uk> – long lasting and 'green' but at present expensive. Multi coloured versions also available see <http://www.smile-plastics.co.uk> but not rigid enough to go more than 400mm between joists
- Any timber planking minimum 20mm. Choose from reclaimed see <http://www.ashwellrecycling.com> FSC certified or what ever you fancy.

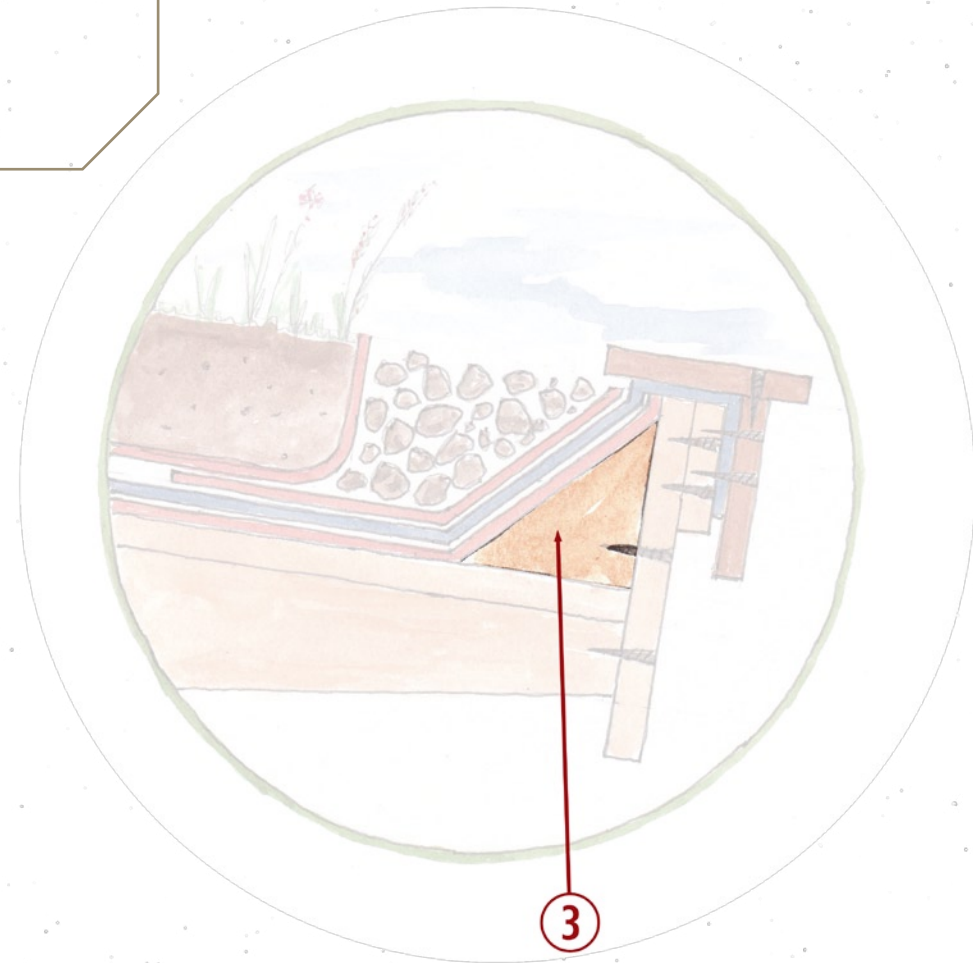
18mm strand board



3. Fix Triangular 'arris rail'

This triangular timber can be cut from a 75mm x 75mm post or more easily bought from your local builders merchant as 'arris rail'. Traditionally used in fencing and sold in 3m lengths, it's more difficult to get untreated or from a sustainable source. May have to be your first compromise.

- This can then be fixed all around the edge of your roof. **See Diagram 3**
- Try to align with the joist edge using a straight edge to butt to.
- Fix with 90mm screws straight down through the deck and into the joist.
- Cut a rough mitre on each corner.



4. Fascia

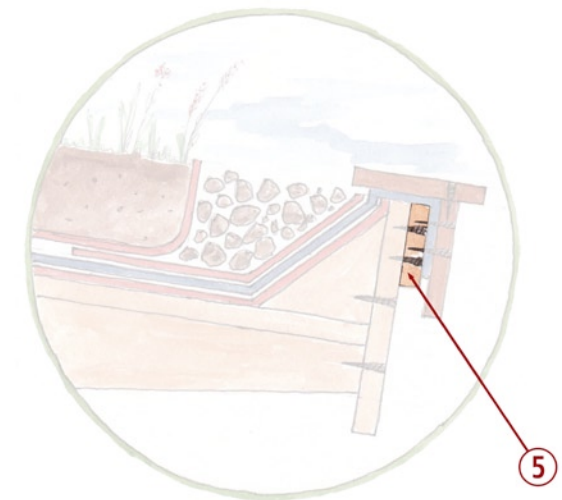
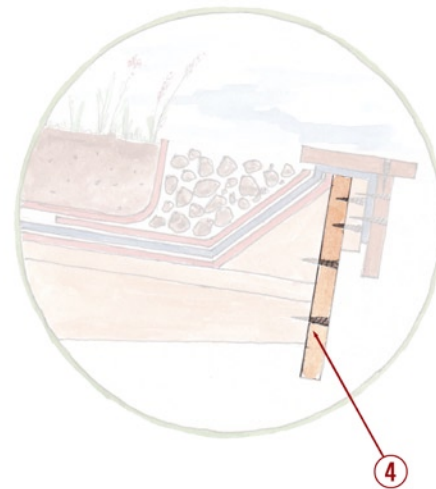
- If you use the dimensions we have suggested in the fascia detail sketch you will need to fit a 175mm fascia.
- Fix your fascia approximately 15mm below the bottom of the chamfered joist and around the roof. This means the top edge will finish just above the arris rail.
- You need one fixing into the end grain of the joist and the other into the arris rail. Make sure you don't go through the rail with the top fixing because it could pierce the butyl liner.
- You will need to paint or finish the fascia before fitting.

5. 75mm Spacer

Next fit 75mm x 20mm spacer flush with the top edge of the fascia. Leave this back approximately 30mm from each corner to allow for the creases in the waterproof liner.



75mm spacer fixed flush with top of fascia and butyl outlet sleeve ready to pull through lower geotextile and roof deck



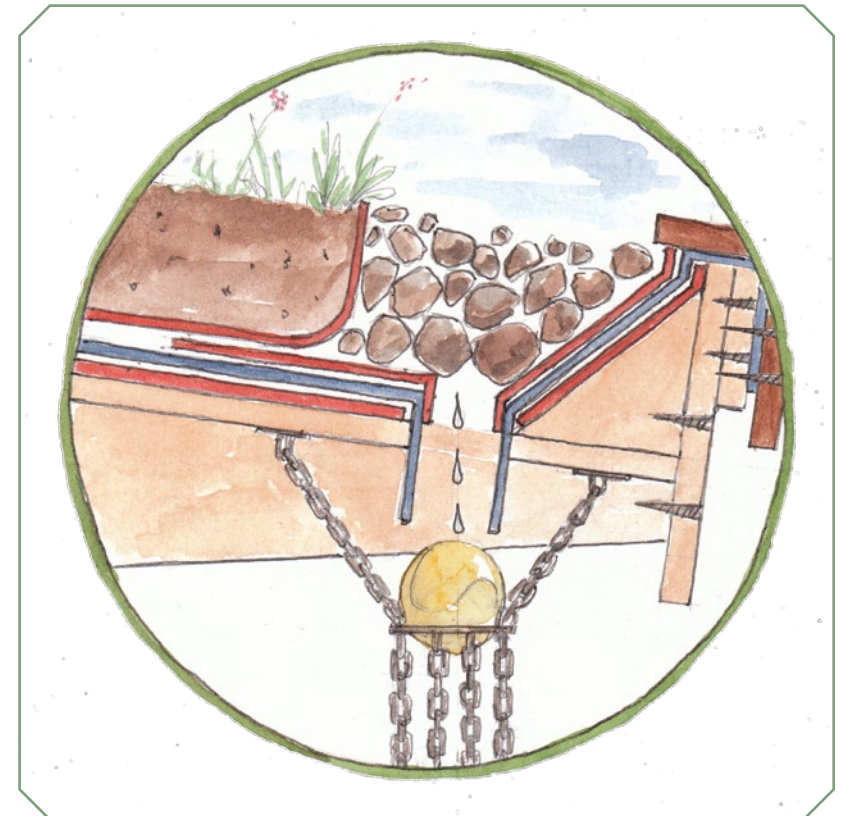
6. Drill Outlets/Outlet

If you are going to use a drainage chain:

- The outside edge of the outlet should not be closer than 100mm from the fascia.
- Positioned in the centre of 2 joists. This will allow you to screw the chain fixings in a circle approximately 200mm in diameter.
- To drill the outlet hole use a 75mm hole cutter. Drill halfway through from above to gauge position then finish from underneath.

