*The Perennial Primer*

Part One:

# Planting and Growing Perennials

by Helen Nash and Marilyn Cook

Perennials form the back-bone of the garden.

Perennials are such an American garden favorite that Il Sik Hong includes them in adaptations of his Oriental garden designs. These herbaceous delights are treasured for their long lives, their variety and beauty, and for their hardy but easy care. Careful planning and a knowledge of basic maintenance are the keys to lush and carefree-looking plantings of perennials, whether as borders, bedding plants, or specimen plants in your yard or around your pond. Plant these favorites for the birds, plant them for the butterflies, and plant them for yourself.

## Basic Perennial Planning

*Assess your site*. Consider not only your area's range of temperatures from summer through winter, but also the particular site conditions in your yard and an analysis of individual plant's preferences and habits — shade, sun, acid or alkaline soil, moisture, form, and height. Don't be afraid to experiment with questionable plants — you might be able to accommodate their preferences in spite of your site! Construction of a charming arbor, for example, might generate enough shade for a desirable plant. Finally, consider the enjoyment of your plantings by yourself from both inside and outside vantages and by the wildlife that you invite into your garden.

*Plan for color*. This includes not only the coordination of your personal garden scheme, but also the sucession of color throughout the garden season...and beyond with dried plants and seeds gracing the winter landscape and dinner table of wintering wildlife.

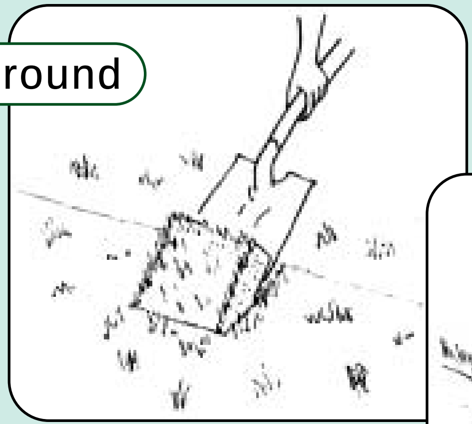
***Hemerocallis*, Daylily**

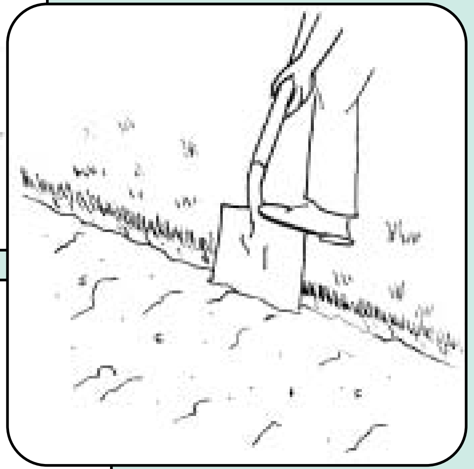


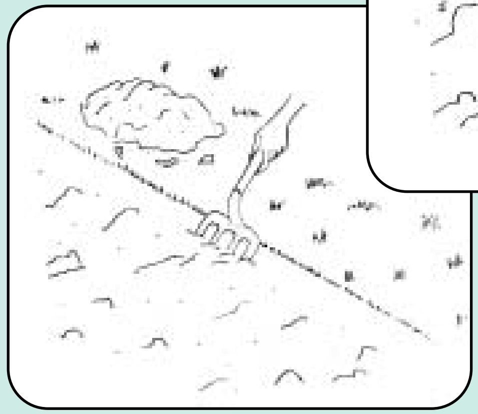
Preparing the Ground

## Preparing Virgin Ground

1. Use your garden spade to cut off the sod where your perennial bed will grow. Cut the sod in squares for use elsewhere in the yard. (Keep them moist and stacked in a shady site until you can set them in their new home.)
2. Work your way through the exposed soil, a shovel's depth at a time, tossing the dirt ahead of your digging. Break the soil up with your shovel. Avoid walking on the spaded area to prevent recompacting the soil.
3. Work soil amendments into the bed as needed by your particular circumstances. You may add composted soil or manure, peat moss, or limestone, for example.

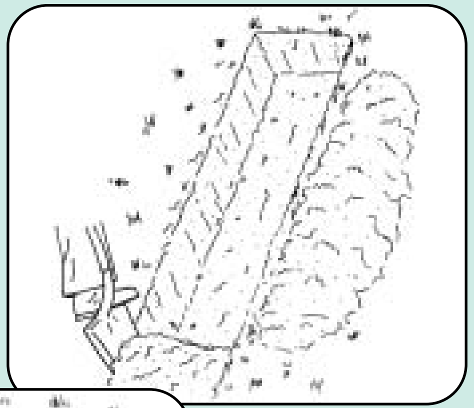


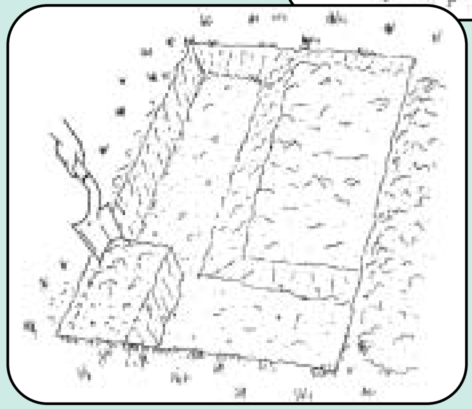




## Double Dug Beds

1. After removing any sod, dig a trench to a shovel's depth, placing the topsoil in a wheelbarrow. Beginning at the head of the trench, turn over and break up the exposed soil to a depth of a half to another shovel's depth. Work in soil amendments such as composted manure into the loosened subsoil.
2. Dig another trench immediately next to the first and follow the same procedure, except moving the topsoil over to cover the amended subsoil in the row just completed. When the entire bed has been dug and redug, cover the final trench row with the topsoil stored in the wheelbarrow. Work in any further amendments of compost into the loosened topsoil.





***Leucantemum*, 'Snowcap' Shasta Daisy**

# Planting Your Perennials

## Planting Bare-Root and Container-Grown Plants

Plant bare-root perennials in the spring so that they have ample time to establish before going dormant. Milder climates allow for autumn planting, too. Be cautious of planting bare-root plants in ground likely to freeze; chances are you'll find your young perennials lying exposed upon the ground come spring. If your bare-root plants arrive in the mail, unpack them immediately and tend to their roots, as well as to any rot or mildew that may have started during the shipping.

Container-grown plants can be planted throughout the season. Again, however, take special care with fall plantings to avoid their being heaved from the soil. Generally, late-season bloomers need time to establish their roots before directing their energies to flower production. Spring bloomers do well when planted in early autumn to allow establishment for their next bloom season.

Plants received bare-root can be held for planting by keeping their roots covered and moist for as long as two weeks. If you cannot plant within that period, heel them in the garden (if all danger of frost is past) or cover the roots in moist, untreated sawdust, compost or leaf mold in a shady location. Be sure to plant the held plants properly by the time you notice fresh growth.

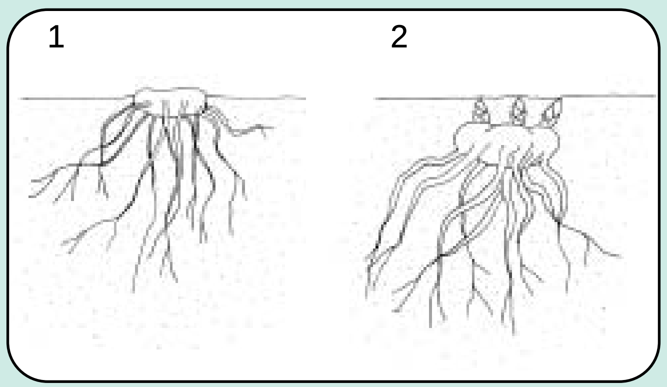
## Planting Depths for Bare-Root Perennials

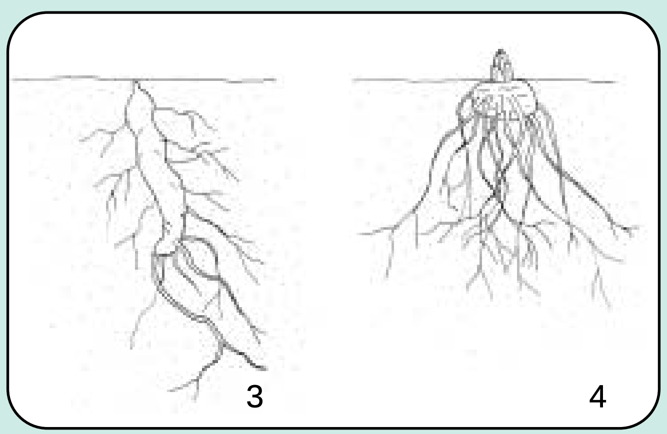
(1) Plants such as irises and bergenia that grow from rhizomes should be planted so that the surface of the rhizome is exposed at the soil level.

(2) Peonies are planted with the tips of the buds just below ground level in mild winter regions. Plant them up to two inches below the soil's surface in zones 6 or colder.

(3) Hostas, like most perennials, should be planted with the crown at the soil's surface.

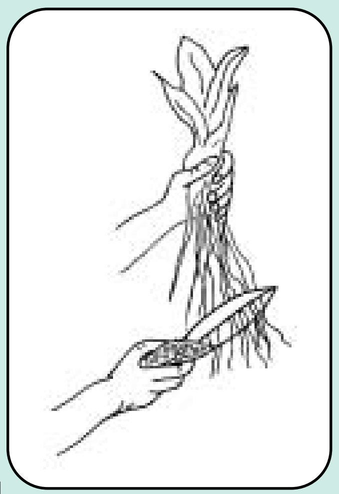
(4) Plants with fleshy primary roots, such as daylilies, should be planted with the root vertical and growing tip just below the soil's surface.



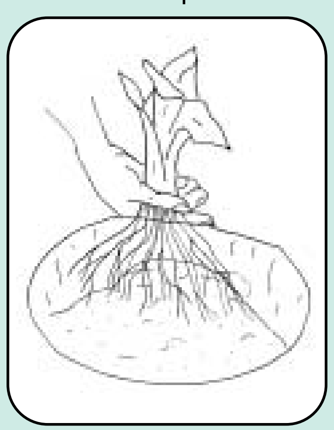




## Planting Bare-Root Perennials

(1)After unpacking the plants, remove any damaged roots or leaves. Store the plant in a bucket of water as you prepare the planting site. Adding Vitamin B to the water may ease transplant shock. In a prepared bed, dig the hole as deep and as wide as the plant's longest roots. Form a mound in the center of the hole that will support the plant's crown at its proper level.



