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Pesticide Handling Area and Biobed Manual

(includes Biofilters)

Guidance on the design and use of Pesticide Handling Areas, Lined Biobeds and Biofilters

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1. Introduction and basic concepts

This manual explains the basic concepts which apply to all pesticide handling areas and biobeds but then goes on to provide detailed design and operational advice for the main types of biobed. The manual pulls together regulatory and design information previously available in two separate documents and also includes new information on Biofilters.

The manual has been prepared as joint exercise by the Environment Agency, The Voluntary Initiative and Catchment Sensitive Farming with expert help provided by ADAS, Bill Basford and Horticultural Development Company (HDC).

The questions below help explain some of the basic concepts but further information on most aspects can be found in the body of the manual.

What's the problem?

Pesticides reaching water can harm aquatic life and affect drinking water supplies; resulting in water companies having to treat drinking water, which in turn leads to pressure for further regulation and controls on their use. If farmers and growers want to continue to have access to a range of pesticides without further regulation then standards of handling and application need to continue to improve.

Why do pesticide handling areas matter?

Case studies at farm level have shown that losses from pesticide handling areas can account for more than 80% of detections in a catchment; although at a national scale it is thought that 40% of pesticide detections come from the handling activities with the remaining 60% coming from the field through run-off and drain flow.

Improving the pesticide handling area and managing the washings and wastes that come from pesticide handling is one relatively simple measure that can be taken to help keep pesticides out of water. Correct design and management can virtually eliminate this particular source of pesticides.

What is a pesticide handling area?

The pesticide handling area is the site where the sprayer is filled and is often the site used for sprayer washing, nozzle calibration, sprayer testing, maintenance and storage. Splashes and spills of pesticide that can occur during sprayer filling, as well as the larger quantities of liquid produced during sprayer cleaning can seriously harm water quality unless suitable measures are put in place to protect water.

What is a biobed/biofilter?

A biobed is a mixture of peat free compost, soil and straw (biomix) covered with turf that is placed in a lined pit. A biofilter uses the same biomix, but does not require turf and uses a series of IBCs (Intermediate Bulk Containers) instead of a pit.

Liquids enter the biomix within a biobed or biofilter from a bunded sprayer filling area either by gravity drain or pump, where they undergo bioremediation and are then drained from the biobed or biofilter. This liquid, with minimal pesticide residues, can be used for land irrigation or re-used e.g. for subsequent sprayer washing.

What does a biobed/biofilter do?

The biobed concept was developed to provide a simple low cost method for on-farm treatment of dilute pesticide wastes. The biomix in the biobed allows any pesticides within the waste liquid to cling or lock onto organic matter, particularly onto the straw. Some chemicals do this very rapidly. The bacteria within the soil and within the biomix then slowly work to break down the pesticide residues, with the compost helping stabilise the moisture content within the mix.

What is different about a biofilter?

A biofilter is generally smaller in area than a biobed and is normally built above ground. It comprises a number of robust containers (often referred to as IBC's) containing the biomix. These form the 'liner' as with a biobed. These containers are stacked one above the other and include a system to allow drainage by gravity from container to container.

What can a biobed or biofilter treat?

Biobeds and biofilters are designed to treat non-hazardous pesticide solutions. Examples include small spills and drips that may occur during handling and mixing, run off from the pesticide handling area and equipment washings. However, biobeds and biofilters are not a substitute for best practice and every effort should be made to avoid spills or splashes of pesticide concentrates. For example place a drip tray under the induction hopper. Best practice also requires that in most cases, the first set of tank washings should be sprayed onto the target crop ensuring the maximum dose is not exceeded. Provide best practice is followed the performance of the biobed and biofilter technology has proved acceptable to the Environment Agency and Scottish Environmental Protection Agency.

NEVER dispose of concentrated pesticide through a biobed or a biofilter. If concentrated pesticide should enter the biobed, the resulting effluent is likely to be a hazardous waste and hence highly polluting.

How much does it cost?

Costs vary depending on whether a new handling area is required, the final choice of system, and whether farm labour and /or second hand materials are included in the cost. For a biobed this has ranged from £1,500 - £7,000, for a biofilter around £300-£1,500 and a sprayer filling area £1,000 - £2,500. More details on costs are available later in the manual.

How much spray waste can a Biobed/Biofilter treat

The waste exemptions allow Biobeds to treat up to 15,000 litres of spray waste (excluding rain water) per annum. Most farm spray operations will generate around 5-7000 litres/year. It is recommended that a Biofilter should treat no more than 15,000 litres including rain water.

Are there any other options?

A simple solution is to have an entirely field based system with all filling and handling and wash down taking place in the field, but this is not always practical or convenient; other options include collecting washings and run-off from the handling area in a sump and paying for professional waste disposal or spraying the washings out on an area with a groundwater permit. Large farms and research farms have installed the Sentinel (carbon filtration system) and there are some novel solutions in development but at the moment these have not yet got environment agency approval

Do I need to get permission?

If you want to build a biobed, biofilter or install a Sentinel you will need to obtain relevant waste exemptions from the local environment agency. Disposal of washings from a sump by spraying out to land requires an environmental permit.

2.1 What are the options?

Option	Best For	Guide Cost	Environment Agency
Entirely Field Based System	Small farms and larger farms with a field bowser	Free + Bowser & Staff Cost	No contact required but ensure filling and wash down areas are at least 10m away from any watercourse, 100m from any borehole and do not take place on compacted soil
Pesticide Handling Area draining to sump with Professional Disposal	Small to Medium sized farms	Annual disposal charge	No contact required; but ensure no more than 1500 litres is stored at anyone time and that there is no risk of liquids leaking from the sump
Pesticide Handling Area draining to sump with disposal to an area with a Groundwater Permit	Small to Medium sized farms	Annual permit	Requires groundwater permit from environment agency, and ensure that no more than 1500 litres is stored at anyone time and that there is no risk of liquids leaking from the sump
Pesticide Handling Area draining to sump for treatment in an Offset/Indirect Biobed	Medium to Large farms with an established concrete filling area	£1500-7000	Require appropriate waste exemption(s) from Environment Agency/SEPA
Drive over Biobed	Medium to Large Farms needing a new or repositioned pesticide handling area	£5000-7000	
Pesticide Handling Area draining to sump for treatment in a Biofilter	Glasshouse units, small or mixed farms	£1000-2000	
Covered Pesticide Handling Area draining to sump for treatment in a Biofilter	Medium to large farms with spare barn	£1000- 2000	
Pesticide Handling Area draining to sump for treatment in a Sentinel	Large farms Research establishments	From £12,000	

2.2 Planning and Permissions

There are a number of basic steps that need to be considered before building a biobed. These are:

1. Checking the Risks to Groundwater
2. Drawing up a site plan and local risk assessment
3. Deciding on the configuration type of biobed you will install
4. Calculating the size of the biobed
5. Registering the relevant waste exemptions with the environment agency

1. Checking the Risks to Groundwater

It is vital that a Biobed poses no risks to groundwater and the Environment Agency Exemption only allows for biobed to be installed in low risk sites classed as Source Protection Zone 3 or in areas where there no groundwater supplies. For the larger/most significant abstractions these zones are mapped (for small abstractions default distances apply) but all show the risk of contamination from any activities that might cause groundwater pollution in the area. The closer the activity is to the point of abstraction, the greater the risk. To assess the suitability of the proposed biobed site in terms of risk to groundwater, you should follow this process to find SPZs that have been mapped in your area:

1. Use the link below to enter the Environment Agency Web site
<http://www.environment-agency.gov.uk/maps/info/groundwater/>
2. Enter your post code under “What’s in your back yard” and click “OK”
3. Under ‘groundwater source protection zones’ click on “View map of results”. The map will show whether your proposed location falls within one of the four source protection zones

Zone 1 (Inner protection zone) RED

Closest to the source, and shows the most vulnerable groundwater.

Zone 2 (Outer protection zone) GREEN

The outer zone covers areas at risk from pollution by pollutants that do not break down quickly.

Zone 3 (Total catchment) BLUE

the total area supplying water to the source.