If on the other hand you choose to run the water into a conventional downpipe:

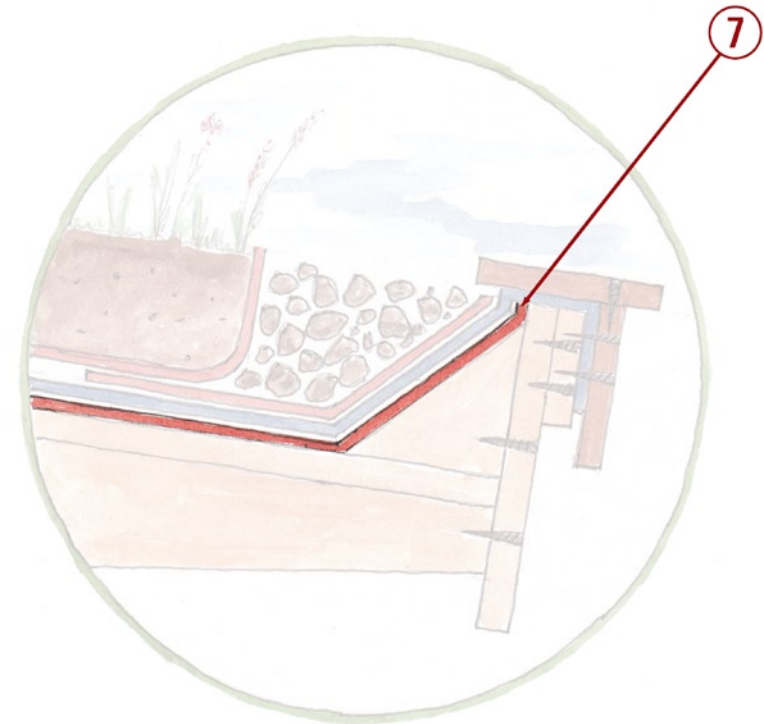
- It is easier to site the outlet edge close to the edge of the triangular section arris rail.
- This means the top clip for the downpipe can be fixed on to a spacer fixed to the inside of the fascia.



7. Lower Geotextile Layer

This provides a protective barrier between the deck and the waterproofing liner.

- Check the roof deck and edges for anything sharp especially nails through the arris rail and deck fixings not hammered home.
- Sweep the whole roof well and ensure that the surfaces are free of anything that could puncture the waterproof liner.
- You need a soft layer to protect the waterproof liner in the same way you would protect your pond liner from puncturing. This is the lower geotextile and is available from www.butyl-products.co.uk.
- The lower geotextile layer can be a cheaper grade than the upper geotextile layer [this has to be higher quality as it protects the waterproofing from damage by the substrate]. Lay this down overlapping each sheet by 100mm all over the deck and up the arris rail but not over the top of the fascia.



8. Waterproof Liner

At this stage extra care must be taken. The liner is vulnerable to damage until it is protected by the upper geotextile.

BUTYL LINER

For smaller scale green roofs, up to about 35 m², a one-piece butyl liner can be pre-fabricated off site including any prefabricated sleeve. The position of the pipe sleeve [outlet sleeve] needs to be specified to the fabricator so they can pre-weld this to the liner. We use butyl products [<http://www.butylproducts.co.uk>] – Using a prefabricated pipe sleeve [outlet sleeve] and liner means the whole roof can be completed without the need for a specialised contractor.

Once over 35m² the weight of the liner will mean that you will need a lot more manpower to get the liner onto the roof.

The advantages of butyl for small scale builds are:

The pipe sleeve [outlet sleeve] can be supplied pre welded to your liner in the position you specify, saving work and detailing for the DIY builder.

- Butyl also has a very long life even when exposed to UV, meaning it will last even longer beneath a green roof.
- It is light and flexible

The disadvantage is:

- Butyl is not as puncture resistant as other membranes therefore **CARE** is needed.

Ordering the liner

Measure the exact size of the roof and then add around 700mm to each figure. So for a 5m x 4m roof, order 5.7m x 4.7m. This gives you enough material in case your roof is not exactly square! Furthermore with the best will in world the pipe sleeve may not be exactly where it needs to be. The slack allows the pipe sleeve to be positioned and ensures that there is enough liner to go up and over the edge detail.

The water outlet position will obviously vary depending on the roof design. The most common location is in the corner of your roof. Tell the fabricator, which corner the pipe sleeve needs go in and to position the sleeve 500mm in from the 2 sides of the corner. Where the two 500mm lines meet is the centre of the 75mm pipe sleeve. The pipe sleeve is 75mm as this will fit neatly into a standard drainpipe if you do not choose to use the chain method described below [section 13].

To install the liner

Cut away the geotextile from above the outlet hole

Push the pipe sleeve through the outlet hole.

Roll out the liner

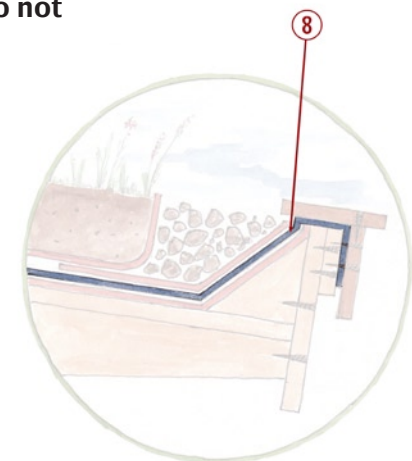
If your measurements are right the liner should hang over the 75mm spacer all round the roof edge.



Outlet pipe sleeve



Outlet pipe sleeve pre-welding



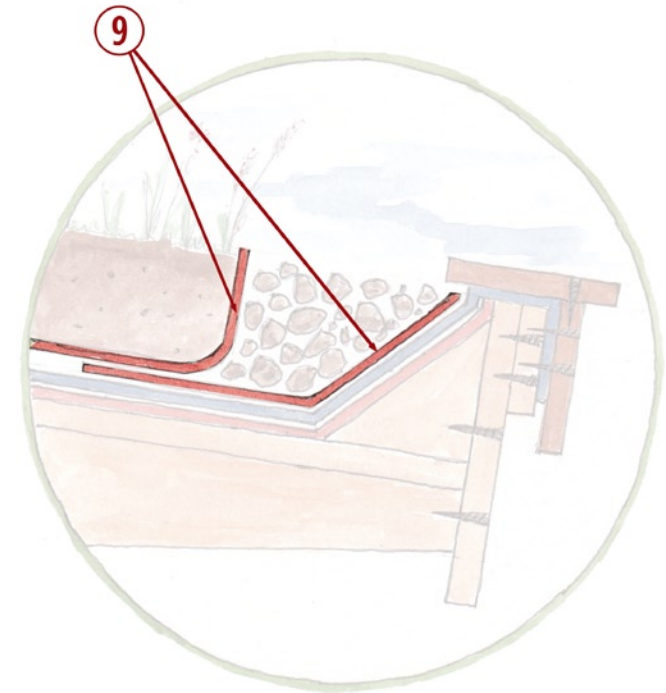
If you choose not to use butyl and prefer to use a felt or high end water proofing finish we would recommend suppliers listed on www.livingroofs.org

9. Upper Geotextile Layer

This fabric is essential. It protects the waterproofing and is important that it is laid onto the liner as soon as possible. Get a good quality geotextile. We recommend a 5400 CBR geotextile <http://www.butylproducts.co.uk> If you use another supplier ensure that the grade is equal to 5400CBR.