(2)Set the plant on the mound and gently spread out its roots. Fill in the hole, tamping the soil over the roots. Water well and mulch. If the plant is set in full or afternoon sunlight, set up a canopy over the plant for the first couple days to lessen the chance of transplant shock. During the first few weeks of planting, provide nighttime protection if surprise frosts occur.



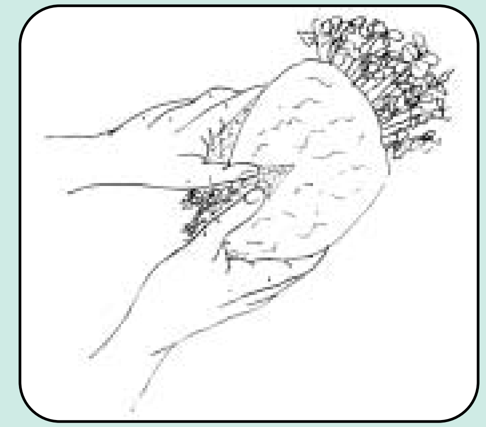


## Planting Container-Grown Perennials

(1)In a prepared bed, dig a hole slightly larger than the plant's container. Tap the pot's bottom and gently roll the sides of the pot to loosen the plant for sliding it from the pot. With your hands, gently loosen roots all around the outer surface of pot-compacted soil.

(2) If the plant is root-bound with the roots exposed and circling the soil, slice into the bottom of the rootball to an inch or two depth with a sharp knife. Gently spread the soil and loosen what roots you can. (If you find many roots must be pruned away, be sure to compensate with comparable pruning of the top of the plant. Severely pot-bound plants may require pruning of both roots and tops to regain vigor.

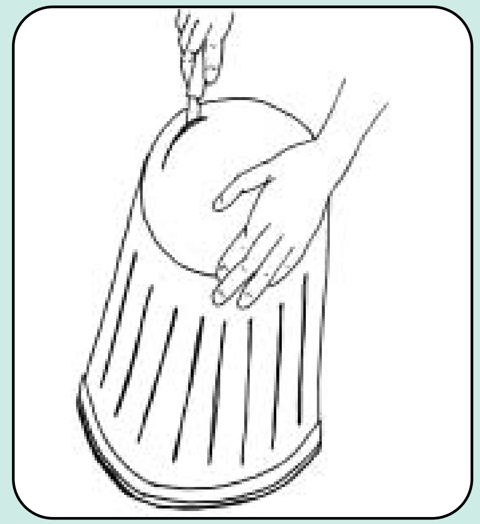
(3) Set the plant in the prepared hole. Spread any roots. The crown of the plant should be level with the surrounding soil. Fill the remainder of the hole with tamped soil, water well, and mulch.

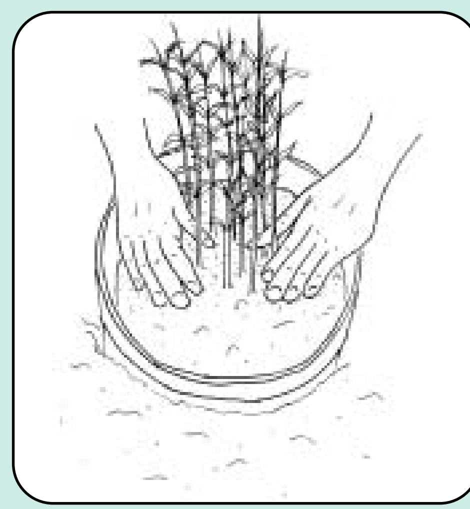


## Controlling Vigorous Spreaders

(1) Cut the bottom out of a large plastic pot.

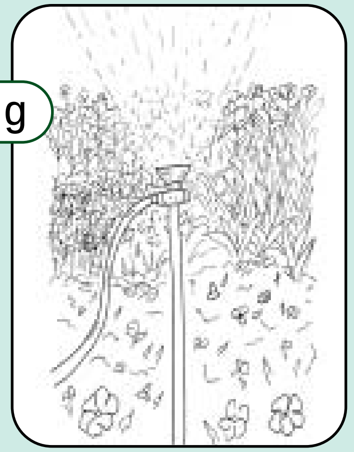
(2) In a prepared bed, dig a hole large enough to accommodate the now bottomless pot. Fill the container (and outside it) to a level that will allow the plant to present its crown to the soil's surface. Finish covering and tamping around the plant's roots, water, and mulch well. Use mulch to conceal the extended ridge of the retaining pot.





***Monarda***
**Bee Balm**

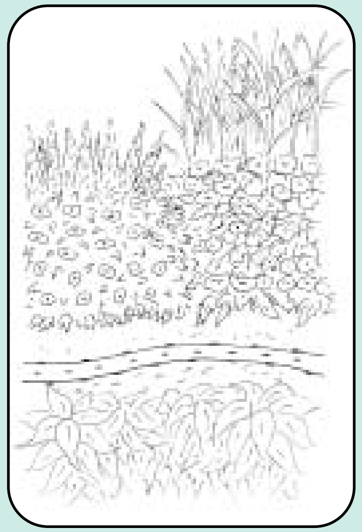
# Watering & Mulching



Generally, perennials require from one to one and a half inches of water a week. Be certain of the particular plant's water requirements! Plants that do not need so much water can rot away. Long and slow soakings are best to ensure the water penetrates to the depths of the plant roots. A rate of an inch of water in a 6-hour period avoids wasteful runoff. Soaker watering is the most carefree method, however, sprinkler systems may be used as well. Overhead watering is best performed in the early morning to avoid excessive evaporation and sun-scald on tender leaves during the heat of the day, as well as to avoid fungus and mildew attacks on wet leaves at night.

(1) Use an overhead sprinkler system early in the day and at a rate equal to a gentle rain — only one inch of water in 5 to 6 hours.

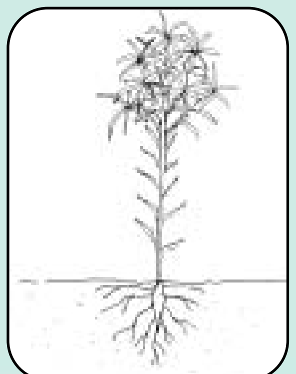
(2) Conceal a soaker hose under your garden's mulch and let the water seep gently into the soil around your plants.

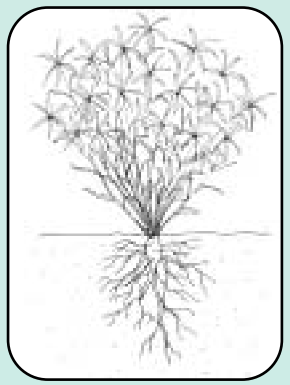


## The Importance of How You Water Your Perennials

(1) Frequent small dousings of water produce shallow-rooted plants with spindley stems. These plants will be most susceptible to extremes of heat and drought.

(2) Deep watering, as outlined above, produces healthy, deep root systems that support full and lush foliage and blossoms. These plants will better survive adverse conditions.

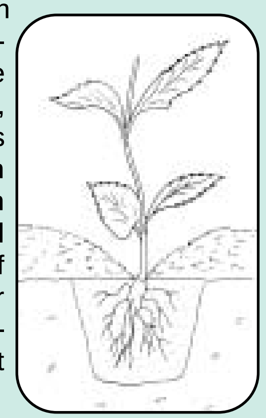




*Aster novi-belgii*

## Mulching, the Right Way

Mulching provides valuable assistance to your perennials — it helps retain moisture and discourages the growth of weeds. Pile up to two or three inches of fine, organic mulch around your perennials. Use 4 to 6 inches of woodchip mulch. Keep the mulch from touching the plant's stem and crown lest you invite rot. Organic mulches, as opposed to stone, offer nutrients to the soil as they degrade and are replaced. Hotter climates find the mulch layer needs replenishing more frequently as the mulch decomposes more rapidly in high heat and humidity. In cold-zone climates, enhance this mulch layer in the winter with an additional mulching of pine boughs or straw to insulate and protect the plants.

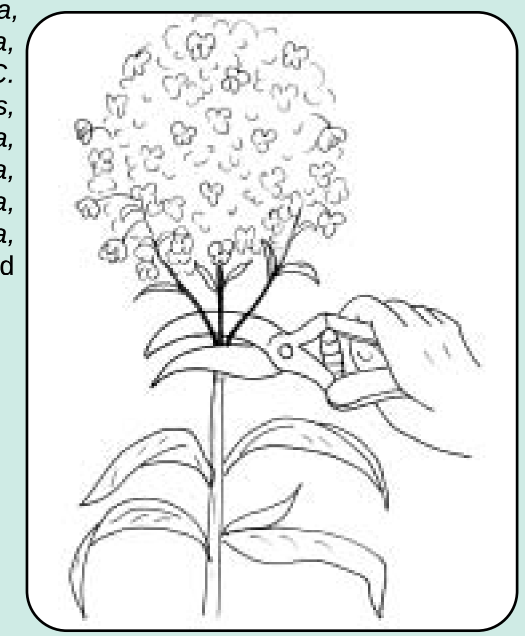




# Deadheading and Pinching

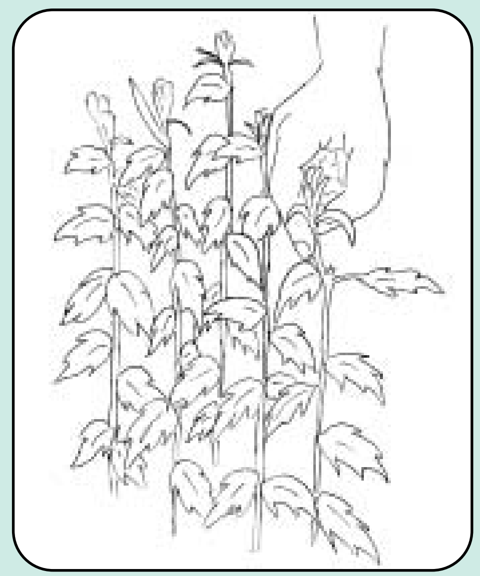
## Deadheading

Treat deadheading or the removal of spent flowers as a quiet and relaxing chore that allows you to savor the sights and sounds of your garden. Deadheading is important for many perennials as the plants may go to seed long before you are tired of their blooms. The flowers of some plants may fall off by themselves, while still others provide attractive winter form (and birdseed) to the garden. Simply cut off the fading flower. Plants with leafy flower stems and a rosette of leaves should be cut back to just above the topmost unopened bud. Cut the stem off just above the foliage if there are no buds. Bare-stemmed perennials are cut off close to the ground. Deadhead the following perennials: *Achillea, Anthemis, Armerioa, Campanula, Centaurea, Chrysanthemum maximum, C. Morifolium, Delphinium, Digitalis, Echinops, Eupatorium, Gaillardia, Heuchera, Lobelia, Nepeta, Penstemon, Phlox paniculata, Platycodon, Salvia, Scabiosa, Sidalcea, Stokesia, Verbena,* and *Veronica*.