Zone of special interest BROWN

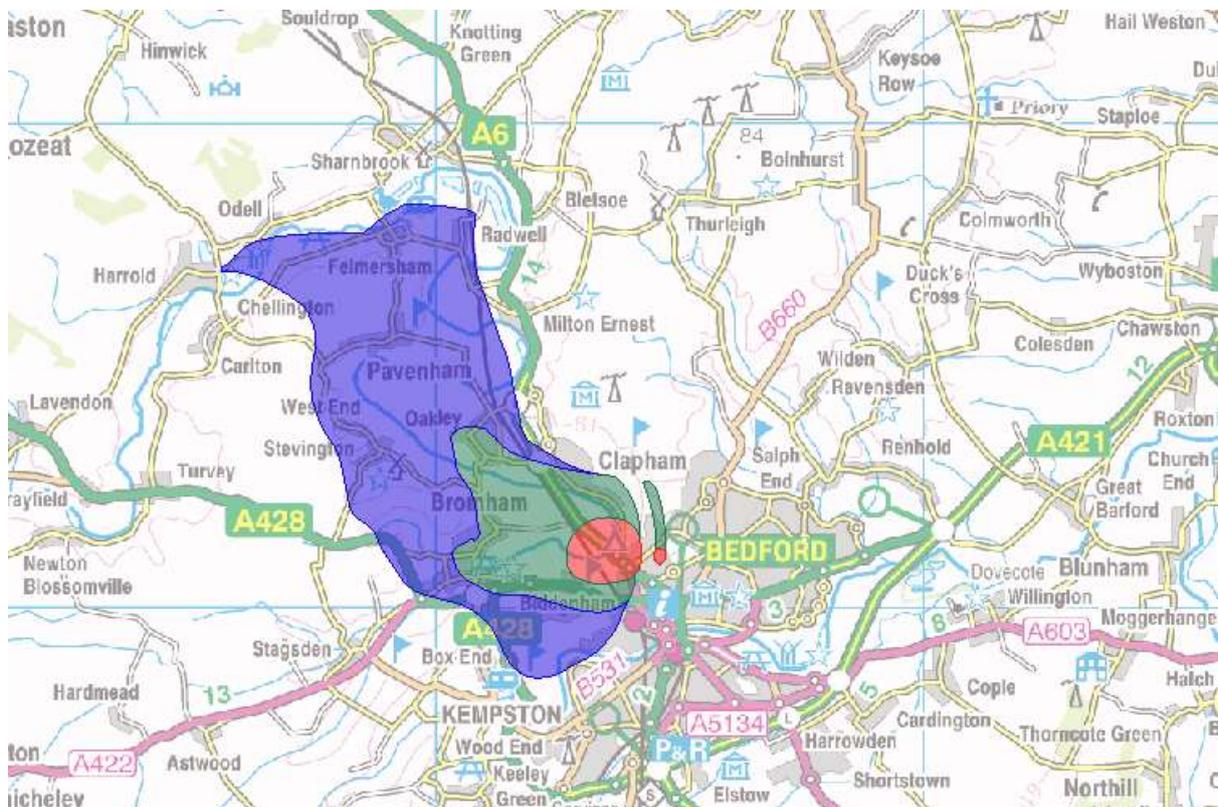
Sometimes, a fourth zone is defined. This is usually where local conditions mean that industrial sites and other polluters could affect the groundwater source even though they are outside the normal catchment area.

4. **A local site inspection by EA is needed if a Biobed/biofilter need to be located within a SPZ 1 or 2.** If the proposed location of the biobed falls within an SPZ1 or 2 you should consider first if an alternate location that is outside the

SPZ1 or 2 is an option. If not contact the Environment Agency Agriculture Waste Registration help line 0845 603 3113 to discuss the arrangements for a site inspection.

5. The location of all wells, springs and boreholes (e.g. private supply on neighbours' land) that have not had SPZs mapped, including those not used for human consumption also need to be considered. For this, you will need to make local enquires within at least 50m of you proposed biobed site.
6. Take a screenshot of the your post code area confirming that it is not in an SPZ1 or 2 and keep a written record of your enquiries to show that you have taken account of groundwater risks.

In the example below farmers wishing to build a biobed in the red and green areas below will need to consult with the Environment Agency.



Screenshot showing Groundwater Source Protection Zones around Bedford May 2012

Different arrangements for Groundwater Protection apply in Scotland for further advice consult with your local SEPA Office

2. Draw up a site plan and local risk assessment

Draw up a basic site plan including features such as the pesticide store, the location and size of the biobed, associated sumps and pesticide handling area and the area that will be irrigated. Make sure the drawing shows any local ditches, ponds, farmyard drains, rainwater drains and any foul water sewage or septic tanks. Show any route where water can flow around your proposed site and also mark the direction of drainage and any slopes. It is good practice to ensure that the pesticide handling area is at least 10 m from any water course, but **it is an Environment Agency requirement that the biobed or biofilter is not located within 10m of any surface water body or clean water drain / watercourse**. This will include all yard drains and other drainage channels e.g. French drains. If the drainage from the biobed / biofilter or post treatment irrigation area (section) could meet any underground field drains, you should intercept and / or divert the drainage.

On the plan show any local environmentally sensitive area or protected habitat¹ this is important as there is a risk that Biobeds or Biofilters could produce harmful discharges. If either the biobed or at a later date the spreading of biomix is likely to take place be within 250metres of an environmentally sensitive area then you should produce an Environmental Impact Assessment (EIA)².

Finally the site needs to be secure from public access so make sure the map shows any roads and foot paths and as well as the main farm traffic routes

3. Deciding on the configuration type of biobed you will install

As you will see later there are three basic options, the offset/indirect biobed where the biobed itself may be some distance away from the planned or existing pesticide handling area, the drive over biobed which provides the function of a pesticide handling area as well as a biobed or a biofilter. An important consideration is to ensure the site and handling area design minimises the quantity of rain water entering the biobed system.

4. Calculating the size of the biobed/biofilter

¹ Examples of environmental sensitive areas or protected habitats include Sites of Special Scientific Interest (SSSI), Candidate Special Areas of Conservation (CSAC), Special Areas of Conservation (SAC), Special Protection Area (SPA), sites as defined under the RAMSAR convention, Areas of Outstanding Natural Beauty (AONB) and reservoirs You can get more information on environmentally designated areas and sensitive habitats including location at <http://www.jncc.gov.uk/>

² The EIA should ensure that all possible risks around installing a biobed/biofilter are considered and that measures are put in place to manage the risks. The EIA should include a description of measures that you would be put in place to avoid, reduce and, if possible, remedy significant adverse effects. You should also consider alternative sites you may use and the reason for selection of the preferred site.

A biobed is sized to provide sufficient biomix to degrade the expected chemical loading. The basic specification is based on one square metre surface area of biobed per 1000 litres of liquid to be treated.

A simple example is given below:

1. Annual volume of pesticide waste and washings: 15,000 litres is used in this example as the maximum permitted within the exemption per biobed. The actual amount may be considerably less than this where limited tank washings are involved; therefore a careful assessment must be made of the annual production of washings/wash down etc to indicate biobed size. (see Appendix 2)
2. Annual rainfall: 650 mm Average rainfall data can be obtained from <http://www.metoffice.gov.uk/climate/uk/>.
3. Required area of pesticide handling area: 7 x 5 metres = 35 square metres

Taking the maximum volume of liquid requiring treatment per biobed: 15,000 litres of pesticide waste and washings plus 22,750 litres of rainwater (650 mm on 35 square metres) equals 37,750 litres³. Based on a figure of 37,750 litres and the requirement for one square metre per 1000 litres, the biobed needs to be 1.0 m deep and have a surface area of 38 square metres. In practical terms, this would mean that the biobed as a minimum would be 6.0 m wide x 6.5 m long x 1 m deep.

The above calculation is only an example. The size of sprayer filling area will vary with the size of sprayer, while rainfall and the amount falling on the filling area will vary, e.g. whether roofed or not, annual rainfall.

Should the biobed be covered to exclude rainfall?

The biobed itself should not be covered as this will impact on the ability of the biobed to degrade the pesticides. However, there are benefits from limiting the volume of the clean rainwater entering the biobed. Purpose built buildings are becoming increasingly attractive to cover the fill area and to house the sprayer during non spraying times as well. Any building which would allow the bunded handling area to be covered would mean the overall size of the biobed to be reduced significantly and a Biofilter could be a better more compact option.

Biofilter Size

The basic design of Biofilter is based on the assumption that 3 x 1000 litre IBCs linked in series have the maximum capacity of treating 15,000litres per annum.