Installing the layer:

- Check the roof for anything sharp and sweep off.
- If you are going to wear shoes look at the tread.
- Paranoia at this stage is good!
- Roll out the fabric.
- Overlap each run of fabric by at least 150mm.
- The upper layer geotextile should run over the waterproof liner and up to meet the top cap. See diagram 9.
- This will prevent any substrate getting between the geotextile upper layer and the waterproof liner.
- Trim the geotextile. Be very careful not to damage the waterproof liner beneath.



NOTE

The upper liner now protects the waterproofing.

However it is still vulnerable to damage.

Any work you do on the roof before the substrate is applied could cause damage.

We recommend laying any off cuts from the geotextile layers in areas where you want to work. This just gives that extra bit of protection.

It is also very useful to lay off cuts on the area you will stand while you lift the substrates up.

You must trim the geotextile around the outlet otherwise the water will not release quickly enough.

10. Capping

The waterproof liner should now be hanging over the 75mm spacer all round the roof. The waterproof liner can now be secured around the edge of the roof:

- Fix the 100mm x 20mm side cap flush with the top of the spacer.
- This traps the liners.
- This piece also serves as a drip.
- Ensure there is some slack in the liner at the edge before securing.

11. Top cap

The top cap finishes the fascia detail and covers the top of the liner.

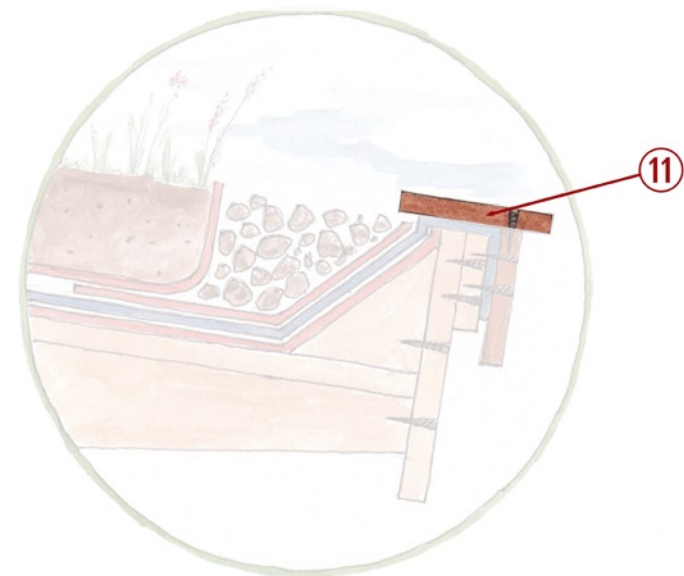
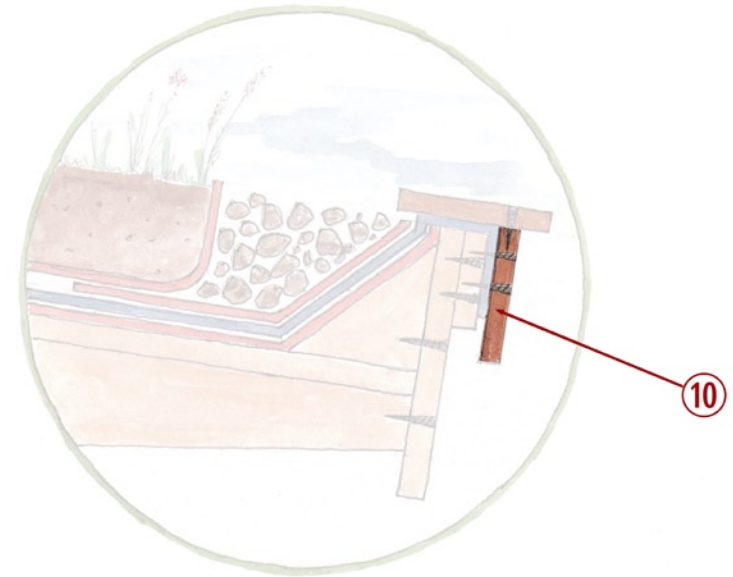
- Screw the 75mm x 20mm top cap through the side cap you have just installed.
- **Don't fix through the liner!**
- **It will cause a leak!**

The top cap is the most vulnerable to decay as it is exposed to direct sunlight above and damp from the roof substrate below. Recycled plastic or reclaimed hardwood is recommended for the top cap.

Now: Trim off the excess liner with a sharp knife between the back of the side cap and the 75mm spacer. Roof should now look 'tidy'. If not don't worry; the plants will soon cover the edge.

It is best to cover the liner with the chosen substrate or finish immediately as the wind may lift the upper geotextile and, more importantly, the waterproof liner.

If this is not possible weigh down the liner to ensure that this up-draught doesn't ruin your work.



12. Drainage

Drainage layers are a matter of choice in terms of money, what you want to achieve and the pitch of the roof. All roofs will need a drainage 'gully' as in diagram 12. On commercial roofs there is always a 300mm shingle perimeter around all upstands and drainage elements. The drainage gully serves the same purpose allowing water to freely drain and restricting the movement of vegetation and other soils.

Flat roofs and Gentle Pitched Roofs

On flat or shallow pitched roofs up to 6 degrees additional drainage is probably advisable to help remove excess rainwater. Not using such a layer could mean that water builds up on the roof and 'drowns' drought tolerant plants, particularly during the winter months.

You can deal with the additional drainage issue in 3 ways:

Using stone:

- Add 10–20mm stone, crushed concrete or commercial drainage mat evenly on top of the geotextile layer, 30mm in depth.
- Then cover with a filter fabric, such as Terram or equivalent. See <http://www.terram.com/>
- Adding chalk or other water retaining material to the stone helps to hold some water during the dryer months.
- It is always a balance of water holding/drainage.



Using a conventional drainage layer available from commercial suppliers. See Livingroofs.org:

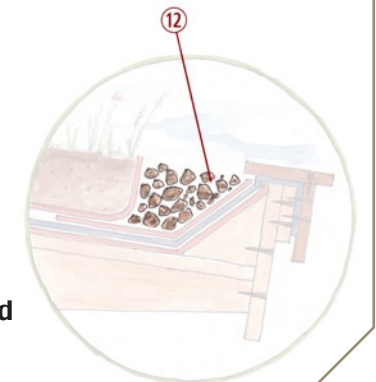
- These are either in the form of a sponge with spaces beneath or the classic eggshell design.
- Most of these come with a filter sheet attached to ensure that fines cannot escape into the drainage layer and away from the roof.

Creating drainage 'channels':

- Another option is forget a uniform drainage layer beneath the green roof substrate and to create a series of drainage channels running to the outlet. **See photo 10**
- This can provide an added 'feature' to your roof if you are interested in the creation of a biodiverse roof.
- You could use rubble or shingle or pea gravel.
- These will vegetate in time.
- The rubble/shingle channel should run the length of the roof and terminate near the drainage outlet. **See photo 10**
- This is also quite good if you have the potential for water to spill from another roof.

Steeper Pitched Roofs

On slopes over about 6 degrees with a free draining substrate no drainage layer is required. However as with flat and gentle roofs a drainage gully is needed.



12a. Drainage Gully

The drainage gully is a shingle/rubble edge at the base of the roof. This allows the rain water especially in times of heavy rainfall to leave the roof quickly.

Commercially 20 –40mm shingle is used, however pea gravel or crushed rubble of a reasonable size is just as good.