## Pinching Stem Tips

To produce new branches with smaller but more plentiful flowers, pinch off emergent stem tips just above the tiopmost unfurled leaves. Pinching plants encourages bushier and fuller plant form, too. Pinching summer blooming plants in the early spring keeps the plants more compact and less likely of requiring staking. Spring pinching will not delay bloom, whereas summer pinching will.



***Rudbeckia fulgida* 'Goldsturm'**
**Black-eyed Susan**

# Adding water to your garden

**Part 1:** Research and Thinking
by Chuck Rush

Ponding is really simple if you follow *all* the steps: Research and Thinking, Planning and Building, and Planting, Stocking and Maintaining. Your first question is probably Research and Thinking??? Yep. A pond is different from any other do-it-yourself landscaping task. It's permanent. BOY, is it permanent. Think about it. If you put in a flower bed and decide you don't like it there, you only have to dig up a few plants and let the grass grow. Or if you want it bigger, no sweat. To get rid of your pond, you have to fill in the hole you spent a month of weekends digging!!!

Why are you interested in ponding? You think it looks neat? She Who Must Be Obeyed commanded? Those are the 2 most popular answers. How about a few more? Did you realize that a water garden is actually fairly water conservative? 1000 square feet of grass consumes over 25,000 gallons of water a year, while a filled 10 by 20 foot water garden needs less than 7500 gallons a year! How about this: in which position would you rather be in 110 degree heat in the middle of August — bent over a thorny rose bush, clipping off spent, puny blooms, or up to your hips in water snipping 8-inch water lilies, maybe, as in my case, with a few overly-friendly koi and goldfish trying to rip the hair out of your legs? Or how about this — you don't have to mow a pond!!!

If your lot is hilly, collect ideas of tumbling and trickling falls and streams.

Okay, you want a pond. How do you take your lawn from bare-bones grass to a tropical paradise? The first thing you need to do is write off for a few pond-ing catalogs because they will take a while to get here. They are a great resource for photos and general information of plants, fish, equipment, and books.

Next is the most important advice I will ever give you: call your local utilities. Here in Dallas, they all cooperate in a program where you make one call and each utility comes out, searches, and marks your yard for buried utilities. Knowing this stuff can save your life! Someone in my area was killed digging a pond when he dug into a buried power line. Even if it doesn't kill you, you will probably have to pay for damages. If you have them come out and mark, you aren't liable if it's not where they said. In place of such one-call service, be sure to call each service — phone, electric, gas, cable, water, sewer, etc. — delivered to your house.

The classic 'before' picture of our backyard.

Now, take a *good long look* at your yard. Do it in photos and video if you can. Memorize this photo. It will be the basis of everything you will do from here on out. You will also want to hit the library and book stores and, of course, the book section at your local pond shop. Reading as much as you can on the subject arms you with information and options.

The first question you have to answer is, "What kind of pond do you want?" Most people are building informal, natural ponds. Use Nature as your inspiration. You have your photo of your backyard; take a look around you wherever you go and keep your camera loaded to save the scenes and ideas that capture your interest. Go back and take a look at all your old vacation photos. Visit a city pond. We're blessed here in the Fort Worth/Dallas area with lots of civic water — the Fort Worth Botanical Gardens and the Dallas Arboretum, for example. There are *tons* of good ideas all around you. Look at all these things with the photo of your backyard in your mind. Heck, keep a copy of the backyard photo on your dashboard!!

Join a local pond group. You'll find water gardeners a friendly group who enjoy sharing their knowledge, experience, and ponds. Ask around at pond shops and gardening clubs or look for such a group on the Internet. Check out the club section in the back of this magazine, too.

After a few weeks, your catalogs start arriving, and you have started your book collection. Now you can start on step 2, Thinking, while you continue with step 1. Here are a few of the questions that will pop up.

1. Where will you put the pond?
2. How big will the pond be? How deep?
3. Do I want fish? Plants?? Both???
4. Do I want my pond to be above ground? In-ground? Half and half?
5. How do I want to retain the water?
6. Filtration?
7. And He or She Who Must Be Obeyed will inevitably ask, "What will it all cost?"
8. And shortly thereafter H/SWMBO will ask, "What are you going to do with all that dirt?"

Streams do not have to tumble downhill — lush landscaping tucks the stream bed into the terrain.

Other questions will pop up, but these will get you started. A lot of the books you read will be by European authors. They know their stuff, but in the past few years, we have seen an explosion of new products and new techniques here in the US. These differences will raise more questions. Even more conflicting information will come from ponders in different areas from your own. If you live, say, in northern Canada, you might take a different approach than someone farther south. I know of a man who has a pond in northern Manitoba, and he has only 3 months out of the year when he doesn't have ice. Different conditions require different approaches. Keep an open mind and don't feel bound by convention. Even the type of soil in your area dictates what you have to do with your pond.

Let's start to answer that list of questions.

*First, Where will you put the pond?* Your initial inclination may be to put it in that low spot in the yard where the water already collects. That's probably the *worst* pond site if you don't take necessary precautions. All the nasty chemicals that your neighbors put on their lawns — herbicides, fertilizers, insecticides — could end

Seek ideas that would work in your own situation. Here a very narrow backyard is creatively landscaped with water.

In your search for ideas, capture the 'little ideas' that catch your fancy.

up as runoff in your pond, harming your fish and plants. If your pond will include plants, the site should receive at least 4 hours of sun, more for any bloomers, even more for lilies, and still more for lotuses. (For a shady site, research those plants best suited to such conditions.) Building too closely to trees invites more maintenance from the leaves dropping in, but then again, trees make a good backdrop. Locate the pond where you can enjoy looking at it, even if you are indoors. If you want a fountain or filtration, you'll need access to an electrical source. And don't forget a water source! If you live in the city or suburbs, call your local building inspectors for any guidelines they might have. There may be restrictions on where you can put your pond and how big or how deep it can be, for example.

*Next, how big will the pond be?* How deep? My advice, too, is to make your pond as big as you can afford. The main regret of most ponders is that they did not build a *bigger* pond. Secondly, a big pond is easier to clean than a small pond. A pond large enough to get into allows you to tend your plants at waist level rather than bent and stretched over from the edge. Also, nets and scoops are managed more easily in a big pond.

How deep depends on a lot of things. If you want plants, water lilies require at least 18 inches to give them 10 to 12 inches from the plant's crown to the surface. Again, more depth brings the plant closer to waist level if you can work inside the pond. Deeper water protects your fish by ensuring a

As you think and plan for water in your garden, consider if the feature will be visible from *inside* your home

warmer layer of water at the bottom of the pond in the winter and overall cooler water that better retains dissolved oxygen levels in hot summer weather. Temperature fluctuations that stress fish are also minimized. I recommend a depth of 30 to 36 inches for a mixed purpose pond. If your pond is to be strictly a koi pond, you will need 4 feet or more to make the koi happy and to maintain their healthiest condition. Finally, how deep *can* you go? You might run into bedrock and have to resort to modifications of at least partially aboveground construction. Blasting is usually recommended only for the truly warped ponder.

*Do you want the pond above ground*? In-ground? Half and half? Largely a matter of personal preference, an inground pond looks more natural, but an aboveground pond may be more accessible and allow for a bench around it that eases maintenance and closer enjoyment of the pond. If your site is sloped or your soil type warrants, you may have to do some of each. Rental properties, the presence of children, or physical/health limitations may make a preformed pond set upon the ground the perfect choice.

The ideas you collect will include whole vistas.
*Photo by Richard Schmitz.*



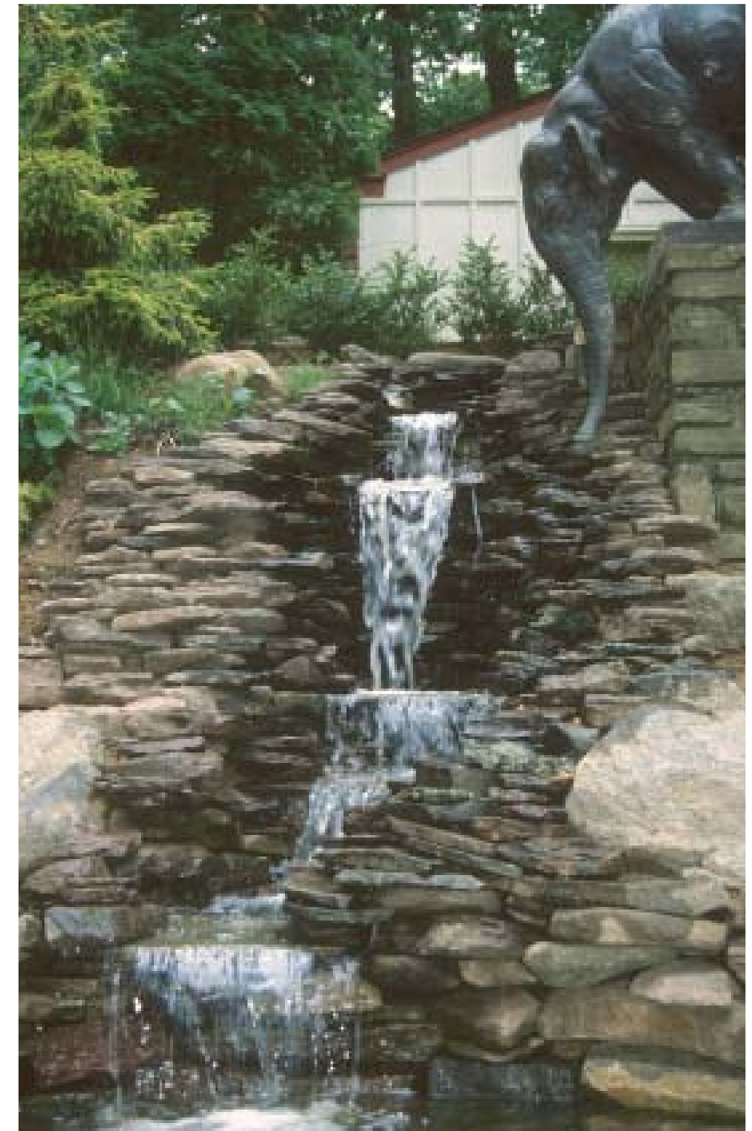
*How do you want to retain the water?* These options can be divided into 2 groups: hard liners and flexible liners. Hard liners are of 2 basic types: concrete and molded plastic or fiberglass. Major drawbacks of concrete are the expenses of material and hiring professionals for the construction; long-term maintenance and cracking repairs are also a consideration. Although preformed structures are limited in available sizes and the fiberglass products can be expensive, they are relatively easy to install. They are also a practical option in loose or sandy soils. And if you have a dog that enjoys water, hard liners are definitely worth considering!