³ It is not necessary to include the area of the biobed when calculating the volume of rainwater intercepted by the biobed. This has already been taken into consideration in the one square metre requirement for every 1000 litres of liquid. For direct biobeds the surface area is governed by the volume of spray waste and the physical dimensions of the sprayer

Unless alternate sized IBCs are used then a basic calculation to confirm that no more than 15,000 litres (including rainfall) will pass through the biofilter every year.

5 Registering the relevant waste exemptions with the environment agency

There is no requirement for an Environmental Permit (formally called a Groundwater Authorisation) for any of the systems provided they are designed, maintained and operated appropriately. You will however need to obtain a T32 Permit Exemption for the Biobed/Biofilter and a U10 Exemption for spreading the biomix

Waste exemption T32 allows the treatment of non-hazardous pesticide washings in a biobed or a biofilter. Details of the T32 exemption are included at the end of this document or within para 42 of the Waste Management Licensing (Scotland) Regulations 2011 in Scotland

The exemption has a number of conditions and limits. These are to ensure that any lined biobed or biofilter is built, run and looked after in a way that ensures the pesticide washings are correctly treated and that the treatment does not cause pollution or harm to groundwater and/or surface waters. This includes the requirements that:

- The biobed/biofilter is located in a secure area of the farm place and the waste cannot leak from the biofilter/biobed.
- The lining of the biobed is impermeable
- The biobed/ biofilter is suitable for treating the waste
- The biobed is covered with turf – not required within a biofilter.
- There is secure storage of the biomix for 12 months prior to spreading to land in accordance with exemption U10 – Spreading waste on agricultural land to confer benefit.

As a part of the registration process you are expected to commit to comply with the limits and conditions of the exemption, that your biobed or biofilter will not pose any significant risk to the environment and that you have prepared appropriate plans and risk assessments.

Registration of an exemption can be done on line or by post and there is no charge..

Keep it simple Keep to the guidelines

Farmers, being farmers, will come up with a range of ingenious and creative ways of making their own biobed. The problem is that the research showing biobeds work has been conducted on a standard design. EA and SEPA support and approval of biobeds is based on that standard design. Deviation from the standard design may be possible but you will need to discuss this with your local EA or SEPA office first.

Don't be surprised if they appear cautious, they want to be satisfied that your variation is as good as or better than the standard design in this manual and they may ask for research evidence. The long and the short of it is that it may well be less hassle to stick to the basic designs in this manual.

Once you have registered the waste exemption you can proceed to build your biobed/biofilter

3.1 Pesticide Handling Area

Many sprayer filling areas have been sited near to a convenient chemical store, water supply and electrical supply with little attention to potential pollution from the site. It is worth reviewing the location, design and construction to limit pollution potential from the area. You also need to consider how this area relates to the size of biobed/biofilter which may be needed. Initially it is worthwhile conducting an assessment on the current site to improve matters by using the system offered through the VI link

http://www.voluntaryinitiative.org.uk/Attachments/resources/1464_S4.pdf

It is likely that the sprayer fill area may be improved by including a bund to include drips, spills and washings and exclude as far as possible other waters. The area should have an internal drain with a silt trap which is directed to a tank or chamber. From this facility (maximum size 1500 litre) Options which are possible:

1. Disposal via a registered waste carrier to a suitably permitted disposal site.
2. Disposal to a Permitted area approved by the Environment Agency on the farm
3. Directing liquid to a biobed or biofilter for bioremediation

The latter requires an assessment to be made to calculate water loadings into a biobed or biofilter. Where the filling area is not covered the rainfall amount should be assessed. Note that for every 1 mm falling on 1 square metre then 1 litre of water may be collected. This is important to be included in calculations (as on page 13 of this manual) to specify the size of a biobed or biofilter. However, the 15,000 litre T32 maximum spray washings allowance does not include allowance for rainwater; but the area of the biobed should include an allowance for rainfall under current guidance.

Table 1 Typical dimensions required for pesticide mixing / handling areas

Sprayer Type	Overall length (metres)	Overall width (metres)
Self propelled sprayer	7	5
Trailed	7	5
Mounted	4	5

The size of the bunded handling area is a compromise between containment, minimising the volume of clean rainwater requiring treatment and maintaining the ability to work safely. The areas suggested will not allow for full boom unfolding. However, it is possible to modify the handling area for an indirect biobed to enable the boom to be fully extended. Note that the Code of Practice for using Plant

Protection Products recommends that boom spray out should normally be done in the field area previously sprayed.

The example in Section 2.2 shows how to calculate the size of an indirect biobed system including the fill area contribution.

Constructional detail of sprayer filling area

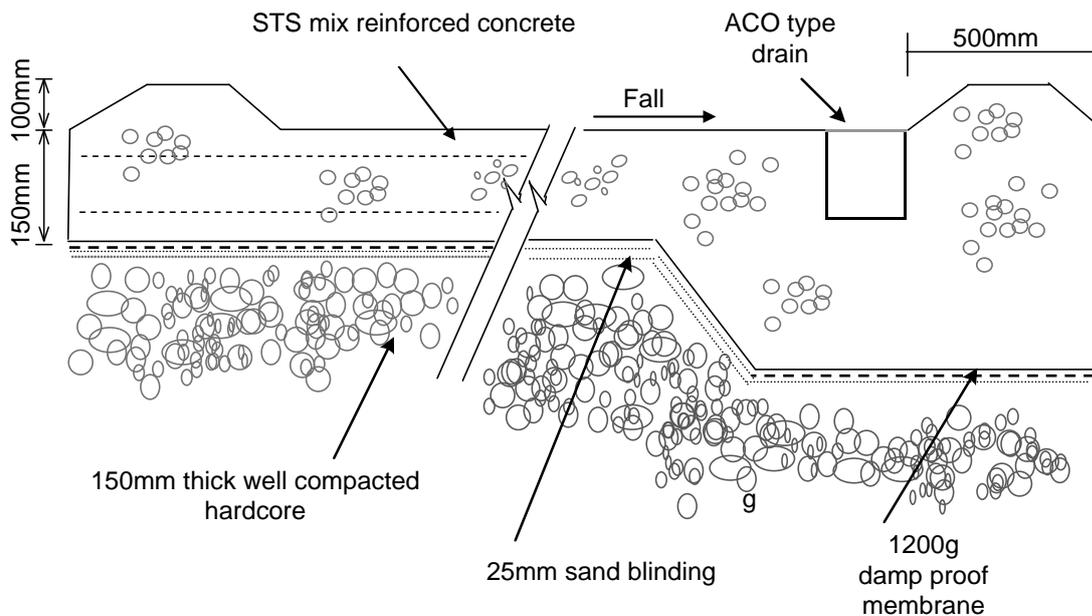
1. Remove existing topsoil. Excavate site as necessary to allow the following construction:
2. The excavated site should be with approximately 150 mm of well compacted hardcore over which a sand blinding layer (approximately 25 mm) should be placed to protect a damp proof membrane (dpm) of 1200g weight. A 150 mm thick, reinforced concrete slab should then be laid to falls of not less than 1:100. A concrete bund (300 mm wide x 100 mm high) should be constructed around the entire perimeter of the slab (**Error! Reference source not found.**). This size has been shown to be practical within the biobed evaluation work. It may be possible to create an acceptable bund by other means so long as it is impervious and does not allow over topping of liquids.
3. The banded concrete slab should have a drain installed, for example an ACO slotted cover type drain (100mm x 100mm), installed in accordance with manufacturers instructions, which is connected to a silt trap, with removable cover, with a nominal capacity of 250 mm below inlet. Some operators prefer to install concrete sloping 4 ways to the centre of the slab where a drain is situated. This is achieved without the need for joints which could lead to premature leaks and failures. A silt trap must be provided within this drain.

Sometimes it may be possible to modify an existing concrete area to form the banded sealed area needed. You should make the following checks / modifications.

1. Check the concrete is in good condition, i.e. free from damage, pitting and cracks such that liquid can not pass through. Also check that there is adequate fall (1:100) though this must be related to bund height ensuring that the bund prevents over topping of liquid from the fill area.
2. Is there a drain present that can be intercepted to only take runoff from the mixing handling area? If not, you need to install one, for example an ACO type drain. Cut the concrete along one edge of the handling area (suited to the fall) to accept a 100 mm x 100 mm ACO type drain, and install in accordance with the manufacturer's instructions. The drain should connect to a silt trap, with removable cover, with a nominal capacity of 250 mm below inlet.

- Construct bund edge of minimum 300 mm wide x 100mm high around the entire perimeter of the handling area. See note above linked to construction of a new area. The existing concrete surface may need to be roughened, including bonding agents or similar to accept the new concrete mix.