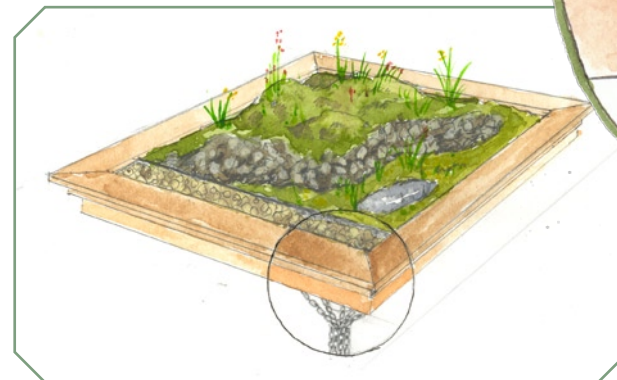
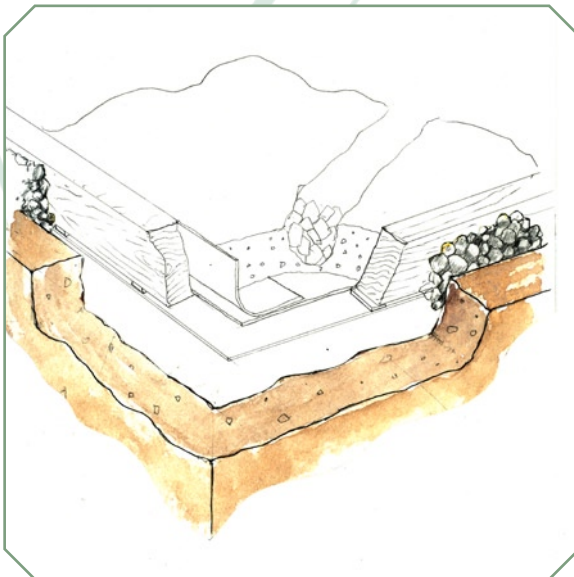
The gully should be at least 100mm wide.

To stop drainage material from falling through the outlet, cover the hole with some 20 mm square galvanised mesh.

Make sure the geotextile is lapped up against the drainage layer to separate this gully from the growing medium/substrate [see diagram on page 21].

The waterproofing is protected, but it is important you are aware that it will still be vulnerable to damage. We lay an off cut of geotextile on the area of the roof we intend to use to pass up the soil/substrate.

The application of the green roof substrates and plants will be dealt with later. We will now cover some detailing.



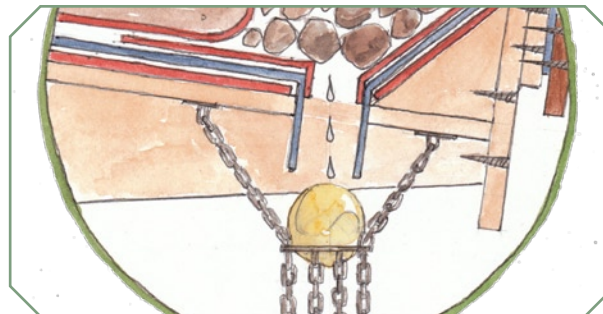
13. Rain Chains

Our roofs use a German detail to run the excess rainwater to the ground. You could choose to use more conventional methods such as down pipes etc. The Chains, however, give a unique finish. They are not only attractive and virtually indestructible but the combination of the stone gully and the chains will mean you will never have to use any plastic fittings on your building. The chains could run to a traditional outflow or to a rainwater butt.

Installing the Chains

The number of chains will depend on the area of the roof the outlet serves. For a roof with an area of less than 50m² then 6 chains should suffice.

- First take a plastic bowl that is larger than the outlet.
- Use the bowl to mark a circle on the underside of your roof deck. The centre of this circle should be in line with the lower edge of your outlet hole.
- Around the circle you have drawn screw lacing eyes or equivalent (supplied by yacht chandlers) equal distance apart to the roof deck using screws no longer than 20mm, otherwise you will go through your waterproof liner!!
- The number of lacing eyes should equal the number of chains you are going to use
- Use small shackles to attach the chains to the lacing eyes.
- Gather the chains together just under the outlet
- Tie and secure the chains in a bundle using galvanised wire
- There will always be a little splash back. To reduce the water splashing off the chains, place a tennis or foam ball on top of the cluster
- The ball catches the water and directs it the centre of the chains, thus reducing splash back
- Trim the chains so that they hang just above ground level



13a. Ground Level Drainage Outlet

If the outlet is standard it can be made wider to direct any splash back into the drains.

The design is down to the individual, be it a sloping concrete finish or a pebble mosaic (See photos 11 & 12).

Alternatively the chains could sit in a water butt.

NOTE

Don't forget to make use of the water from your roof (in photos 11 & 12 the water runs to a pond) although you should note that there will only be a fraction of water from a green roof compared to a conventional roof.



14. To Irrigate Or Not?

Certain systems may well need irrigation depending where you are in the country. If you are going for a very lightweight sedum system then we WOULD recommend irrigation. If you are using one of the wildflower turfs systems these will probably need irrigation, but ask the supplier.

On the other types we have described it is optional. Most systems will brown off in the late summer. That is natural. However you could choose to have the option to irrigate. It is relatively inexpensive to install.

If irrigation is your choice we recommend the rubber soaker hose or 'leaky pipe' available from most garden centres. It comes in 25 or 50m coils and you need at least 1m for each m² of roof.

- If using a sedum blanket system then this needs to go beneath the blanket on top of the substrate or the rock wool.
- Installing a soaker hose into the top 30mm of the substrate when it is applied to the roof.
- It is very tricky to get the hose into the top layer of the substrate without it springing out.
- Unroll the hose at ground level and try and unwind the bends etc.
- Pulling from the coil will mean you will get into a serious mess.
- Drag the hose up on to the roof as you go.

To install

- Bend over the end of the hose about 100mm and secure with wire or cable tie.
- This stops the water pouring out of the end when the tap is turned on.
- Start laying the hose at the lowest point of the roof.
- Lay the hose up the roof in a series of loops approximately 500mm apart.
- Bury the hose as you go.
- When you reach the top fit a hose connector.
- To the hose connector attach a short section of standard hose long enough to reach the top edge of the roof.
- This should run over the fascia and down the side of the wall.
- It is good to position this to the rear of the building in question.
- Secure to the side of the building.
- Fit another hose connector to allow you to connect to your ground level hose.



Leaky pipe end showing cable ties



Leaky pipe irrigation showing loops

Construction Guide - Notes About Fixings

Try to use fixings 2.5 times the thickness of the material you are securing. So to fix a 20mm fascia board use 50mm screws/nails.

However, if you are fixing into the end grain of timber (say when you fix your fascia into the end of your roof joist) use at least 3 times the thickness.

Most of the roof fixings are exposed to the weather to some extent so if you can always use either stainless steel screws or nails then sheradised or galvanised ring shank versions are preferable. See www.screwfix.com

If you are using stainless steel screws always pre-drill holes, as they are prone to snapping when put under too much tension. You will need to countersink screws flush to prevent possible damage to liners, geotextile layers etc.

If screws are on show and there is no need to have them flush then small coach screws look good, especially if it is a slightly bulkier construction.

If you are using a lot of screws then a small battery impact driver is invaluable. See www.screwfix.com

Ring shank nails are far superior to standard nails. They have a series of backward facing rings on the shaft that means they hold far more securely.

When nailing try to avoid leaving the shape of your hammer in the wood (a half moon).

We tend to use nails for the fascia and side caps as we prefer the appearance, but you could use screws if you prefer. Obviously use screws when fixing into a material that is not solid. For instance, we would generally screw the top cap on the roof edge detail.