Flexible liners are what most ponders use today. You are limited only by your imagination as to size, shape, and depth. Flexible liners are easy-to-install sheets of material such as PVC plastic of varying thickness, rubber liner, or a new material called HDPE plastic. PVC is inexpensive, but it has a limited life span. It comes in 20 mil and 32 mil thicknesses. Sunlight (UV rays) makes the material quite stiff

Preform ponds are available in a small range of sizes and shapes.

and prone to deterioration. These liners require replacement within 5 to 10 years, or even earlier. HDPE is another plastic, but instead of being one extruded piece, it is made of several very thin layers bonded one on top of the other much like a very thin plastic plywood. Reportedly formulated to be UV and puncture resistant, it is reasonably priced, but it can be hard to find and is not as flexible to work with as other materials. Rubber liners are known as butyl or EPDM. Butyl rubber is the real natural rubber product that has been used in Europe for decades. In the past few years, a synthetic rubber, EPDM, has become the liner of choice, available in thickness from 45 mil on up to 60 mil. A controversy continues regarding the less expensive EPDM used for flat roofing. Because tests have shown some of these roofing products may be toxic to your fish, you may wish to purchase the EPDM denoted as 'pond safe' or 'fish safe.' The difference in overall pond cost is not much, and you may prefer to have one less thing to worry about.

*Filtration?* There are 2 different types of filtration and 2 general locations for their use. Mechanical filtration removes particles from the water. (Particles can result from things as small as algae to things as big as fish.) Mechanical filtration protects your pump and helps clear your water. The other type of filtration is biological. Your fish produce wastes in the form of various nitrites. In sufficient quantity, these toxic chemicals can harm or kill your fish. Fortunately, nitrifying bacteria converts the nitrites into nitrates (essentially harmless fertilizer used by the plants in the pond). Although these bacteria grow on all the surfaces in your pond, your pond water may benefit from substantially increasing their number if you have many fish, large fish, or heavily fed fish. A biofilter is a container filled with a material or media that offers great surface area for growing colonies of these bio-critters. Water is pumped through this filter at a rate that allows the nitrifying bacteria to convert ammonia to nitrite and nitrite to nitrate before returning to the pond. Biofilters are designed either as down-flow or up-flow units. In a down-flow filter, water enters at the top, flows down through the filter media, and exits the filter at the bottom. In an up-flow filter, the water enters the filter at the bottom, flows up through the media, and exits from the top. An up-flow filter can also act as a mechanical filter by allowing particles to settle at the bottom of the filter from where they can be drained away. You can buy your filter or build your own. Part of your pond design



This striking waterfall is memorable for its use of smaller stones that can be managed by a single person.

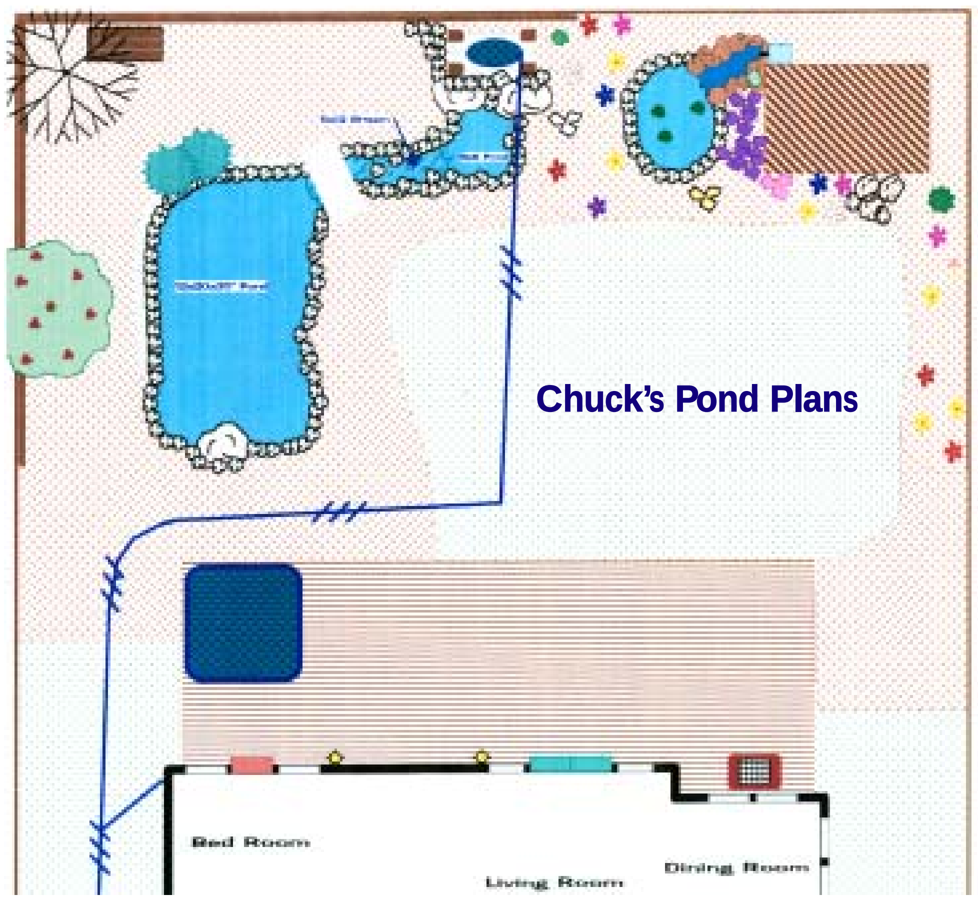
If you wish to include special fish like koi in your pond, you'll need to research their needs.

may include provisions for filtration.

Filtration also involves pumps. For your filter to run properly, you need to run the volume of your pond through your filter about every 2 to 4 hours. If your filter is also a mechanical filter, an even slower flow may be necessary to allow particle settlement. Don't buy your pump until your pond is installed and you can accurately compute the water volume and your pumping needs.

Carry your camera with you to bring back ideas you like, such as the way water moves over rocks in nature.

Pumps are available as submersible in-pond machines and as external or out-of-pond units. External pumps are presently difficult to find for smaller ponds. If you buy a large capacity pump, the external pump costs a lot more up front, but is much cheaper to operate. For instance, a Little Giant 6ECIM pumps about 3500 GPH. It costs around $150, but at 14 amps, it costs $70 a month to run. On the other hand, a Sequence 1000 at 3700 GPH costs $350, but at 2 amps, costs $10 a month to run. I use both types of pumps; an external pump recycles the water through my filters and waterfalls, and a submerged pump helps in draining the ponds. For the smaller pond, submersible pumps tend to greater efficiency than out-of-pond units.




And He or She Who Must Be Obeyed inevitably asks, "What will it all cost?" You probably won't have an exact cost ahead of time, but you can come up with a working figure. Write down your basic components: liner, pump, filter, and major plumbing items. Add another 30% to 50% of that total for miscellaneous plumbing like pipes and fittings. Plant costs are variable, but a way to over-estimate that cost is to figure out what you want and gauge the prices from one of the more expensive catalogs. A trip to your local nursery will help estimate the cost of landscaping plants around the pond.

Another major variable cost is the pond edging and other rock work (waterfall, stream course, and adjacent landscaping). This can be the crowning touch of your pond design. While the edge can be made of other materials, it is usually some form of rock, and rock can be *expensive*. I know of one extreme example of a small pond in which the rock-work alone was over $10,000. You can save money by collecting rather than buying your rocks. I collected over 3 cubic yards of rocks from a neighborhood housing addition. If you don't know someone with a farm, you may find farm fields with collected rocks piled to the side. Don't be afraid to knock on the door and ask the owner if he'd mind your hauling some away! I know of some people who had several house parties with the request that the guests bring them rocks for the pond rather than a bottle of wine or a dessert.

If you can splurge on anything, think about having a professional do your rock work. My parents collected all their rocks and then had a professional come out to build the waterfall and pond edging. The cost was about $1700 for an 11x18 pond. Unless you are good with rocks, you can really tell the difference. So while you are thinking about your pond, start collecting rocks. You will use more than you think.

And shortly thereafter SWMBO will ask, "What are you going to do with all that dirt?" A 10 x 12 x 2.5 foot pond will result in over 11 cubic yards of dirt or about 50 large wheelbarrows full. That's a lot of dirt! If you're like me, you're going to look for options that don't cost anything. Some of that dirt can be used to level out low areas in your yard. How about filling in that trench between your house and your neighbors'? I used the extra dirt to build a little character into our dull, flat, suburban backyard. It became a hill behind the pond and the supporting mound for the waterfalls. Besides varying the topography of the yard, you can put the topsoil to good use in creating new planting beds. How about a rock garden or an herb garden or a butterfly garden?

An above-ground pond structure allows accessibility.

Look to nature for your inspiration, remembering that what you create in your backyard will likely be on a smaller scale.

Until next time when we'll get into the construction and commitment phase, start researching, learning, planning, and collecting ideas....and rocks!