Pesticide Handling Area



Concrete pesticide handling area with bund and ACO type drainage system

Post filling area and temporary liquid storage

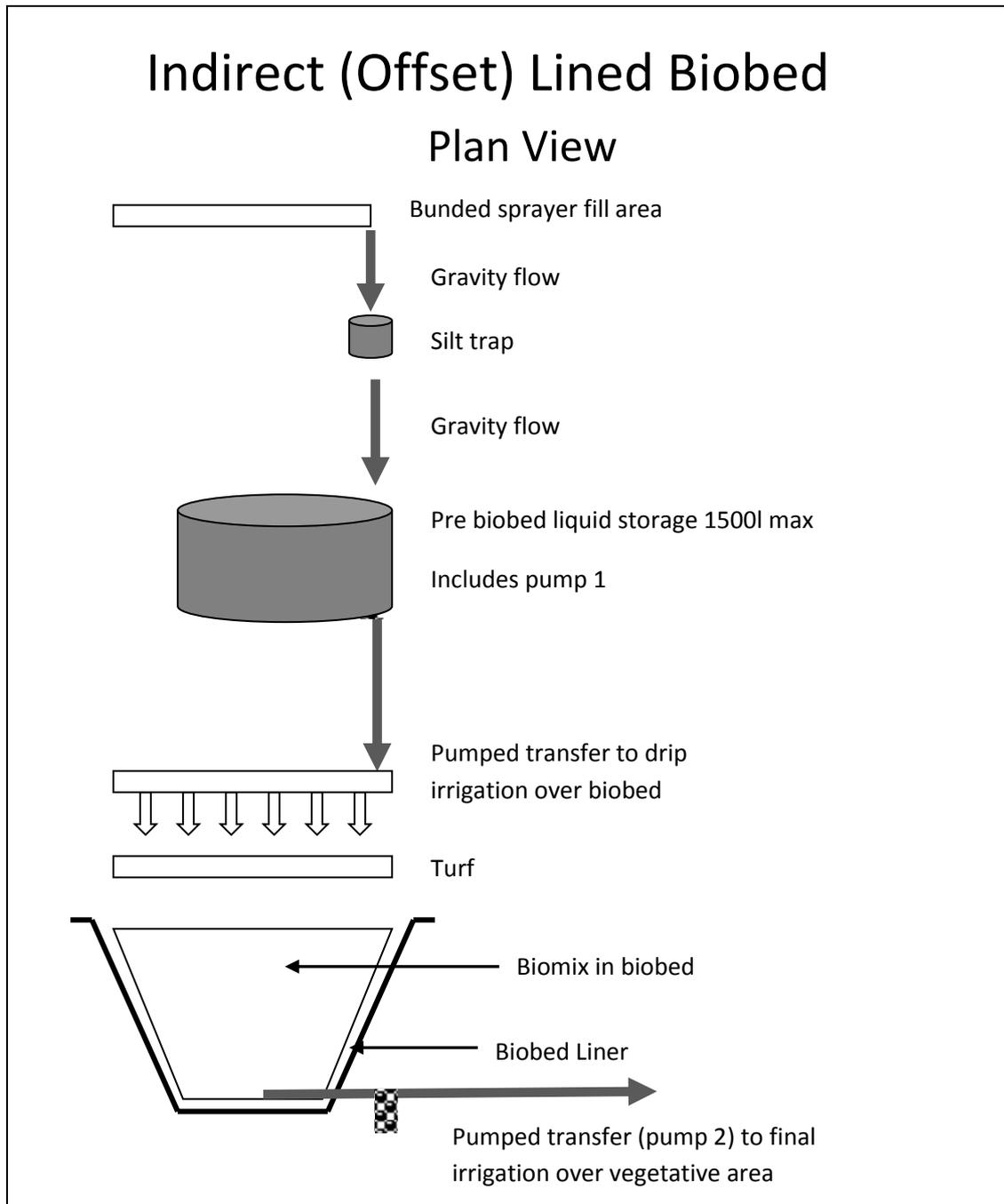
All runoff from the pesticide handling / wash down area **MUST** drain, via the silt trap, to a secure temporary storage, constructed of seamless polyethylene or similar. Old single skin metal tanks are not suitable. The pump switch levels must be set to

ensure that not more than 1500 litres of waste is deliberately stored. You may also need to allow some feedback in the tank for situations such as electricity or pump failure, or excessive wet periods when biobeds cannot be irrigated. If this is not addressed, either the biobed will be over-irrigated or damaged, or the handling and wash down areas may flood and overtop. With care it is possible to plan for any failure to allow liquid to feed back to the fill area thus indicating early maintenance required. The overall tank size will be determined by these two considerations. Under certain conditions the tank may need to be bunded. These will depend on the potential environmental risks associated with tank failure.

The Environment Agency exemption/registration process does not require the farmer to submit their risk assessment, it assumes that the risk assessment is sufficient (i.e. if anything goes wrong the EA will look at the farmers risk assessment and risk management plans. Consider if holding tanks for spray wastes need to be bunded especially if located in 'high risk' areas. The tank should be located near to the biobed /biofilter. Precise constructional details for the installation of this tank will vary with design. You should be guided by the manufacturer. You must ensure that the connection between the silt trap and storage tank is secure, such that **NO** leakage can occur.

3.2 Indirect or Offset Biobed

The indirect biobed is a system where all pesticide mixing and handling takes place on an impermeable surface with a sealed drainage system. This directs run-off to an adjacent biobed.





Indirect biobed. Sprayer is parked on impermeable handling area with runoff diverted onto an adjacent biobed



Indirect biobed system under construction. Bunded handling area in foreground, with a boom wash out section all draining to single collector. Background - hole waiting to be filled with biomix and secure intercept tank awaiting installation.

Liquid transfer to an indirect biobed

It is important to distribute the liquid held in temporary storage evenly over the biobed so as to utilise the full surface area, this has been successfully achieved using low cost drip irrigation. These systems have a low pressure demand (nominally 7 m head) which can be supplied by a submersible pump, fitted with a float switch and installed into the base of the temporary storage tank. Pumps with a nominal capacity of up to 50 litres per minute @ 6.5 m head (approx. 200 watt motor) would be suitable. Flow rates from the emitters on this type of irrigation are typically one to two litres per hour and should be spaced at 0.25 – 0.4 m, with the dripper lines spaced at a similar distance. The system should be inspected regularly for signs of damage and loose joints.

3.3 Direct (Drive over) Biobed

With a direct biobed system the sprayer is parked, washed and filled on a reinforced steel mesh grid over the biobed, thus intercepting directly any spill, drips and washings. Gravity helps with movement of liquids and the liquids are contained in one area. However, unlike the indirect system, it is unlikely that any existing facility would be suitable for modification, so a new construction will be needed.