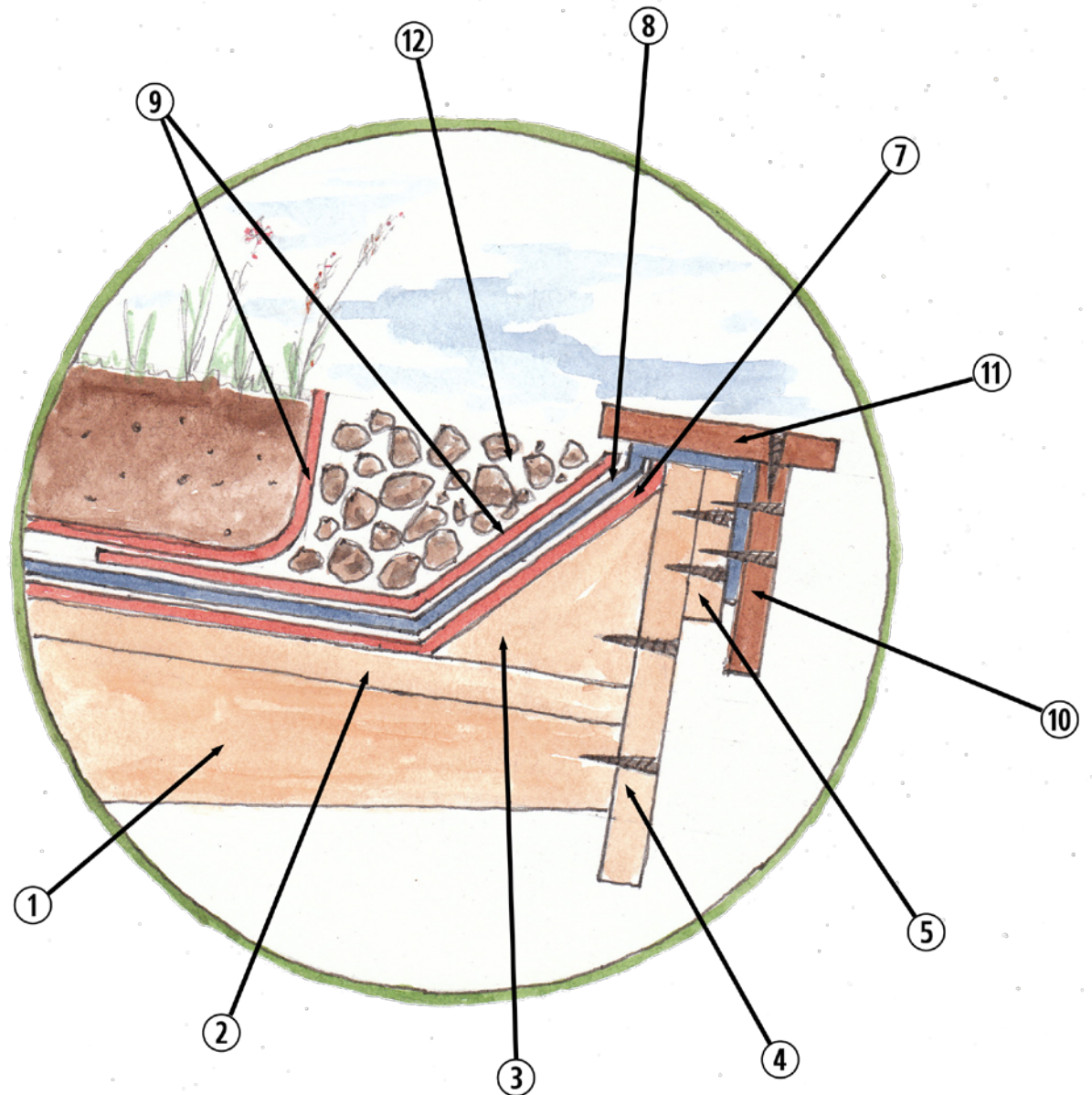
Here is a list of the fixings we use on the roof construction detailed on [page 13](#);

- 1. To fix roof joists to your walls use 100mm ringshank nails or 90mm x 6mm screws,**
- 2. To fix roof deck to joist use 50mm ringshank,**
- 3. To fix arris rail to joists use 90mm x 6mm, angle them so they don't go through the end of the chamfered joist,**
- 4. Use 63mm sheradised ring shank into the end grain of the joist and 50mm into the arris rail,**
- 5. 50mm ringshank for the spacer,**
- 9. 50mm ringshank for the side cap,**
- 10. 4.5mm x 50mm stainless screws for the top cap,**
- 14. 20mm stainless screws for the lacing eyes into the 18mm roof deck.**

Construction Guide - Overview Diagram

Key [click heading to go to section]

- 1. Fit Joists**
- 2. Fix Roof Deck**
- 3. Fix 'Arris Rail'**
- 4. Fascia**
- 5. 75mm Spacer**
- 6. Drill Outlet(s)**
- 7. Lower Geotextile Layer**
- 8. Waterproof Liner**
- 9. Upper Geotextile Layer**
- 10. Capping**
- 11. Top Cap**
- 12. Drainage**



You may have an existing flat roof extension that you are considering as a potential green roof. You will need to follow the same principles as outlined above.

Be sure:

- How much weight you can get on to the roof.
- Be sure that you are happy with the waterproofing as it is or boost it by applying a butyl liner or an extra layer of felt.
- If you are not using a butyl liner you could use a 300 micron damp proof member double thickness to act as a root protection layer. If there is a need to overlap sections ensure that overlaps are at least a 1 m wide and that sheets further up the roof lap **over** sheets further down.
- Consider where the water will leave the roof.

If your roof is flat you are advised to use an engineered drainage layer to ensure excess water can leave the system or use a gulley method. Using a uniform gravel drainage layer may not be possible due to load.

You will need a terram/geotextile/filter sheet above this to stop fines from leaving the system. Some commercial drainage layers come with a filter sheet attached. You have two choices once you have laid the drainage layer onto the roof.

Option 1

Create a shingle boundary around the perimeter of the roof and around the drainage outlet.

Then ensure geotextile and filter sheet runs up edge of shingle and then add substrate and plants as outlined below.

Option 2

You could create a wood frame for the green roof to sit in.

- Lay out the root barrier [butyl liner or 300 micron damp proof membrane] onto existing waterproof layer. It should cover the area you wish to green including the wood frame to retain the soils.
- Create a square frame on top of the root protection using reclaimed timber.
- Railway sleepers can be used or other tannelised wood.
- The wood wants to reasonable wide and have a height of at least 100mm.
- The frame will need to sit on 20mm spacers on top of the root membrane. This allows water to drain under the frame.
- The root protection should extent under the wood frame.
- Lay out the drainage layer in the frame. Ensure that the filter element runs up the side of the frame.
- Install cross noggins inside the frame to ensure that the frame doesn't warp.
- If it doesn't sit on the drainage layer and this element finishes at the inner edge of the frame, the frame must sit on spacers so that water can freely run below the frame.
- Add substrates and plants as outlined below.

This can be a very useful way to create a field station/labs for students

THIS SECTION PROVIDES A GUIDE TO EVERYTHING ABOVE THE ROOF DECK INCLUDING WATERPROOFING AND GEOTEXTILES

THE GROWING MEDIUM

The Green Roof Growing Medium is often referred to as the substrate, the green roof soil or the growing medium. Ideally most green roof growing mediums have a good degree of aggregate within the mix to both store water and allow water to free drain.

Commercial green roof soils are generally light, very porous with lot of voids to store water [thus retaining water] and come from a recycled source.

Plants will grow in virtually any material so there is plenty of choice. However substrates should have good water retention capacity, as this will help the plants through the summer.

Sedum Blankets

For sedum blanket systems suppliers should provide the base substrate that the blanket is to be laid on. Sedum blankets will grow on a good aggregate based soil and we recommend at least 20mm at least. If you can try to add about 40mm as this will retain more moisture in dry summers

Sedum Plugs Systems

For a 75mm Sedum plug system you will need an extensive green roof substrate. Extensive green roof soils can be bought from reputable companies. These are often based on a crushed recycled brick with approximately 10% organic matter blended into the aggregate. If you want to buy and blend your own soils, you can choose from a whole range of materials depending on their weight.

Biodiverse/Meadows/Roof Gardens

We have built green roofs with just garden 'soil' from the site. This is fine but it will not necessarily give such a diverse community. We would suggest using a range of substrates with some nutrients blended in. We would recommend no more than about 20% soil/organic material. This will allow the flowers to dominate rather than grass. You can also play around with the substrate in the system, creating areas with more substrate and areas with less. Again this will provide a range of diversity.

We would also recommend varying the depths of the substrates. This will add diversity.

Here are few materials that are or have been used as extensive green roof aggregates:

- ***Light expanded clay aggregate [LECA]*** is often used as a base material as it is light. However, it can be a nightmare to walk on and you would have to add some soil to provide some nutrients. Generally extensive soils have about 20% organic material, whether it is stripped pine bark, green waste compost or soil. The rest is the aggregate. One of the downsides of Leca is the high impounded energy as it uses a lot of Carbon Dioxide when produced.
- ***Lava*** is often used as a base material for green roofs on the continent. Some companies use it here but it has to be imported and therefore will have a quite high impounded energy. The beauty of lava is it is light.
- ***Commercial recycled brick based extensive soils*** are commonly used by many of the companies. The advantage of this type of material is that it is relatively light, will come with a data sheet so you will know how much it weighs. They can often be bought in 25kg bags which means handling is easier.