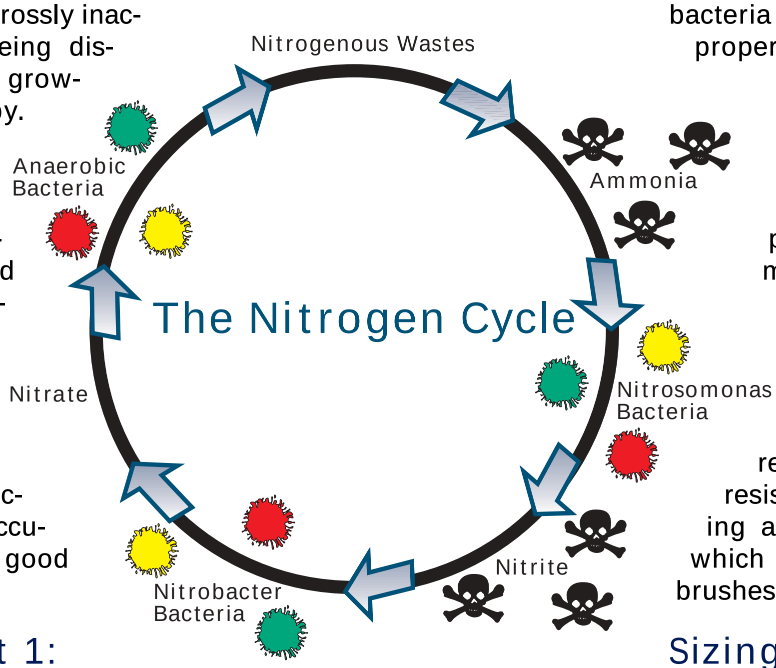
*Chuck Rush joins us this month as a regular columnist and contributing writer. He is well known to ponders on the Internet and in the Fort Worth/Dallas area. You can reach him at crush@dallas.net.*

# The Great Filtration Debate

## Why, When, and How to Filter Your Pond
## Part 2: Sizing and Choosing a Filter

by Chic Kelty

We continue to address the widespread confusion surrounding the mysterious and important world of pond filtration in this second article of a three-part series. While surfing the Web this week, I visited some water garden chat rooms and was once again reminded of how much grossly inaccurate information is being disseminated in the rapidly growing pond hobby. Insufficient or inaccurate advice, lack of industry standards, discomfort with technology, inexperience, exaggerated claims, unprofessionalism, poor research, and profiteering have all contributed to the pandemonium. We hope that this filtration series will separate fact from fiction and arm you with accurate information to make good decisions.




### Overview of Part 1: Filtration Basics

Although clear water is a goal for most pondkeepers, it is only part of what a filter should achieve. Another critical component of pond health that a filter should address is the unseen world of water quality or chemistry. Even when the water is crystal clear, many of the chemicals that can make water quality deadly to fish are present at toxic levels.

Water clarity and water quality are unreliable in unfiltered or in poorly filtered ponds. In addition to degrading the aesthetic beauty of a pond, bad filtration jeopardizes fish health. Good filters reliably control waste accumulation, water clarity, and water quality. The main functions of pond filtration are the removal of solid wastes, reduction of the planktonic algae that cause green water, control of toxic chemicals, and the elimination of cloudy water.

Understanding filtration requires a knowledge of what happens to waste in a pond. As organic debris enters the pond in the form of fish and plant wastes, uneaten fish food, and dead organisms, it begins to decompose and produce toxic chemical by-products. The most toxic of these by-products are ammonia and nitrite. Unseen beneficial bacteria, called nitrifying bacteria, consume ammonia and nitrite and produce nitrate, a generally harmless by-product. This process is called the nitrogen cycle. Effective filter media collects debris and provides a roomy home for beneficial bacteria which are necessary for proper filtration.

Commonly available media include gravel, lava rock, filter mat, open cell foam, buoyant bead, mixed plastic media, filter brushes, plastic ribbon, ceramic media, sand, and plant roots. In terms of the criteria of cost, maintenance, ability to collect debris, available surface area for bacteria, space requirements, durability, and resistance to clogging, channeling and compacting, the media which perform best are filter mat, brushes and buoyant beads.

### Sizing Your Pond's Filter

Once a filter style and media are selected, the filter must be properly sized to effectively clear and clean the pond. The size of a filter is determined by pond size and design, type of media used, filtration purpose, and maintenance requirements. For plant ponds the filter is primarily used for collecting solid wastes to improve water clarity while requiring little area for biological filtration. It can, therefore, be substantially smaller than filters designed for fish ponds.

In fish ponds the filter should not only clear the water, but it should also provide ample surface area for beneficial bacterial. When fish are present, removal of toxic chemicals is critical. Maintenance is also a factor in sizing a filter. Smaller filters require cleaning more frequently. Even the most enthusiastic pondkeeper tires of high maintenance filters. If the filter requires frequent or extensive maintenance, it will eventually be neglected. Money saved buying an undersized filter often results in more expense later when it needs to be replaced. The following sizing recommendations should be altered to reflect where the pond is located, how many and what type of plants and fish are being kept in the pond, and how often fish are being fed. Ponds in which the fish are infrequently fed and which are lightly stocked do not require larger filters.

Most people are intimidated when confronted with the appropriately sized filter for their pond. When introduced to truly adequate filtration, “It's SO BIG and UGLY,” is the startled cry of most pond hobbyists. Many people are misled by highly exaggerated manufacturer claims, lack of education and, sometimes, experience with swimming pool filters that are the size of an ice chest and still suitable for a twenty thousand gallon pool. It is important to remember that in a spa or swimming pool, the primary sources of filtration are chemicals such as chlorine or bromine. The actual filter chamber is used *only* to collect the relatively small amount of waste which falls into the pool. An ornamental pond, on the other hand, contends with a much heavier load of organic debris which grows inside the pond itself. Unlike swimming pools, toxic chemicals cannot be used to retard these growths without jeopardizing fish and plants. Therefore, a pond filter needs to be substantially larger than a pool filter.

In addition to the challenge of size, pond filters, like water heaters or air-conditioners, are generally not aesthetically pleasing. They are designed to perform a practical purpose and are expected to be hidden by clever design techniques. Some filters have been manufactured to look like waterfalls or planters. While this is a noble effort, most of these designs are small and only effective for use in ponds of less than 300 gallons.

**Low pressure biomechanical filters,** such as gravity-fed or gravity-return systems, which use media such as mat or brushes, should hold 7% to 10% of the total volume of water in the pond. This means that in a 3000 gallon pond, 210 to 300 gallons of water should be held in the filter chamber. If gravel is used as the filter media, the volume of the filter should hold the equivalent of 23% to 28% of the total volume of water in the pond. In the 3000 gallon pond, a gravel filter should hold 690 to 840 gallons of water. These sizes are based not only on the filter having to collect and remove waste products from the pond but also having to support massive colonies of bacteria. In addition to filter size, water circulation is critical to making it operate properly. The total volume of pond water should be recirculated through the filter at least every 3 hours , and no more than every 30 minutes.

When the ideal biomechanical filter size is unattainable, the filter is undersized. Good water clarity is more difficult to maintain with an undersized filter. Supplemental filters, such as ultraviolet clarifiers, may be necessary to achieve the desired clarity. In these situations, the formulas listed below help determine the best approach to sizing an undersized biomechanical filter while still minimizing maintenance and maintaining good water clarity and quality. For effective removal of ammonia and nitrite, a filter that uses synthetic media can constitute as little as 1% of the total volume of pond water. Don't get too excited. A 1% biological filter requires cleaning several times a week in order to function properly. This frequency of cleaning normally harms the bacterial growth in the filter so much that it never fully establishes. A 4% to 6% filter, assuming that synthetic media is used, only needs to be cleaned every 8 to 12 weeks. At that cleaning frequency, disruption is infrequent enough that the bacteria are able to thrive and maintenance is relatively low. Unfortunately a 4% to 6% biomechanical filter is not large enough to clear most ponds. The addition of a supplemental filter, such as a UVC, is needed for reliable water clarity. *A 7% to 10% percent filter, on the other hand, only needs to be cleaned once or twice a year and will maintain good water clarity without supplementation.*

**High pressure biomechanical filters** that use buoyant beads as the media are sized quite differently. Typically, the one percent rule is used for making the filter effective biologically. That creates the advantage of having a much smaller filter to accomplish the same results as a low pressure system. However, due to their small size, the mechanical aspect of waste collection is limited. Cleaning must be done frequently, as often as once or twice a day. Automatic methods, although very expensive, have been developed to relieve the pondkeeper of this arduous chore. Despite the frequency of maintenance, high pressure biomechanical filters do not disturb beneficial bacteria during the cleaning process.

Buoyant bead filters come in several designs. Specific manufacturer's recommendations must be followed regarding appropriate sizing for effective mechanical waste collection. *Buoyant bead filters do not offer sufficient biological action to effectively control planktonic algae; therefore, a UVC must be used to attain reliable water clarity.*

Ultraviolet filters (UVCs) are sized according to a variety of factors: pond volume, sunlight exposure, wattage, flow rate, intensity of exposure, and fish load. The quality of the bulbs and components used in UVCs vary dramatically from one manufacturer to another. If your pond requires a UVC, consult with a pond dealer for the manufacturer's sizing recommendations.

Plants, if used as the sole means of filtration, should be housed in a separate pond. This plant pond acts as a filter chamber. It should be the equivalent of 10% - 20% of the surface area of the main pond and approximately 10" to 18" deep. For plant filtration to work, water must be moved slowly through the plants. The total volume of pond water should travel through the plant bed no more rapidly than every two to four hours. More plants need to be placed in the main pond as well. To curtail the growth of planktonic algae, some experts recommend that approximately 60% of the main pond's surface should be shaded with plants such as water lilies, water hyacinth, and water lettuce.

Calculating water volume. To determine the appropriate size of any filter, the pond volume needs to be calculated. Below are some basic formulas for determining how many gallons of water a pond holds. Ponds with sloping sides, many shelves, or extremely irregular shapes make calculation difficult and may require a pond dealer's assistance. First measure the pond's <u>average</u> length, width and depth. These measurements must be in feet, not inches (e.g. if the length is 48 inches, divide it by the number of inches in a foot, 12, which equals 4'). Multiply the average length by the average width and then multiply that by the average depth. Finally, take that sum and multiply it by 7.48 (the gallons of water held in a cubic foot). If the pond is more or less rectangular in shape but has rounded corners and sides, like a kidney bean shape, multiply the last figure by 0.85 to compensate for the volume lost by the rounded edges. For round ponds, in feet, multiply the radius, which is half the diameter, by itself and then multiply that by 3.14. Then multiply that sum by the average depth in feet. Lastly, multiply that figure by 7.48. These calculations are spelled out below. Remember to include the gallons held in your waterfall and in any additional pools or streams included in the system. Once the system's total gallons have been determined and the style of filter has been selected, these figures can be used to determine the size filter necessary.