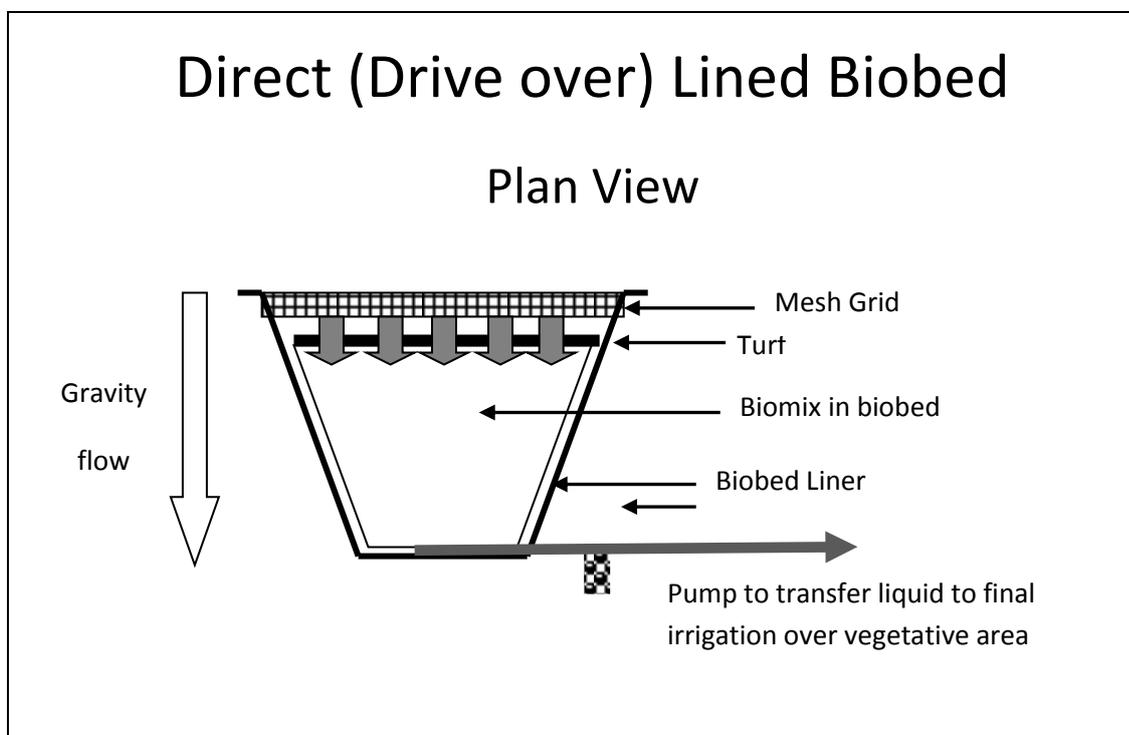
The biobed is constructed as described in section 3.2. However, to allow vehicles access to the biobed, a robust grid over the surface needs to be constructed. This grid needs to comply with all Health and Safety requirements both in terms of an operator handling concentrated pesticides and the support of a fully loaded sprayer. A 40 mm x 100 mm steel mesh is recommended. All liquids as well as soil/mud from tyres should be able to pass vertically through the grid and onto the biobed. The grid will also require removable sections, to allow for maintenance of the biobed. The grid should be supported with end and side foundations. These will need a firm sub-base to lay the concrete over. We recommend that you liaise with the grid supplier over the anchorage system for the grid. The direct biobed system should only receive from the sprayer above. Therefore a bund, similar to that for the indirect biobed intercept area should be installed, with a raised edge of minimum 300mm x 100mm.



Direct biobed system. The sprayer is parked on top of the metal grid such that that all spills, drips and washings are intercepted directly by the biobed.

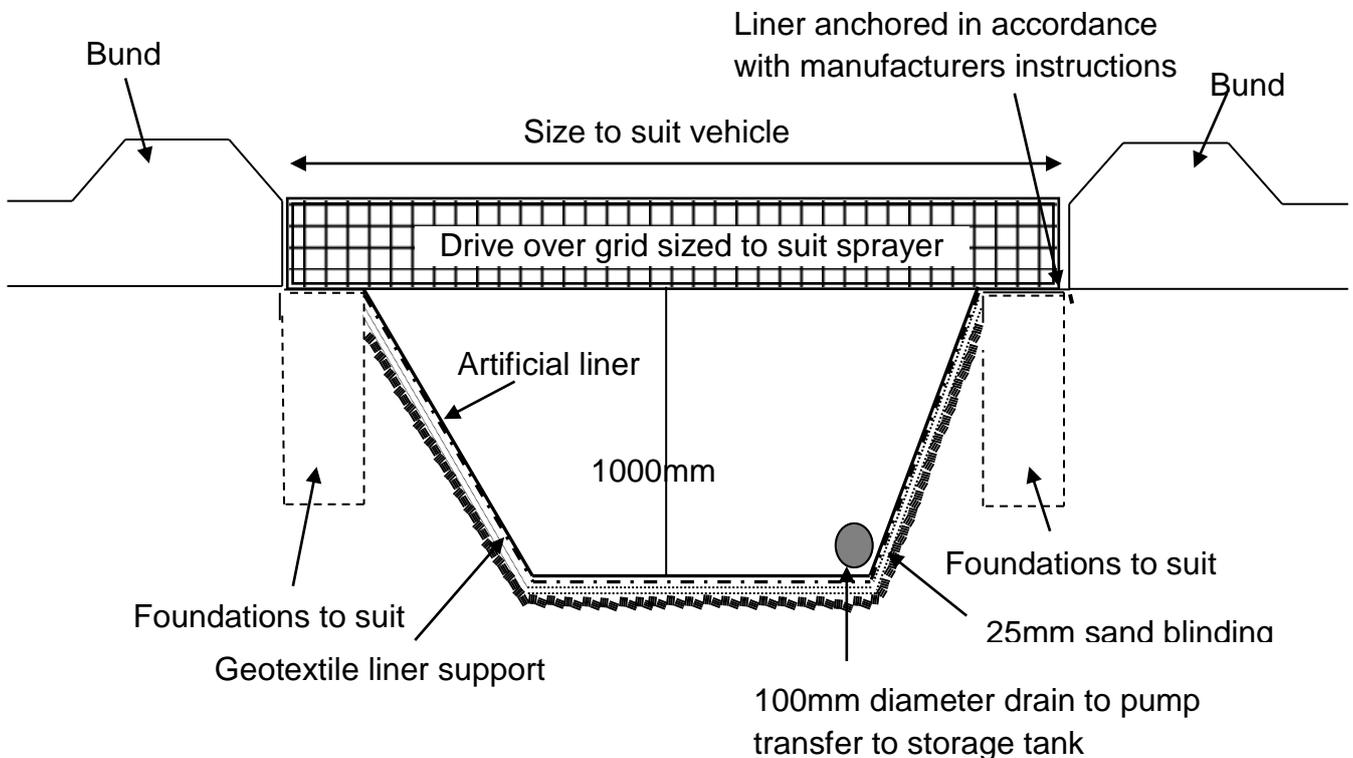


Example of grid construction used to allow access to direct biobed systems



Direct (Drive-over) Lined Biobed

Biobed section also suits indirect system



Biobed Construction

The exact design of the biobed can be adapted to meet specific local requirements. For example while most biobed systems will be based around an excavated hole in the ground, however a sealed above ground tank could be used where the volume of liquid requiring treatment is low. An above ground tank based system may also have a lower environmental risk, as it can be inspected. For this reason it may represent an acceptable reduction of risk in vulnerable groundwater areas. However, the biobed **MUST** be sealed, be at least 1.0 m deep and have a minimum surface area of 1 square metre for every 1000 litres of liquid requiring treatment.

The following detail describes a typical biobed system.

A pit should be excavated to contain the biomix. This can be a shape to suit any tank or lining system. Successful biobed construction has been achieved with soil side slopes of 30 to 35 degrees. These should be blinded with 25 mm sand, over which a geotextile membrane of 190 grams per square metre should be laid. The hole should then be lined with a material of a type suitable for a small reservoir. This liner should be 1.5 mm thick and be constructed from a synthetic material; it should be one piece and not contain any unsealed seams as this could allow seepage of

pesticide solution. Two systems allowing water flow from the biobed have been used:

1. Liner with bonded outlet point

A drain is inserted through the liner; this requires a bonded outlet point, able to accommodate a 100 mm outlet. The liner manufacturer should be consulted before ordering the bonded outlet as its construction will depend on the angle of the soil side slopes. The bonded outlet **MUST** be installed in accordance with the manufacturer's guidelines, as if it is not sealed correctly this could result in the biobed being unfit for use. The outlet should be installed at the lowest point of the excavation, compatible with the site layout. This outlet facilitates the rapid transport of the treated water for final distribution or re-use. A coil (approx. 5m) of 100mm perforated drainage pipe should then be laid into the base of the biobed (on-top of the liner) and connected to the drain intake to prevent the biomix material clogging the pipe

2. Internal Sump

A sump is created when excavating the biobed pit. The liner is then laid incorporating the sump area and the liner is not perforated. A central permeable vertical access tube is installed approx 0.5 metre diameter. This will allow water to flow into the sump base and a pump is installed within this tube. A ring of perforated drainage pipe should then be laid into the base of the biobed (on-top of the liner) which assists the flow to the pump. The pump then operates on the float switch setting to pump the treated water to the final irrigation point.

Turf cover

The lined biobed hole should then be filled with biomix and covered with turf. Domestic grade turf is not recommended as this has little soil reserve and limits the development of the grass growth over the biomix. If the biobed is not to be used immediately, adding the turf layer should be delayed to allow for the addition of fresh biomix following an initial settlement period. The turf layer **MUST** be in place before pesticides are added to the biobed.