Of course we like to encourage people to 'do' their own thing. Using local aggregate waste is a good option whether it is sourced from your own house, garden or a local demolition/waste yard. You can then lay this out adding soil, or composted stripped pine bark or green waste compost at varying depths.

NOTES / IDEAS

Consider adding areas of sand as many bees like to nest in sand. But keep these to the edges or areas of higher loading as sand is a lot heavier than most aggregates commonly used in green roof construction.

The rule of thumb with aggregates is that wherever possible they should be free draining, low nutrient in character and preferably light.

There is often no easy way to get the material up but if you have a lot of material you can hire small conveyor belts; other than that, friends are the only answer.

THE PLANTS

Wildflowers



Chives



Sedum



Dwarf Red Hot Poker



Red Valerian



Chives



Kidney Vetch



Hare's Foot Clover



Birds-foot-trefoil



Toadflax



Viper's-bugloss



Melliot

THE PLANTS

Annuals



Cornflower with Bee



Scented Mayweed



Corncockle



Cornflower and Ox-eye Daisies



Corn Marigold



Cornflower

THE PLANTS I

You can choose from any of the plant or seed options below but better still use a combination of all or some of them.

Diversity is the key to a dynamic roof!

Sedum mats

In general sedum blankets are best placed onto at least 20mm of substrate. When buying from a recognised supplier they should provide the substrate. A number of suppliers pre-seed the mats with herbs, which germinate over time and provide variety.

If you really want the instant effect of a sedum mat you can always consider placing on 100mm of substrate roof. You can then plant through the roof with plugs and bulbs. The sedum blanket acts as mulch.

Sedum blanket system will have some weeds in the blanket as the seeds colonise from the surrounding land where the blankets were growing. Grasses will also soon colonise. So if you want it to remain as when you bought it you will need to follow the maintenance instructions provided by the supplier. However try and allow a few dead stems to remain on the roof, as these can be an important hibernation area for some invertebrates.

Sedum/Wildflower Plugs

If you are going for a sedum plug roof it is probably best to purchase the plugs from a recognized supplier. In general commercial sedum plug roofs use about 15 species. Don't forget that there are only a few sedums that are native/naturalized. Using plugs means there are more spaces for other species to colonise, you could add a seed mix in and around the plugs to add variety and suppress unwanted species. Seeding with an annual mix gives extra colour in the first few years. Plant at 15 – 20 plugs/m². It is important that when using plugs you consider that the best time to plant plugs is in September or March. It is also important to wet the plugs thoroughly before planting and to thoroughly water the roof once they have been installed. We would recommend regularly watering once a week for a month or so to ensure that the roots have taken hold in the green roof substrate.

One of the problems with plugs is that they are unlikely to have been grown in the substrate you are planting them into. Therefore it might worth adding a little more soil/organic material around the plugs to get the roots established.

There are good suppliers of native plugs and we recommend suppliers listed on www.floralocale.org

Seeds

There are a variety of plants that can be seeded into a green roof. This will depend on the substrate and the substrate depth. We also recommend that you seed with a special cornflower/annual mix at a low density say 1g/m². These annuals will give you an initial splash of colour in the first year. In dry years, when other plants die back the gaps in the sward allow extra light through which triggers the annuals to germinate,

Again we recommend using a native supplier of seeds as listed on www.floralocale.org

There are many naturalised and non-native plants that can be seeded as well so the choice is there. You just have to select what you want. Also don't forget that many plants will colonise the roof from surrounding areas.

Another thing to consider is collecting seeds from your neighbourhood. Dusty spends hours over the summer collecting seeds from wasteland sites in London. What's interesting is that many of the species listed below can be found on local waste ground and are therefore already growing in the similar conditions you would find on a green roof. This is also a good way to get to know plants that actually grow in your area.

However, we would recommend that you follow the code of conduct for collecting;

http://www.thewildflowersociety.com/wfs_new_pages/1f_code_of_conduct.htm

THE PLANTS II

Native Hay Mulch

Another alternative is to dress the green roof substrate with wildflower hay. We are currently working on a couple of projects, where hay from local nature reserves is to be used on neighbouring green roofs. This really is native provenance. There is a lot of work being undertaken on this method in Switzerland, where hay from an orchid rich roof is being used to increase diversity on other green roofs. Some thought needs to be given to the substrates the hay is to be scattered onto. It is important that the hay is placed in sacks during transit. Once laid onto the roof ensure that any seeds that have collected at the base of the sacks are distributed over the roof as well. The hay should be laid at a depth of about 20mm and spread.

Wildflower Turf

There are a few companies that have developed wildflower turf. We would recommend that you use turf systems that have been developed for green roofs. It is important that the turf contains a good proportion of wild flowers preferably those associated with chalk downland as these species will be happier under green roof conditions. Good companies to contact are Lindum Turf and Coronet Turf [see suppliers section]. Depending on the amount of substrate they are placed on they may well need irrigating in the summer. The suppliers will be able to advise.

Bulbs

It is possible to plant bulbs into your substrate and plant into you sedum blankets/turf. You will need at least 100mm of substrate as a rule of thumb. The type of bulbs that you can plant need to be ones that can survive the harsh summer conditions, i.e. dry and sun-baked. Alliums (Chives etc – can be planted in shallower depths) are classic green roof plants. Grape Hyacinth is another good bulb though it can take over. Star of Bethlehem has turned up on a few of our roofs in the waste soils and seems to do very well. There is currently work being undertaken at Sheffield University so ‘watch this space’.

Other Planting Suggestions

Why not add to your plant mix by growing some hops up a single pole next to your roof? Wild hops may be too aggressive for your taste so you could try golden hops. Once established the hops will twine up the pole and spread across a section of your roof giving you a plant that stays green during the height of summer when your roof plants may have browned off or died back. Golden Hops always die back in the winter which means they should not overpower your roof plants and each year they will reuse last year’s old stems to reach the roof.

NOTES/IDEAS

A FEW PLANTS ARE DROUGHT TOLERANT IN SUMMER BUT DON'T COPE WITH SATURATED CONDITIONS IN WINTER. SOIL, AS IN TOPSOIL, BASED ROOFS OFTEN TEND TO HAVE THESE CONDITIONS.

USE A VARIETY OF TECHNIQUES: PLUGS, SEEDS, BULBS

DON'T PANIC. ONE OF THE GREAT THINGS ABOUT A NEW ROOF IS THE EXPECTATION OF WHAT IT WILL LOOK LIKE. IF YOU START OFF WITH LITTLE YOU CAN ADD AS YOU GO ALONG.

ADDING LOGS AND LARGE STONES CAN PROVIDE A BIT OF SHADE, THUS REDUCING EVAPORATION. WE HAVE FOUND THAT SOME PLANTS WILL DO THAT LITTLE BIT BETTER ON THE NORTH SIDE OF LOGS

THE PLANT LIST

The plant list below is a guide to the type of seeds and plugs that could grow on a roof. We have provided a guide to the type of depth/substrate that maybe needed to support these species. It is not definitive.