*length* x *width* x *depth* x 7.48 = gallons per cubic foot for a natural pond

$r^2$ x 3.14 x *depth* x 7.48 = gallons per cubic foot for a round pond

Internal Box Filter

## Filter Types

Every year new filters, filter modifications, and filter media make their way to a growing market. When confronted with a constant influx of evolving technology, it can be challenging to know which filter will do the best job. Advice from a qualified source can help. Be cautious, however, about taking advice from people or businesses with limited experience. Although their intentions are to help, it is reckless to generalize from "this works great for me so it will work great for you." What worked well in one setting can easily fail in another. There are many variables at play in a pond ecosystem: amount of light, pond size and shape, type of water feature, water quality, seasonal temperatures, the owner's fish feeding regimen, the size and quantity of fish and plants, as well as what type are present, pH level, and more. The human element, the habits of the pond keeper, is perhaps the most unpredictable factor impacting pond and filter success. To assist, we'll review some of the most commonly used filters. They are critiqued for expense, electrical usage, water usage, ability to clear and chemically clean the water, ease of maintenance, and availability of replacement components. The filter types are separated in groups: internal biomechanical filters, external biomechanical filters, external biological filters, external mechanical filters, and chemical and electronic filters.

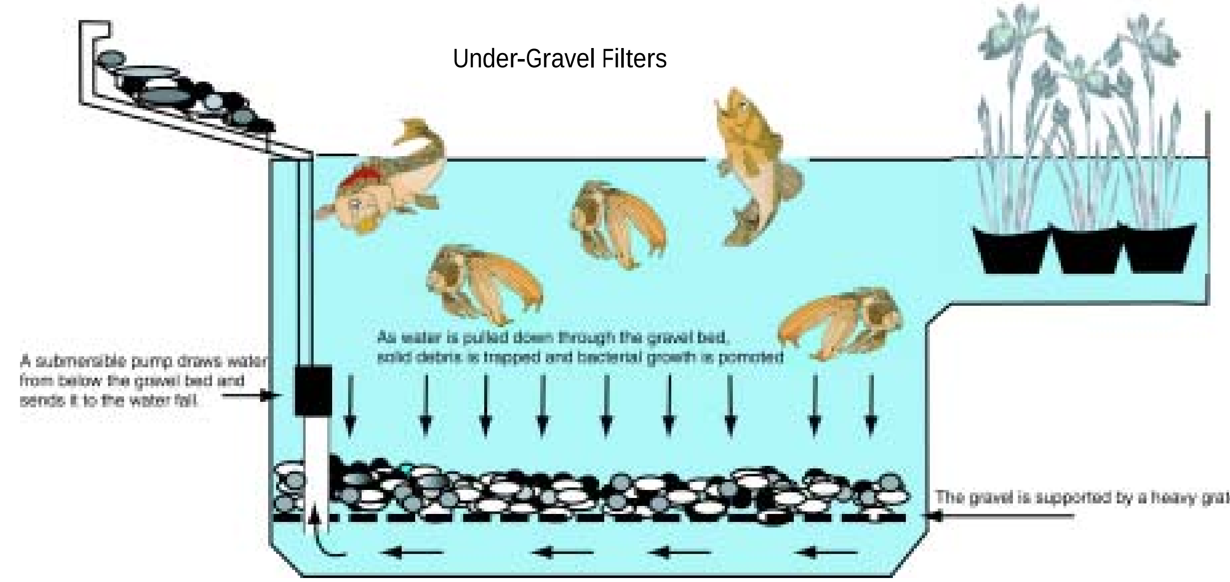
## Internal Bio-Mechanical Filters

### Internal Box Filters

Internal filters, or submersible filters, are placed inside the pond. Low cost, ease of application, and extensive marketing have made these filters common. The standard internal box filter is basically a plastic box with a screen for the water intake. Inside the box, filter media, such as foam, mat or gravel is used to perform biomechanical filtration. The pump is housed in either an internal compartment or attachments are available to connect it to the outside of the filter. The pump pulls water through the filter box and discharges it out the opposite end.



Under-Gravel Filters




Exaggerated claims, low cost, and lack of clear information have resulted in these small filters being used inappropriately on larger ponds. There may be two problems: ineffective media and small size. Often the filters are seen with open cell foam (blue looking sponges) or gravel. Gravel, as previously discussed, requires large quantities to provide enough surface area for beneficial bacteria to live on. Foam is so dense that it quickly clogs and requires constant cleaning. Filter mat is a better choice for internal box filters. Size is the other key problem. To keep the water clear and healthy for fish, the most efficient biomechanical filters hold 7% to 10% of the pond's total water. Applying this formula, the largest, most efficient commercially available internal box filter is suitable for ponds holding less than 50 gallons! Fortunately, small pond systems can bend the rules by using supplemental filtration such as plants, chemicals, beneficial bacteria, and UVCs in addition to limiting stocking and feeding of fish. Through supplements and waste reduction, the best internal box filter can, instead of being limited to a 50 gallon system, be used to help filter up to 300 gallons. The water will typically not be clear year round without a UVC or chemical filter supplementation. On larger ponds these small filters frequently clog and good water quality and clarity are difficult to maintain. Filter cleaning in small ponds is typically required on a three to five day cycle; better units may only need cleaning every 4 to 6 weeks. Box filters fitted with open-cell sponge cartridges or gravel require the most frequent maintenance and are suitable for only the smallest of ponds. Mixed-mat filters usually require less cleaning.

Advantages: Inexpensive; easy to apply; with good media is effective at clearing small ponds; readily available; widely used; water loss due to maintenance is low; replacement parts and filter media are usually inexpensive.

Disadvantages: Too small for most ponds; may require entry into the pond for maintenance; require frequent maintenance; can be unsightly in the pond.

### Under-Gravel Filters

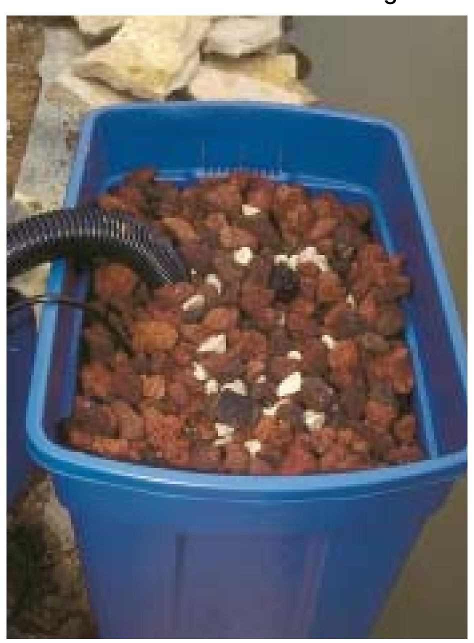
Originally designed for the aquarium industry, under-gravel filters have been popular for use on larger ponds. The standard design features a shallow tray for a filter chamber. It is filled with gravel and installed on the bottom of the pond. To properly function, the surface area of the tray should be the equivalent of 20% to 50% of the total surface area of the pond, depending on the projected waste load. An intake assembly, using either a grate or perforated pipe, is installed on the bottom of the filter tray. A 4" to 10" layer of 3/8" to 1/2" rounded gravel is then placed on top of the intake assembly. The pump draws water from the bottom of the tray and creates a downward flow through the gravel bed. Gravel creates an effective biomechanical filter by supporting beneficial bacteria on its surface while trapping debris. Once a system is installed, it clears the water and takes little maintenance for the first year or two. After that period of time the effectiveness of the under-gravel filter drops dramatically. Furthermore, gravel is not as efficient as other media, and it consumes a great deal of space and is heavy. Since it is installed on the bottom of the pond, cleaning is arduous and causes great disruption to the pond's ecosystem. In fish tanks, for which this filtration system was developed, cleaning is done efficiently with a siphon-action vacuum cleaner. However, ponds are installed below ground level and siphon-action cleaners do not work efficiently. This is not to say that you cannot drain an in ground pond by siphon action. However, the siphon action is not strong enough to create an effective vacuum cleaner. In addition, siphon action cleaners consume more water in cleaning the pond. Also, only a small percentage of the pond's water should be changed at any one time, and siphon cleaning can drain extensive amounts of water. Therefore, the only effective way to clean an under-gravel filter is to drain the pond to remove and rinse all the gravel by hand. Not only is this labor intensive, but highly disruptive to the pond environment. Under-gravel filters have been popular not only because they are inexpensive and relatively easy to install, but because other options were not readily available. Now, although there are much better alternatives, under-gravel filters continue to be promoted due to entropy and lack of education.

Advantages: Fairly easy to apply; provides good water clarity and biomechanical filtration; systems using perforated pipe are inexpensive.

Disadvantages: Difficult to clean; cleaning the filter disrupts the pond environment; gravel bed is prone to compaction/clogging/channeling; gravel bed *usually* requires major overhaul every two to three years and sometimes as often as once a year; sensitive to plant invasion which clogs the gravel bed; labor and/or equipment costs for maintenance can be expensive; cleaning methods such as siphon cleaners are not effective for in-ground ponds, and power vacuums are expensive; the pond needs to be partially or fully drained for effective filter maintenance; water usage by this type of filter is relatively high.

## Internal Down-Flow Filters

This type of filter is a modification of the under-gravel filter. It uses synthetic media such as thick fibered mat or brushes instead of gravel.



Internal Down-Flow Filter

The chamber can be deeper than a typical under-gravel filter so less surface area is required.

Advantages: Media is lighter and easier to handle than gravel; less surface area and over all size is required to achieve similar results to an under-gravel filter; inexpensive to operate; effective at biomechanical filtration.

Disadvantages: Most synthetic media is prone to compaction in a down flow environment; appropriate media is expensive and difficult to clean without polluting the water or disrupting the pond environment; moderately expensive to build; filter media replacement can be expensive; pond needs to be partially or fully drained for effective filter maintenance; water usage is relatively high.