3.4 The Biofilter

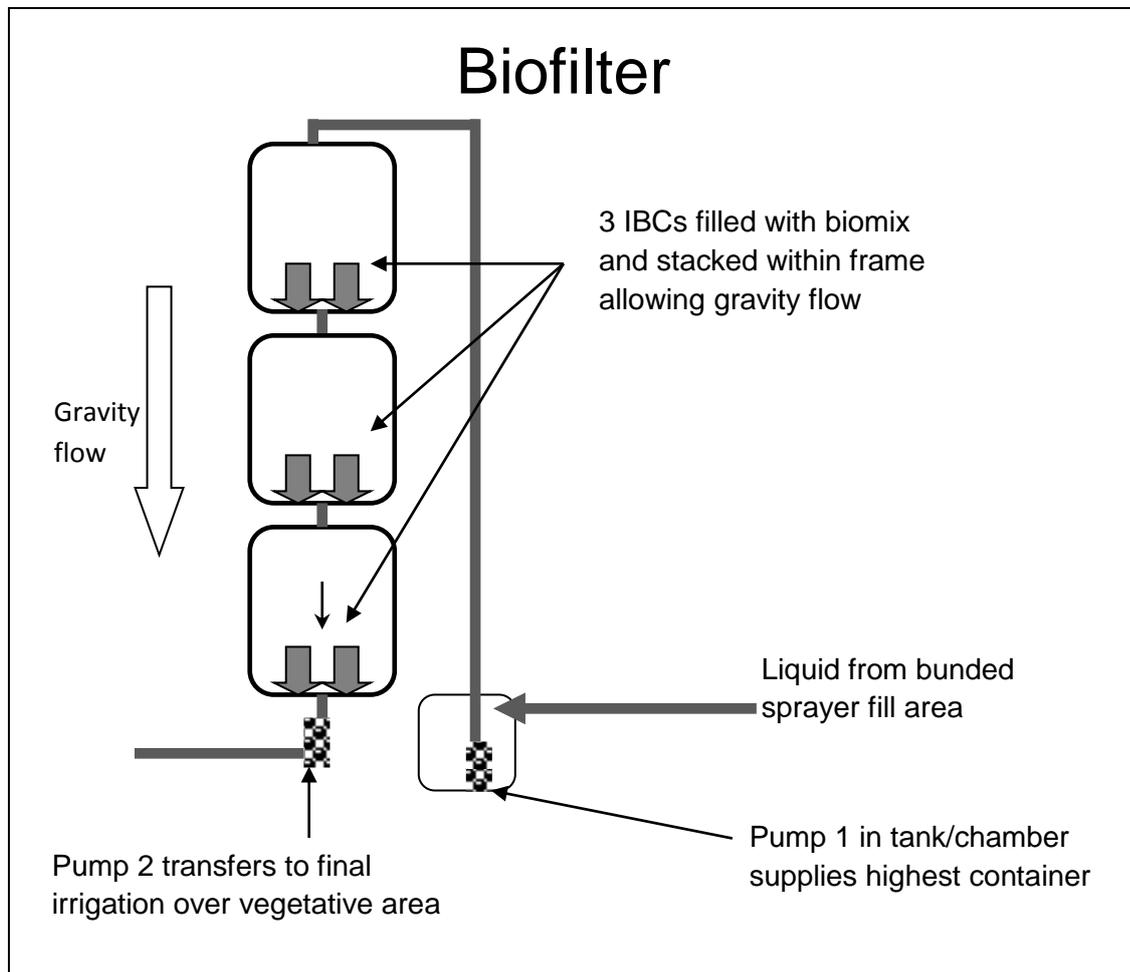
This relatively new system provides similar chemical breakdown to a biobed and may suit smaller operations or those where limited volumes of pesticide waste are produced, and/or little or no rainwater enters the system (e.g. a covered filling area). The same basic concept is followed: containment, liquid ratios to biomix, ingredient types and final use and as with a biobed. The system was evaluated by ADAS for HDC (Horticultural Development Company) in 2008. This confirmed that the biofilter gave as good as and in some cases better performance than a biobed. Thus the biofilter has been included by EA within the T32 and SEPA Para 42 exemptions and is subject to the same siting restrictions as a biobed.

A biofilter may include a number of Intermediate Bulk Containers (IBC) which contain the biomix. These containers are mounted one above the other with a connection made between each container to allow drainage through the system. See plate and diagram. The trial was based on IBC's of a nominal 1000 litre capacity with their tops removed and linked plumbing allowing liquid distribution from the top container to the next underneath and so on through to the bottom container. The top of the upper container should be covered to prevent rainfall entering the system, or the biofilter is located under a roof. It is important that the liquid spreads uniformly over the material surface within each container.



Plate ... Biofilter system used in HDC trial.

Basic Construction



The components of the system are:

- Tank/chamber to collect sprayer washings and pump to transfer liquid to the highest container
- 3 IBCs offering volume for appropriate biomix volume required
- Plumbing connections between containers
- Final liquid collection and pump transfer to re-use, irrigation or recirculation through biofilter system
- Irrigation area

Constructional detail and comment

- Follow the design advice for the pesticide handling area. The total area required may be much smaller if handheld or small sprayers are in use. Detail of the required fall and silt trap are as for biobeds.
- It is also sensible to install the biofilter itself within a bund to trap any possible leaks and avoid any risks to water. This could be within the main bunded pesticide area.

- The capacity of the biofilter bund should at least match the volume of liquid held in the biofilter and associated storage tanks.
- Ensure the biofilter is safe the container stack should be placed on a level base and held within a frame to ensure the stack remains vertical.
- The liquid coming from the fill area is then stored within a tank or chamber subject to the 1500 litre limit This facility will include a suitable pump, see below:
- Biomix ingredients, mixing and pre loading storage are all covered in Section 3.5 as for a biobed. Turfing of the biomix surface is not required within a biofilter as the stack principle covers the lower containers thus limiting potential turf growth.
- A small pump is needed to lift the water from the pre biofilter tank to the top container and pressurise the distribution system. This has been provided by a submersible centrifugal pump with integral float switch. A 240 v pump with circuit breaker protection delivering 50 l/min at 7 m head was employed within the HDC trial. It is possible that a low voltage system would also be suitable, perhaps with solar charging where no mains power is available.
- Secure plumbing throughout system as below:



Plate..... Distribution pipe work above each IBC

12mm push fit domestic push fit plumbing can be used to produce uniform distribution in each IBC. Holes, 2 mm diameter drilled in the upper surface of the pipe at 100 mm intervals allows good distribution to biomix surface.

- A final tank with a pump is needed to collect the treated liquid prior to re-use, irrigation or recirculation through biofilter system. This will be affected by site and any distribution system. Distribution could be by drip irrigation as suggested for the biobed. As the amount of treated liquid is likely to be smaller than a biobed (evaporation is greater in an above ground system) then the irrigation area may be reduced.

BIOFILTER CONSTRUCTION

1. Calculate biomix volume required and mix ingredients, leave to compost as for biobed.
2. Create a sprayer fill area with silt trap and discrete drain following guidelines out for biobed use. It is likely that the bund size can be reduced where pedestrian operated or hand sprayers are used. The bund should limit vehicular and other pedestrian access and contain calculated liquid amounts.
3. Develop a level impermeable base suiting the dimensions of the container stack, concrete is suitable. Concrete mix as in section.....
4. Install appropriate power supply, protected by circuit breaker.
5. Install pre-biofilter container or designated IBC, max volume of 1500 litre capacity following manufacturers' instructions, particularly where this is installed underground. This must allow suitable pump to be inserted and allow clear operation of the pump level switch system.
6. Select number of containers to be used, remove top section of each at container shoulder. Ensure that the frame and container are not weakened unnecessarily; devise system to improve this if justified. Retain one cover to cover the top container of the stack whilst in use to limit rainfall entry unless the stack is under a roofed area. Insert wire mesh lining in each container base, cover with a permeable landscape membrane (Plantex ®) or similar. Install a layer (10cm) of washed quartzite pea gravel over this to ensure the drainage outlet to the container below is not blocked.
7. Load containers with biomix ensuring there is an even consolidated fill with no 'short circuit' routes for liquid.
8. Create plumbing system from main pump in pre biofilter tank to lift to top container and through top cover to piped ring distribution system see photo below.