Latin Name	English Name	Substrate Depth
<i>Acinos arvensis</i>	Basil Thyme	50
<i>Achillea millefolium</i>	Yarrow	50
<i>Agrimonia eupatoria</i>	Agrimony	150
<i>Anthyllis vulneraria</i>	Kidney Vetch	75-150
<i>Armeria maritima</i>	Thrift	100
<i>Campanula glomerata</i>	Clustered bellflower	100
<i>Campanula rotundifolia</i>	Harebell	75
<i>Centaurea nigra</i>	Common Knapweed	100
<i>Centranthus rubra</i>	Red Valerian	100
<i>Clinopodium vulgare</i>	Wild Basil	75
<i>Dianthus deltoides</i>	Maiden Pink	75
<i>Dianthus armeria</i>	Deptford Pink	100
<i>Echium vulgare</i>	Viper's-bugloss	75
<i>Erigeron acer</i>	Blue Fleabane	100
<i>Erodium cicutarium</i>	Common Stork's-bill	75-100
<i>Galium verum</i>	Lady's Bedstraw	100
<i>Geranium molle</i>	Dove's Foot Crane's-bill	50-100
<i>Helianthemum nummularium</i>	Rockrose	50-100
<i>Hieraceum aurantiacum</i>	Orange Hawkbit	100
<i>Hypericum perforatum</i>	Perforate St John's-wort	100
<i>Knautia arvensis</i>	Field Scabious	100
<i>Leontodon autumnalis</i>	Autumn Hawkbit	75
<i>Leontodon hispidus</i>	Rough Hawkbit	75
<i>Leucanthemum vulgare</i>	Ox-eye Daisy	75
<i>Linaria vulgaris</i>	Common Toadflax	150
<i>Lotus corniculatus</i>	Bird's-foot-trefoil	75
<i>Ononis spinosa</i>	Spiny Restharrow	75
<i>Origanum vulgare</i>	Wild Marjoram	75
<i>Malva moschata</i>	Musk-mallow	100

Latin Name	English Name	Substrate Depth
<i>Medicago lupulina</i>	Black Meddick	75
<i>Pilosella officinarum</i>	Mouse-ear Hawkweed	75
<i>Plantago media</i>	Hoary Plantain	75-150
<i>Primula veris</i>	Cowslip	100-150
<i>Prunella vulgaris</i>	Selfheal	100-150
<i>Pulsatilla vulgaris</i>	Pasque Flower	100
<i>Ranunculus acris</i>	Meadow Buttercup	100
<i>Ranunculus bulbosus</i>	Bulbous Buttercup	75
<i>Reseda lutea</i>	Wild Mignonette	75
<i>Salvia pratensis</i>	Meadow Clary	100
<i>Sanguisorba minor</i>	Salad Burnet	100
<i>Scabiosa columbaria</i>	Small scabious	50
<i>Silene vulgaris</i>	Bladder Campion	75
<i>Sedum acre</i>	Biting stonecrop	50
<i>Sedum album</i>	White stonecrop	50
<i>Sedum reflexum</i>	Reflexed Stonecrop	50
<i>Thymus drucei</i>	Wild Thyme	75
<i>Thymus serpyllum</i>	Breckland Thyme	50
<i>Trifolium arvense</i>	Hare's Foot Clover	75
<i>Trifolium campestre</i>	Hop trefoil	100
<i>Verbascum nigrum</i>	Dark Mullein	75
<i>Veronica spicata</i>	Spiked speedwell	50
<i>Lathyrus latifolius</i>	Everlasting sweet pea	50-100
<i>Koeleria macrantha</i>	Crested Hair-Grass	50-100
<i>Briza media</i>	Quaking Grass	50-100
<i>Stipa arundinacea</i>	Pheasant's Tail grass	100
<i>Stipa tenuissima</i>	Feather Grass	100
<i>Glaucium flavum</i>	Yellow horned poppy	100
<i>Rosmarous officinalis 'Prostratus'</i>	Prostate Rosemary	100
<i>Kniphofia rooperi</i>	Red Hot Poker	100

You will notice that we have recommended only a few grasses. It is best to start off with flowers, as the grasses will colonise in time.

There are as yet very few proprietary green roof seed mixes in the UK. However the Green Roof Centre in Sheffield has an extensive green roof seed mix, which contains a combination of native and non-native seeds that are classically used on green roofs [www.greenroofcentre.co.uk].

Emorsgate Ltd [www.wildseeds.co.uk] has a living roof mix, which has been developed for the London area.

BIODIVERSITY

The type of green roofs advocated in this guide should have significant benefits for nature, but often the real benefit is unseen as rare unassuming bugs can find refuge on very small areas of habitat in our gardens and around our houses.

Throughout the guide we have encouraged the use of a variety of substrates and substrate depth. This will ensure that a range of plants can grow but as importantly a range of different bugs can find refuge on the roof.

Some bugs like bare and very dry habitats and roofs are an ideal to create this type of habitat. Certain bee species rely on flowers with special sepals, such as the trefoils, toadflaxes and vetches. It is also important to ensure that there are flowers in bloom from April to September. This provides a food source for bees throughout their foraging season. Plants, like toadflax, which flower mid to late summer and early spring bulbs, such as grape hyacinth are very important. Toadflax is also important for a rare UK moth, the toadflax brocade. The common blue butterfly feeds on bird's foot trefoil and medicks. The small blue feeds on Kidney Vetch. The dingy skipper's caterpillars also feed on bird's foot trefoil as well as horseshoe vetch. Rock-rose, crane's and stork's- bill species are good for the brown argus. As grasses colonise the roof other butterfly species might find food plants on the roof such as the meadow brown and small heath.

It is also good to have a mind for the bugs, which though small and unassuming find refuge on brownfield sites and dry grasslands. There is a small black beetle, which is increasing rare and depends on Autumn Hawkbit. This plant flowers late in the year thus providing an ideal nectar source for bees and butterflies.

Creating your own roof gives you the opportunity to create different microhabitats. Logs, both dried and rotting, are important for a whole range of bugs. Some like the sun beaten logs to nest in and rotting logs can host a range of invertebrates including stag beetles.

Boulders and bare areas can be very important too. There are a number of spiders that like to hunt in these areas, such as money, wolf and crab spider species.

If you can add small mounds of coarse sands, there are a number of mining and solitary bees that nest in sand.

These are only some suggestions, mostly based on knowledge of the southeast. However in other areas of the country other plants and features may be more beneficial.



Poppy



Campion



Cowslips

COST GUIDE FOR THE CONSTRUCTION OF A NEW GREEN ROOF.

THESE COSTS ARE ONLY A GUIDE. WE HAVE TRIED TO GIVE A SINGLE ITEM PRICE AND M² PRICE AS BEST AS WE CAN.

THE TOTAL COSTS TO THE RIGHT OF THE TABLE ARE FOR A COMPLETE NEW ROOF INCLUDING ALL THE JOISTS AND THE DETAILS.

ON A SHED IT WOULD BE CHEAPER.

ITEM	Single Item Price + VAT	Price per m ² + VAT
JOISTS		
100mm X 50mm	£1.30/linear m	£3
150mm X 50mm	£2.00/linear m	£5
200mm X 50mm	£3.00/linear m	£6
Strand Board	£15	£5.20
WBP	£28	£11.50
FSC 18mm Shuttering	£19	£8
Arris Rail [3m length]	£4	£1
Under Liner Geotextile [2500CBR]		£1.50
Butyl Liner		£6
One Outlet	£120	
6 X chains / fittings / outlet	£80	
Upper Liner Geotextile [5400CBR]		£2.50
Fascia 170mm X 20mm		£1.75
Spacer 75mm X 25mm		£1
Top and Side Cap	£1.50/linear m	£2.40
Drainage Layer		£8-9
Extensive Substrate	£120/linear m @ 100mm depth	£12
Green Waste Compost	£25/tonne	
Sedum Mat	£25	£25
Sedum Plugs	£0.30	
Wildflower Plugs	£0.70	

TOTAL COSTS

FOR SEDUM MAT FINISH ON 100MM SUBSTRATE THE COST WOULD BE IN THE ORDER £50/M², INCLUDING 1 OUTLET WITH CHAINS.

FOR SEDUM/WILDFLOWER PLUGS AND SEED ON 100MM SUBSTRATE THE COST WOULD BE IN THE ORDER OF £40/M², INCLUDING 1 OUTLET WITH CHAINS.

YOU WILL NEED TO ADD ROUGHLY 15% FOR WASTE AND DELIVERY COSTS.



GENERAL CONSTRUCTION HINTS

Bracing the Building

It is important to ensure the building is rigid when you are installing a green roof. The extra weight on top of the building means you must be sure adequate bracing is installed. This could be plywood panels fixed internally, recycled plastic panels, or if you prefer, a diagonal brace fixed within the stud wall. This is obviously not an issue with a brick or block building.