Plant Filtration

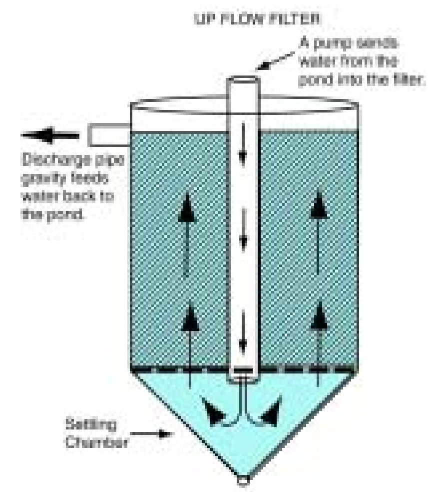
## Phyto-Filtration

Also known as plant filtration, phyto-filtration can be as simple as having plants in the pond. More elaborate systems incorporate a flow through pond, or chamber, specifically designed for housing plants to act as the filter. The plants can be planted in a gravel bed at the bottom of the chamber or placed in pots. The chamber should be the equivalent of 10% - 20% of the surface area of the main pond and approximately 10" to 18" deep. The total volume of pond water is slowly moved through the chamber every two to four hours. Mechanical filtration is achieved as solid wastes settle to the bottom of the plant pond; the wastes serve as fertilizer for the plants. The best plants for this type of filtration are marginal plants, or bog plants, which include bulrush,

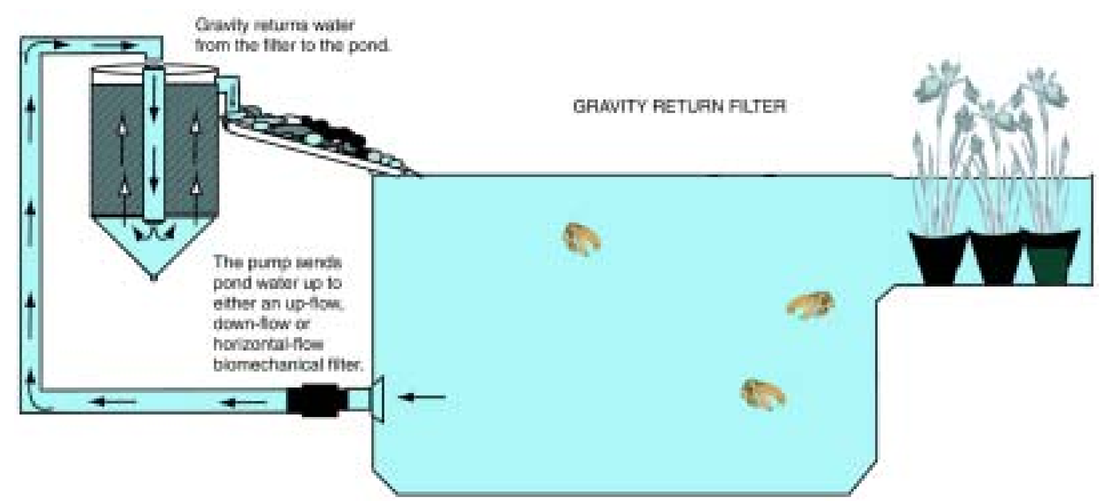
Plant Filtration

cattail, water iris, pickerel weed and lovage, as well as floating plants such as water hyacinth and lettuce. This method of plant filtration benefits from, if not requires, the support of additional plants in the main pond to curtail algae blooms. Up to 60% of the main pond's surface should be shaded with plants such as water lilies, water hyacinth, and water lettuce. Anaerobic bacteria thrive in the oxygen-free environment around plant roots surrounded by soil. These bacteria perform anaerobic biological filtration by breaking down and assimilating the nitrate in the water. They also help break down inorganic matter, such as phosphate, which contribute to algae blooms. In short, plants help remove some toxins from the water and utilize accumulated solid waste as fertilizer.

An alternate style of phyto-filtration exposes and uses plant roots to create filter media. In this application, the dirt is completely removed from the plants to expose the bare roots. The plants are then secured in a plastic box with screening, or some equivalent measure, to hold the plants upright. Approximately 10% of the total volume of pond water should be held in the plant filter box. Water is pumped through the roots to create a biomechanical filter with living, fibrous material serving as filter media. Like any other biomechanical filter media, the roots help trap debris and provide a place for beneficial bacteria to grow (although, unlike other media, plant roots shed their outer layer as they grow which inhibits a stable growth of nitrifying bacteria). Many people who create plant filters are uncomfortable with the technology associated with building a biomechanical filter. Ironically, in the end, that is exactly what is built using this method. However, this method ignores one of the greatest aspects of plant filtration, anaerobic filtration. The anaerobic conditions in soil or gravel based plant beds are essential for the removal of toxins which aerobic filters cannot address. The bare root approach to plant filtration is primarily an aerobic filter that neglects anaerobic processes.




Plants are an appealing asset to almost every pond, even if another type of filter is already present. They are instrumental in achieving clear water, and they can remove toxins that a biomechanical filter does not address. However, plants, when used as the sole means of filtration, cannot keep up with the high ammonia and nitrite levels associated with well stocked fish ponds. They also do not offer effective means for solid waste removal when the need arises. For ultimate water clarity and quality, plants are best relied on only as a supplement to more formalized types of biomechanical filters. If "oxygenating" plants (*Elodea,* Hornwort, Cabomba, etc.) are used as part of the phyto-filter, care must be taken to limit their growth. Remember that the so-called 'oxygenating' plants use dissolved oxygen in the nighttime hours. A proliferation of these plants lowers dissolved oxygen levels in the pond and threatens fish health.




Advantages: Add aesthetic charm and bio-diversity; remove certain dissolved toxins aerobic biofilters do not; offer habitat and shelter to organisms in the pond; provide natural food source for fish in the form of crustaceans, worms and plant matter.

Disadvantages: The oxygen-depleting effects of "oxygenating plants" can be deadly to fish; the quantity of plants required to clear the water can be more expensive and less effective than an appropriately sized biomechanical filter; ineffective at removing accumulated solids; provide unreliable water clarity; many types of plants may not be suitable for ponds with collections of large fish; water loss due to evapotranspiration is increased with certain types of plants; plants may require annual replacement (some of the most effective filtering plants such as water hyacinth and water lettuce are not winter hardy). The overall removal of toxins is of such insignificance that plants should not be relied upon for removal of toxic levels of ammonia.

## External Bio-Mechanical Filters

Numerous filter designs are readily available which are referred to as external biomechanical filters. Unlike their internal counterparts, these filters are installed outside of the actual pond. This approach allows the pondkeeper to hide a larger, easier to maintain filter without disturbing the aesthetics of the pond.

## Gravity Return Bio-Mechanical Filter.

This is considered a low pressure system because gravity is relied on to return the water from the filter to the pond. That is to say, a pump forces water into a filter chamber where it flows through filter media and then gently returns to the pond by the force of gravity. For that reason, gravity return filters are normally situated at the highest point in the circulatory system, such as at the top of the waterfall or stream bed. If it were placed below the highest point of discharge, gravity could not return the water to the pond. When no water feature is present, the filter only needs to be high enough for the water to successfully

Horizontal-flow system

down-flow into the pond. Flow designs include up-flow, horizontal-flow, and down-flow. There are advantages and disadvantages to each type, but in general the up-flow and horizontal-flow designs are considered superior.

Advantages: Extensively used; effective; easy to clean (especially up flow models with synthetic media); require infrequent maintenance if properly sized and applied with synthetic media; relatively inexpensive; easily modified to existing ponds; water use for filter maintenance is nominal.

Disadvantages: They overflow if not installed or maintained properly; tend to be large (7% to 10% of the total system); may have to be installed at the highest point of the water feature; if synthetic media used, it is more expensive to replace.

### Up-Flow

Up-flow systems, as the name implies, are designed so that the water flows *up* through the filter media. The pump sends water to the top of the filter, where it flows down an oxygenating tower to the bottom and into a disbursement area. The disbursement area is usually created with a grate which supports the filter media and creates at least a 1” to 2” open cavity on the bottom of the filter chamber. After hitting the bottom of the filter the water swirls and flows upward through filter media. It then overflows through a side port near the top of the filter and returns to the pond. This design collects waste on the bottom of the filter for easy removal via a drain. It also allows for back washing the filter, so it is very easy to clean and maintain. Most types of negatively buoyant media, or media that does not float, are suitable for this design. Gravel, while being cheaper to acquire than synthetic media, can generate substantial installation costs when it comes to supporting the media above the bottom of the filter chamber.

### Horizontal-Flow

In a horizontal-flow system the water enters through the side wall on one end of the filter and flows horizontally through the filter media. It exits through a port on the other side of the filter chamber. Horizontal-flow systems often have “baffling walls,” or walls which create a zig-zag flow pattern through the filter chamber. The purpose of “baffling” the water in this manner serves two purposes. First, by slowing the water it allows suspended particulates to settle to the bottom of the chamber. Second, it maximizes filter efficiency by eliminating dead spots as the water is forced through all the media. Because of its density and lack of loft, gravel is not suitable for horizontal flow filters. Synthetic media such as mat, brush, open cell foam or ribbon is preferred. Bottom drains can be installed in this type of filter to make maintenance easier, but because back washing is not as effective for this design as with an up-flow design, cleaning the media tends to be more difficult.

Down-flow system

### Down-Flow

In a down-flow system, the water is pumped to the top of the chamber and flows *down* through the filter media. It then exits from the bottom of the chamber. The waste collects in the top layers of the filter where it is difficult to remove. For that reason it is probably the least desirable flow design for a gravity return biomechanical filter. High loft, synthetic filter medias are prone to compression and loss of efficiency in this design. This design forces the filter to use either thick-fibered mat, which is expensive, or a less effective media such as gravel. In a down-flow design, gravel has an even higher tendency to compact and will require more frequent maintenance. Waste collects at the top of the filter which makes back washing ineffective. Removal of the media is required for proper maintenance, making cleaning more labor intensive.

### Gravity Fed Biomechanical Filters

This filter design incorporates one or more chambers at or below water level. These chambers are usually located within 30 feet of the pond. Gravity pulls the water into the filter, and a pump sends the water out the other end and back to the pond. The filter chambers are connected to the pond with a feed pipe. For flows up to 5000 GPH, feed pipes should be 3” to 6” in diameter. Larger flow rates require larger diameter feed pipes. The best systems connect to the pond through a fitting located at the mid-water level. If the pond is 4 feet deep, the feed pipe is located approximately 2 feet below water level.