9. Devise a coupling system for container to container link and from bottom container to discharge or retention as planned.
10. Final assembly. Taking care when working at height to develop the stack of containers and link container plumbing together. Secure containers within frame, connect electricity and test system with water to check for leaks etc.
11. Consider insulation of exposed pipe work and vulnerable areas to minimise low temperature problems

3.5 The Biobed Mix

The biobed is basically an organic filter system. This consists of a mixture of straw (wheat or barley), peat-free compost⁴ and topsoil. The three parts should be mixed **by volume** as one part compost, one part topsoil and two parts straw, (Plate 1). Ideally the mix should be allowed to stand for between 30 and 90 days before being added to the biobed/biofilter. This allows the composting process to start to breakdown the straw, which makes it easier to create a homogenous mix. Note that it is more difficult to create a good mix when using very wet or heavy (clay) soils.



Volumetric proportions of straw, peat-free compost and topsoil

⁴ Use of peat in the biomix is discouraged given that it is an unsustainable resource. A peat free substitute should be used if possible. Farmyard manure is not approved for use in the biobed. There is potential for waste peat based growing media to be used in the biobed as well as composted green waste. However, both do not currently have approval for use in the biomix. If growers feel there is a case for using these or similar materials they should discuss this with their local EA office.

4.1 Handling Area Operation and Maintenance

The provision of a bunded filling area is not an excuse for poor practice. Every effort should be made to contain spills of concentrate chemical by using an induction hopper and drip trays. **N.B.** Concentrated pesticide must **NEVER** be disposed of to a biobed.

Where spillage of a concentrate occurs this should be treated using a proprietary spill kit. If a large spillage of concentrate reaches the biobed then the entire biobed mix will need to be replaced with the biobed mix being removed by a professional waste disposal contractor

Maintenance should include

- Regular clearance of sediment in the silt trap to ensure rapid transport of liquid to temporary storage and subsequently the biobed. Certain pesticides stick strongly to soil. Therefore soil that accumulates on the handling area may be contaminated with pesticides.
- Vehicles other than the sprayer should not have routine access over the handling area as contaminated soil may be transported off the site. You should regularly clean the handling area with any soil collected to be placed directly onto the surface of the biobed.
- Inspection of the concrete surface looking for any developing faults/cracks etc. If found early repair will ensure pollution potential is reduced

4.2 Irrigation of final discharge water

Drip irrigation is proposed to allow distribution of the treated water over a vegetative area. Soil type will determine the spacing of both emitters and pipes. Light soils will require closer spacing; progressively wider spacing on heavier soils to a probable maximum of 0.5m being likely. In order to plan any frequent irrigation a system should be installed to apply 2-4 mm at a time. Where spacing as 0.5 x 0.5m is possible with emitter flow as before such an application would be possible within 30 minutes.

It is possible to bury the drip irrigation some 50 mm below the soil surface which would control surface evaporation and minimise any vermin problems.

This pump should be automatically controlled (e.g. float switch) but allow manual activation for checking purposes.

Other sprinkler types of irrigation may be used. Sprinkler systems are likely to require a higher pressure system and this could challenge pump selection to accommodate this.

Biobeds are classed as waste recovery systems. This means it is necessary to re-use the treated water. Possible re-use options include irrigation, sprayer washing or use as the carrier for pre-crop total herbicide applications. If the treated water is to be used for irrigation, this **MUST** be applied

- to a vegetated area,
- that is neither frozen or water logged,
- is at least 10m away from any surface water,
- 50m from any spring, well or borehole not used for domestic or food production
- and 250m away from a borehole used to supply domestic or food production.

You should fully consider and document the presence of any underground drainage systems. Irrigation must be applied at a rate such that there is no surface runoff generated. A drip irrigation system as described in section 0 would be suitable. It may be advantageous to collect the treated water post biobed and thus the biobed drain outlet should be connected to a second temporary storage tank. The tank should be less than 1500 litres capacity and of a type and installation as described earlier.

3.3 Biobed Operation and Maintenance

Biobeds are intended to be low cost systems that require only minimal technical and management inputs. However, some maintenance is needed to make sure the system performs well. Keep a log book to show that the biobed is being operated and maintained correctly. This should include construction details as well as routine maintenance records, for example when the biobed was topped up, silt traps cleaned, the biomix replaced and date spread to land.

Turf Condition

Monitor the turf for any poor growth, water if necessary in prolonged dry periods of non use.

Annual Top up

The biomix over time will decompose and compact. To keep the biobed performing well, an average minimum depth of 1.0 m **MUST** be maintained. In order to achieve this, the biobed will need to have fresh pre-composted biomix added every year. Wearing appropriate PPE, the turf layer can then be removed; this is normally easy as the turf does not root heavily into the biomix. The fresh biomix added and the turf replaced. Alternatively, the turf layer may be left in-situ, the fresh biomix added and then re-turfed.

Liquid depth in chambers and pump operation.

Experience will indicate normal operational water depths in any chambers or tanks. Checking these routinely will highlight and problems developing. Pump operation can be tested by checking the float switch operation.

Drip irrigation

Check for any damage/leaks etc within the irrigation system. Inspect the biobed vegetative growth. In periods or areas of high rainfall it may be necessary to manually manage the pumping intervals applying to both the biobed and disposal irrigation systems. This will suggest a storage tank post biobed. Experience will guide necessary action relative to soil types, capacities installed and system interaction

Cold weather provision

Most systems will need to remain functional during cold weather to handle natural rainfall entering the system. Installations should limit all surface pipe runs as far as possible. Where they exist they should be insulated to an effective level using proprietary waterproof pipe insulation.

Most systems will be vulnerable where drip irrigation is used over biobed surfaces. It is suggested that these be covered with a straw layer for insulation purposes.

Five yearly replacement of biomix

It is a regulatory requirement that the biomix **must** be replaced after five years⁵. Excavation to remove the used biomix must be done carefully to avoid damaging the liner. It may be prudent to leave a thin layer of biomix in the liner to avoid risk of damage. While the biobed is empty, use a shovel to gently remove any remaining biomix so that the construction can be carefully examined and any defects repaired. Liner life should be longer than two fills and may only be required if it is damaged during unloading.

⁵ Data on the long-term performance of the different biobed systems operated under UK conditions is limited. However, the scientific literature suggests that the biomix should work effectively for five to eight years.

4.4 Operation and Maintenance of Biofilter

1. Arrange for the final discharge pump to deliver to chosen outlet, i.e. Re-use storage, irrigation or recirculation to pre-biofilter tank.
2. With a surface area of an IBC the filling pump should be set to discharge at a maximum of approximately 150 - 200 litres of liquid at each operation. This equates to approximately 115 - 150 mm water max per session within the IBC container type. Pump flow at the pressure head will dictate running time. Three to five minutes should achieve a reasonable application rate, typically this running period may be required every one or two days but this will depending on volume being treated,.
3. The biofilter should never be flooded; therefore it is necessary to check that moisture movement through the container is regular. Flooding and moisture status should be readily visible with translucent containers.
4. Check for leaks frequently initially, reduce checking frequency to 1 per week once system proved
5. Check for problems in cold weather
6. Top up containers once per year or as necessary following inspection.
7. Keep basic records of when biofilter commissioned, overall use periods, faults repairs etc.
8. Completely replace biomix every five years and follow storage and spreading requirements

4.5 Storage and Use of Spent Biomix

The spent biomix must be stored so that there is no risk of it being a source of water pollution.

Storage requirements:

- 10m away from any surface water or clean water drain,
- 250m from any spring, well or borehole
- Store for a minimum of 12 months and no more than 36 months
- No more than 50 cubic metres may be stored at any one time
- Consider sheeting or storing the biomix under cover to reduce of rainwater run-off.
- If the spent biomix is stored **on concrete** (or other impermeable surface), any run-off should be collected and irrigated to vegetated land, that is neither frozen or water logged, subject to the distances given above.
- If the spent biomix is stored **in the field** ensure the storage is sited away from any field drains and that there are no risks to surface and ground water
- Keep a plan and record of your storage arrangements

Spreading spent biomix to land

Used biomix may be spread to land⁶, as long as this results in benefit to agriculture or ecological improvement⁷ and subject to the following restrictions:

1. You must be entitled to carry out the activity on the land.
2. The land is at least 10m away from any surface water and 250m away from any spring, well or borehole
3. Wherever practical target spreading on areas of 'lower risk land'- as defined by the Codes of Good Agricultural Practice
4. The land is not waterlogged, flooded or snow-covered, frozen or been frozen in the preceding 24 hours.
5. The application does not exceed 50 tonnes per hectare in any period of 12 months
6. You make an allowance for the available nitrogen, total phosphate and total potash in the waste when working out fertiliser requirements

⁶ Ensure that you have the U10 permits/exemptions for land spreading waste

⁷ Agriculture benefits include the provision of nutrients such as nitrogen and phosphorus, while the addition of organic matter can improve soil structure and water holding capacity. Ecological improvements could include the maintenance or improvements of habitats.