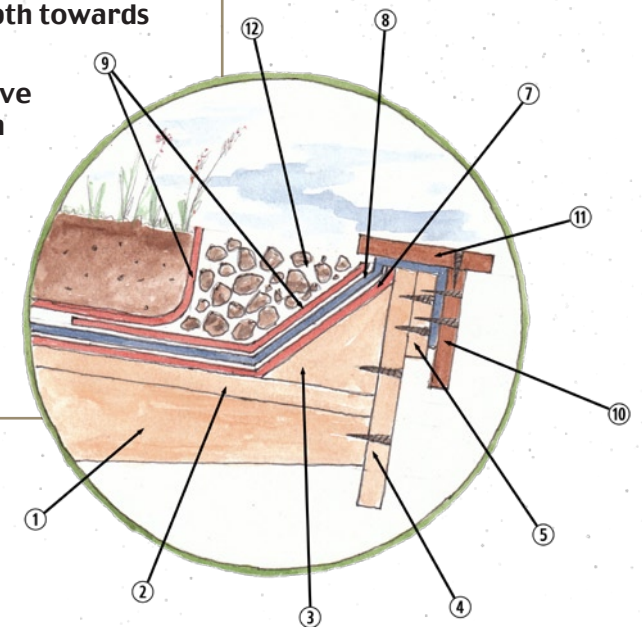
Pitch, Aspect and Shading

These three things will have an effect on not only on what you might plan on the roof but also how diverse your plant mix can be. A pitch up to 30 degrees is achievable, although the steeper the pitch the more limited your plant choice becomes. Indeed, over, approximately 15 degrees, you may need a mesh or noggin structure within the substrate to prevent the soil/substrate from sliding.

With any pitch you will always find the top edge suffers from the most severe conditions and will tend to support only the most drought tolerant species. Whereas, as you move down to the base of the roof, the moisture level increases and the choice of species is much wider.

There is always a balancing act with the pitch on green roofs. The steeper the pitch the more visible the roof becomes but the conditions become more severe and dry. On a mono-pitch roof this is compounded by the eventual height of the roof. If the span of the pitch is more than 4 metres, it inevitably leads to a very high-end wall. If the span is too much you may have to consider a traditional pitch roof. We have found from flat to approximately 12 degrees works best from a biodiversity point of view. Some of the problems of a steeper pitch can obviously be overcome with the use of irrigation. You can also counteract some of the effects of the pitch by increasing the substrate depth towards the top ridge of the roof compared to lower down.

Both aspect and shading will also influence the type of roof and its choice of plants and substrate. We have found it is better, especially in the south east of England, for the roof to not face directly south. North facing roofs will dry out less as out of direct sunlight. This, combined with a certain amount of shading from buildings or trees, reduces the severity of the conditions on your roof. Again, if the roof is to face directly south, substrate depth may need to be increased and harderier, more drought tolerant species used.



MAINTENANCE

In our experience, people are overly concerned with maintenance. This is more an issue for commercial green roofs, where liability issues and 'look' are a concern. Once a green roof is up most people just 'enjoy' it and let it do what it does.

However if you have concerns then here are a few tips:

- *It is standard in the autumn and the spring to check the drainage outlets to make sure they are free of vegetation*
- *If you have gone for a sedum system and want to maintain the sedum look it is advisable to weed out any vegetation that you don't like the look of. Some blanket systems do come with 'weeds' that have blown into the blankets whilst they are growing.*
- *It is really down to personal choice but in the first few years there may be a need to weed out things such as fat hen, members of the mustard family. This could slow the establishment of the seeds and plugs as they provide competition. If you have used a topsoil from the ground you will have a seed base within the soil. This could lead to weeds dominating. That is why we always recommend aggregate based substrate and sterilised subsoil.*
- *Most tree species will wither and die once high summer comes. However buddleia should be removed as this could damage the integrity of the building.*
- *A general rule of thumb is that if there is something that you don't like the look of weed it out.*
- *Most of the people we know have their own maintenance regimes. You choose. None of the roofs we have any 'ownership' over, whether they be small scale [John] or large [Dusty] have any maintenance programmes.*

If you have installed an irrigation system decide when you think there has been too long a period without rain and give the roof a little boost of water. Try to water before the foliage completely collapses. If a species show signs of stress well before the majority on your roof then it might be worth letting them go rather than water at that stage.

But relax. Some of the roofs we have been involved with are over 15 years old and are still going strong. And as we have said before each year the roof will change. That is part of the pleasure.

FINALLY....

One of the things we have learnt over the years is that each roof will be different. Also long as the roof doesn't leak and will not collapse, the plants and soils can change, be changed and be adapted. We have added art to our roofs. We are constantly trying out new plants on old roofs, re-seeding and watching what happens. In the 'designer' age we all too often think there is one way to do things. Let your roof do its thing, remind you of the seasons and how nature changes from year to year.

We hope that this guide has been helpful. It is not a definitive guide. We are all learning. However we hope it encourages as many people as possible to install green roofs on their properties and that it gives people confidence to do it themselves or to pass the guide to a contractor to create a roof for them.

We are sure we have missed many things. We hope to update the guide and issue an update, free of charge, to all who have purchased it. We also hope that people who use this guide and complete projects send us any thoughts and successes. We would be particularly interested:

- To hear about innovative planting schemes native or non native
- Success of regional native planting
- Use of innovative waste materials
- Any solutions you have discovered in your build

We plan to add these to the guide so that it continually evolves. We also hope that people would be willing to send in their completed projects so that we can add them to our websites and use in a newsletters we hope to send out.

And we hope that the guide has put you back in touch with nature if you weren't already. We hope you have had fun and that your roofs give you joy and inspires people around you to follow suit.

Finally, relax.

Good Luck

Dusty and John



SUPPLIERS

Sedum Systems

There are several companies that can provide DIY kits for green roofs, including sedum blanket systems:

www.greenroofs.co.uk

www.sky-garden.co.uk/

www.qlawns.co.uk/

Wildlife Turf Systems

There are a number of companies that are supplying and developing turf for green roofs:

www.coronet-turf.co.uk/

www.turf.co.uk

Seeds and Plants

We recommend suppliers listed on www.floralocale.org

These include:

www.wildseeds.co.uk – Emorsgate Ltd. are one of the largest suppliers of native seeds in the UK

www.britishflora.co.uk – highly recommended native seed and plant supplier

www.wildflowers.co.uk – the largest native plug supplier. Many other native suppliers actually use plugs from [wildflowers.co.uk](http://www.wildflowers.co.uk)

Landlife wildflowers – Plants, bulbs and wild flower seed

Substrates

If we buy in an extensive green roof substrate we usually use:

Shire Minerals Southern.

<http://www.greenroofsubstrates.co.uk>

Contact: shireminerals@aol.com

Butyl Liner / Geotextiles

We generally use:

<http://www.butylproducts.co.uk>

They are used to supplying the down pipe section for us and therefore understand the request.

<http://www.protan.co.uk>

A nordic waterproofing company with a long tradition of supplying turf roofs. They can supply one piece waterproofing and down pipe section

Other suppliers are:

Don & Low Limited, Angus

<http://www.donlow.com/>

EuroPolymers, Lancashire

<http://www.europolymers.com/contacts.html>

Source Control Systems Ltd, Staffs.

<http://www.sourcecontrol.co.uk/>

Hy-Tex Ltd, Kent

http://www.hy-tex.co.uk/ht_hom_home.html

Industrial Textiles & Plastics, York

<http://www.indtex.co.uk/default.asp>

Terram, Gwent (01495 75 7722)

<http://www.terram.com/>

WTB Geotechnics, Bristol

<http://www.geotechnics-uk.com/>

Geofabrics, Yorkshire

<http://www.geofabrics.com/>

BTC Building Supplies Ltd, Lancashire

<http://www.buildingmerchants.net/70129/contact.php>

Fieldway Supplies, Liverpool

<http://www.fieldwaysupplies.com/construction%20items%20suppliers/Geotextiles.html>

Technical Absorbents, Grimsby

<http://www.techabsorbents.com/home.htm>

Twenty4Seven, Oxon

<http://www.twenty4sevenservices.co.uk/page2.htm>

Scott & Fyfe Industrial Textile Manufacturers, Fife

<http://www.scott-fyfe.com/en/default.htm>

Wrekin, Staffordshire

<http://www.wrekinproducts.com/index.php>

Palmhive, Nottingham

<http://www.palmhive.co.uk/contacts.htm>

Tensar international Ltd, Lancashire 01254 262431

<http://www.bpindex.co.uk/manf.html?id=9305>

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