7. The application follows any requirements that apply with to Nitrate Vulnerable Zones”.

Appendix 1

Example Costs

Example costs are given below; these will vary depending on site and systems selected as well as whether any part of any system already exists and can be incorporated into the design.

Biobeds and sprayer fill area

Bunded pesticide and mixing area, with drain and silt trap – concrete	£55-70 per sq metre
Small pump chamber	£300 each
Pumps	£70 each
Electrical supply, time switches etc	£350 per site
Liner and membrane 5 x 4 m, nominal biobed with drain	£800
Plastic water storage tank-double skin 1.5 - 3 cubic metre	£800-1500
Drive over grid – suited to loaded self propelled sprayer	£90 per sq metre
Drip irrigation – biobed distribution and disposal area	£300
Roofing area – single span, mono pitch	£20-25 per sq metre
Package deal to suit 9 x 4 m biobed to include 2 pumps all liner materials, drip irrigation for biobed and final irrigation areas.	£2400.00 plus VAT

These costs are all for proprietary new items. Typically one new un-roofed indirect system using two tanks on a new concrete surface could cost up to £7,000. However in many situations existing concrete areas can be used this will reduce the cost by up to £2,500. The drive-over biobed will cost up to £7000.

Biofilter

There is limited information on the construction costs for a biofilter however based on the costs are likely to be as follows:

IBC's new cost ⁸	£90 each
Frame to support IBCs	£50
Internal plumbing and internal filter bases	£50
Pump	£70 each
Alternative tanks for pre biobed storage	£800-1500

⁸ It is likely that new IBC's rather than recycled IBC will be required if Biofilters are funded through a grant scheme. Check eligibility with grant provider.

Electrical supply – if required

£350

or

Proprietary package unit £1900 -2,300.

Based on proprietary items this suggests for materials only then £500 should cover a simple 3 container system. Additional costs e.g. concrete / drainage / tankage costs may be estimated from the biobed figures.

Many variables exist with each site, especially where part schemes already exist. Modifications to such schemes, using farm or local construction skills, may mean that in reality the actual expenditure figure may well be considerably lower than this.

Maintenance Costs

It is unlikely that large costs will be incurred with routine maintenance. Trial sites have not shown high costs and preventative maintenance routines will pay dividends.

Appendix 2 References and Useful Contacts

- www.biobeds.info,
- www.environment-agency.gov.uk,
- www.voluntaryinitiative.org.uk,
- www.biobeds.org an international site focusing on all forms of pesticide remediation facilities
- www.naturalengland.org.uk/csf
- **T32 and U10 exemptions available from Environment Agency web site**

Appendix 3 Example Sprayer Washing Volumes

Sprayer Washing Scenarios (litres)		Arable Farm			Vegetable Farm			Mixed ArableGrass Farm			Grassland Farm		
	Farm Profile	Generally sophisticated equipment to make most of labour saving devices, good awareness of basic need to keep sprayer clean and to avoid crop damage BUT will plan work to avoid unnecessary rinsing, may not always do end of day rinse			Sophisticated equipment with labour saving devices; very risk averse and will not want to risk damage to crops, overdosing or residues so many full washes a year even if not always needed			Second hand smaller sprayer with few labour saving devices but spraying frequency low and unlikely to be growing sensitive crops limited awareness of sprayer hygiene issues			Small vintage sprayer very basic, sprays 1-2 times year low awareness of sprayer hygiene... may not wash at all!		
Sprayer washing	Typical Process	Frequency/year	Washing volumes for Median Tank Size 3000L	Volume of washings for biobed	Frequency/year	Washing volumes for Median Tank Size 2000L	Volume of washings	Frequency/year	Washing volumes for Median Tank Size 1500L	Volume of washings	Frequency/year	Washing volumes for Median Tank Size 1000L	Volume of washings
Full	Only happens when changing between sensitive crops or reactive products; process would involve 3 rinses each rinse using 10-20% sprayer capacity if internal rinse nozzles fitted; for grassland assumption made that internal rinse nozzles not available	5	3000	3000	20	2000	8000	2	1500	9000	2	3000	6000
End of day rinse	One quick rinse through 10% of sprayer capacity probably applied to arable crop or grass but not veg... for grassland assumption made that internal rinse nozzles not available therefore one full tank rinse	40	300	na	70	200	14000	4	1500	6000	0	0	
Exterior Washing	Either done in the field or with a good facilities draining to a biobed/filter	40	100	4000	70	100	7000	6	100	600	2	100	200
Total Washings				7000			29000			15600			6200
Volumes Exclude Rainwater from handling area													

FAQS

- What volume can be treated in a biobed?

The maximum volume of sprayer washings (excluding rain water) that can be treated by a Biobed is 15,000litres. The surface area of a biobed needs to be big enough to handle all planned sprayer washings and any associated rain water; work on 1m² per 1000 litres of total liquid

- How often can I fill a biobed?

Once commissioned relative to a know volume of liquid the process of 'filling' is routine, early development work showed that rainfall events were managed successfully by the design.

How often will I need to add material to the biomix?

Biobeds will naturally sink by about 20-40cm/year as the straw and peat free compost degrade. Using PPE, gloves particularly, peel back the drip lines and the turf layer and top up annually. Reinstall the turf or cover with fresh supply, re fit drip pipe.

- How often do I need to empty a biobed?

The EA exemption states that the material should be exchanged every 5 years. The old material must be store protected from rainfall for 12 months. Then it can be spread to land under Exemption U 10 at not more than 50 m³ per hectare.

- What is the biomix?

All the UK trial work was based on that biomix used in Sweden. It is by VOLUME 50% any cereal straw, 25% friable soil and 25% peat free compost. Various composts are now available based on a variety of ingredients. The compost needs to be of a fairly fine nature to ensure good moisture migration throughout the mix. Therefore a lumpy mix may not be successful.

- Should the biobed be covered?

No, The biobed works well as a moist environment. Rainfall on the surface will support this, even dews may be helpful in dry times. A roofed environment may lead to the biobed drying out too much.

- How do I maintain a biobed?

Ensure that the liquid transfer system functions well, probably at least weekly during non spraying time. Observation during normal use will identify whether the drip irrigation is working well as well as any problems, leaks etc. Beyond this the biobed does not demand intense management. Yearly top up of the biomix may be necessary.

- How do I operate a biofilter?

Once installed liquid flow from the fill area, normally covered, will transfer through the silt trap to the primary tank and pump. This delivers liquid to the top biofilter container and gravity then ensures liquid flow through the remaining containers. Dependant on design there may then be a final tank, fed by gravity which then allows discharge from the biofilter or a second pump will deliver the treated liquid to the irrigated area.

- What volume of pesticide waste can be treated in a biofilter?

The EA exemption permits up to 15,000l of waste liquid to be treated by a biofilter per annum. However there is much less material in the majority of biofilters than would be found in a biobed. As most units will be linked to a covered fill area this may mean that only 3000 – 5000 l of contaminated liquid will be needing treatment.

- How often do I need to empty a biofilter?

As with a biobed the EA exemption states that the material should be exchanged every 5 years. The old material must be store protected from rainfall for 12 months. Then it can be spread to land under Exemption U 10 at not more than 50 m³ per hectare.

- Should the biofilter be covered?

Yes, excessive rainfall entering the system is likely to be detrimental. Replacing the top cut off an IBC or using a proprietary lid on another container will be sufficient to limit rainfall entry.

- Should the biofilter be irrigated?

This should not be necessary. Where the unit is sited under cover it may be possible that in a dry warm season the contents could dry out. Recirculation of liquid leaving the biofilter may be helpful in maintain the moisture status required.

- How do I maintain a biofilter?
Ensure that the liquid transfer system functions well observing liquid transfer and gravity movement of liquid through the biofilter containers also checking for leaks. Beyond this the biofilter does not demand intense management. Yearly top up of the biomix may be necessary.
- What can I do with the treated washings?
As with a biobed these washings can be irrigated to a vegetative area. Drip Irrigation suits this need well.
- What happens after five years of operating a biofilter?
This will coincide with the need to exchange the biomix, then to store that under cover for a further year before spreading the material to land under the U10 Exemption. It may be possible to exchange the material earlier than this by replenishing one container at a time. Storage of the material under cover is required as with the 5 year rule.