Some newer designs incorporate a system that draws water from a bottom drain fitting. This method presents maintenance problems as the pond ages and the bottom fitting becomes prone to frequent clogging.

Gravity fed filters can also be placed below the pond. This allows aesthetic design flexibility. In this approach, water overflows from the pond into a stream bed or waterfall which carries the water to the filter. The pump returns the water from the filter to the main water feature and back to the pond.

To prevent water loss, the filter chambers must be designed to accommodate surplus water when the pump is shut down. Up-flow or horizontal-flow designs are preferable for gravity fed filters. Low density synthetic filter media is the preferred choice. Compaction and clogging problems with gravel make it inappropriate for use in this type of system. Gravity fed, biomechanical filters are easily hidden and ideal when above ground filters are not feasible or aesthetically unacceptable. Despite the engineering challenges associated with installation, the effectiveness and relative ease of maintenance with this filter design have made it extremely popular among pond enthusiasts.

Advantages: Inexpensive to maintain; requires relatively little maintenance; one of the most overall effective approaches to pond filtration; saves electricity by being able to use a smaller pump while producing similar flow to other filters; easy to hide; water use for maintenance is nominal; low maintenance costs; not prone to the overflow problems associated with gravity return designs.

Disadvantages: Can be expensive and difficult to install on existing ponds; filter media is expensive to replace.

Buoyant Bead Filter

### Buoyant Bead Filters

These filters are rapidly gaining popularity with pond hobbyists. Created for the fish farming industry, the original designer’s concept for this filter was “why treat it when you can get rid of it.” Rather than collecting solid waste in the chamber and biologically breaking it down, buoyant bead filters collect the waste and discharge it from the pond system before decomposition begins. They are designed to automatically and frequently remove wastes from the pond and have just enough biomass to handle the nitrogenous waste produced by the pond inhabitants. This approach allows a much smaller filter to handle the same size pond as a larger more conventional style biomechanical filter. Years of developing this approach have produced a number of filter designs incorporating uniquely shaped filter chambers, the most popular of which is an hourglass shape.

Buoyant bead filters are up-flow filters. Nontoxic polyethylene beads are used as the biomechanical filter media. As water is pumped into the bottom of the filter chamber, the filter media floats to the top and compresses slightly to create an effective biomechanical filter bed. The primary reason for this approach is to make the filter media easy to clean. In the case of “Bubble Bead” filters, a popular brand of buoyant bead filters, all that is needed to effectively clean the media is to turn the pump off and open the drain valve. As the water leaves the chamber, air is drawn into it, and the air bubbles agitate the filter media to dislodge trapped solids and discharge them out the bottom of the filter. Once the chamber is drained, the pump is turned back on and the filter resumes normal operation.

Other manufacturer’s systems clean the beads with a pressurized jet of water. This method is even more effective at cleaning the beads than merely agitating them with bubbles as the filter drains. Some large buoyant bead filters, suitable for ponds in excess of 20,000 gallons, are equipped with a built-in, motorized, cleaning propeller to agitate the beads more effectively during the cleaning cycle.

Buoyant bead filters feature a pressurized discharge so the method of returning the water to the pond is versatile. The filter can be placed as much as 400 or 500 feet from the pond. It is also easier to hide than gravity fed and gravity return units. In most situations, buoyant bead filters need to be used in conjunction with a UV clarifier to achieve good water clarity.

Recently, some buoyant bead filters have been introduced which incorporate both buoyant bead and fluidized bed technologies in one unit; the potential for this approach is promising. The addition of a fluidized bed chamber has made these units even more effective at reducing toxic waste build up. Current models of buoyant bead-fluidized bed filters use a smaller sized bead than most other brands of buoyant bead filters. The smaller bead achieves greater water clarity, also called “polishing,” than their larger bead counterparts. Unfortunately, this approach requires the use of a substantially larger and higher pressure-tolerant pump for proper function. That results in higher electrical bills. Initial feed back on current models has been positive.

Advantages: Smaller filter size compared to other filter styles; requires minimal maintenance when installed with an auto cleaning mechanism; easy to clean; easily applied to most ponds; widely researched; capable of supporting large loads of fish; filter media is durable and should not need replacing; parts which are prone to breakage are not expensive or numerous and are easily acquired through most pond supply or hardware stores.

Disadvantages: Expensive; requires frequent cleaning (as often as once or twice a day during certain times of the year); auto cleaning mechanism (not usually included in the basic filter) is very expensive; larger pump and greater electrical usage may be required to compensate for back pressure; water usage for maintenance is quite high.

*(See page 95 for a diagram of the internal operation of a bubble bead filter)*

## External Biological Filters

A supplemental, high efficiency biological filter may be needed to maintain optimal fish health with large fish collections. The truly biological filter is designed so it offers a maximum amount of usable surface area for bacterial growth and collects as little organic solids as possible. Most ponds are best suited with a biomechanical filter unit and do not need a specialized biological filter. The three most common styles of biological filters are trickle filters, fluidized bed filters, and bio-wheels.

High Pressure Sand Filter

### Trickle Filters

Trickle filters were designed for marine tanks. They incorporate a durable, compression-resistant media, which often look like exotic hair curlers. Water is continuously sprayed over them. Trickle filter designs heavily aerate the water while exposing it to a massive surface area teaming with highly active colonies of beneficial bacteria. Because the water tends to cool through evaporative action as it trickles down through the media, this filter can excessively cool outdoor ponds. It is best suited for indoor applications.

### Fluidized Bed Filters

When compared to other options on the market, fluidized bed filters are unparalleled in terms effective biological filtration. They utilize a fine grade filter media, such as silica sand, which is negatively buoyant (it sinks). The media is suspended in an upward flowing column of water. The flow rate is set to prevent the sand from being “blown” out of the filter chamber or settling to the bottom. This approach provides an abundance of highly usable surface area for bacterial growth and eliminates “dead spots.” Concerns of clogging and channeling are eliminated because each grain of sand in the filter is constantly in motion. The smaller the grain of sand used, the more surface area is available and, in turn, the more effective the filter will be. Unfortunately, many of the filters using fine grain sand compact during shut down and are prone to start-up problems. Some manufacturers have eliminated this problem by using larger media. However, the larger the media, the less the surface area for beneficial bacteria. Fine silica offers as much as 5000 sq. feet of surface area per cubic foot of media. Pea sized granules only offer 150 sq. feet of surface area per cubic foot of media. Fluidized bed filters are suitable for outdoor applications when combined with a biomechanical or mechanical filter.

Ultraviolet Clarifier Unit

### Bio-Wheels

Developed for waste water treatment, bio-wheels have been applied extensively in the fish farming industry. They incorporate a rotating, pleated cylinder which looks like an elongated car air filter. These cylinders are usually constructed of densely woven fiber that serves as the filter media. Water is continuously pumped over the surface of the freely rotating cylinder which creates a water wheel effect similar to the large water wheels in old mills. This action heavily oxygenates the water and promotes abundant bacterial growth on the wheel’s surface. Because these filters tend to be bulky and unsightly, they are most applicable to aquaculture ponds and not to decorative ponds.

## External Mechanical filters

Mechanical filters are designed for efficient solid waste collection with little, if any, biological action. There are two common styles. *High pressure sand filters* force water through a densely packed bed of sand that is usually housed in an egg shaped fiberglass, stainless steel, or plastic chamber. *Cartridge filters* force water through a densely woven, pleated cartridge which is housed in a cylindrical stainless steel or plastic chamber. Both filters were designed for use on spas and swimming pools and tend to be of high maintenance without the use of chlorine, hydrogen peroxide, or bromine. These chemicals are highly toxic to ponds. Many swimming pool builders have taken to building ponds and, unfortunately, have readily applied these filters. Usage in ponds has proven ineffective due to the frequent maintenance they require. They need to be cleaned as often as two to three times per day. Unlike buoyant bead filters, there are no automatic cleaning systems available except for large commercial systems. Effective mechanical filtration is best achieved with a biomechanical filter.

### Settling Tanks

Settling tanks are simply big tanks of water that allow debris to “settle” to the bottom. Upon entering the chamber the velocity of the water is slowed to the point that the heavier particulates in the water fall out of suspension and settle to the bottom of the tank. Most settling tanks have a conical bottom which concentrates the debris in a small area for easy removal by flushing it out a bottom drain. This wastes less water than flat bottom tanks. Settling tanks are normally installed before, and used in conjunction with, either gravity fed or gravity return filter chambers. The best tanks are normally a round shape with water injected through the side. Water entering from the side creates a circular flow, or vortex effect, which appears to be beneficial in pulling the particulates out of suspension. If designed properly with strategically placed bottom drains and drain sumps, the pond itself can act as its own large and effective settling tank.

## Ultraviolet Clarifiers

Ultraviolet clarifiers (UV’s or UVC’s) are probably the easiest and most space-efficient way to achieve reliable water clarity. This has made them a popular filtration supplement for under-filtered ponds. A UVC is typically a cylindrical chamber housing an ultraviolet light which is protected by a clear quartz sleeve. Water is pumped into the filter and exposed to high intensity ultraviolet light. Exposure to the light kills living organisms suspended in the water. The organisms a UVC is most frequently used to remove are planktonic algae which cause cloudy, green water. What is killed and at what rate it is killed depend on the intensity and duration of exposure. While a 100% kill rate of all living organisms in the water is possible, most pond-grade systems are set for minimal exposure time and intensity for the removal of planktonic algae. When this filtering approach was first introduced to the pond industry some concerns were expressed that excessive sterilization of the water might occur when using a UVC. Over-sterilization could result in anemia and generally poor health in fish. Because the size of the UVC required to achieve a 100% kill in the average pond is far larger than the units readily available to the pond hobbyist, these fears have gone unrealized. However, UVC’s can be detrimental to the fish if relied on *instead* of a properly sized and functioning biomechanical filter. The UVC only kills water borne organisms, it does nothing to remove them or the by-products produced by their demise. Therefore a UVC filter should be applied only as a supplement to an effective biomechanical filter. When a UVC is added to a cloudy pond, the clearing effect it has on the pond will not be instantaneous. Allow as much as 10 to 14 days for results. Despite all the controversy surrounding these units, if properly used, they are an excellent addition to the pond. No other means exists to so safely, easily, and effectively clear ponds.

Carbon & Zeolite

Advantages: Relatively inexpensive; space efficient; easily applied to existing systems; energy and water efficient; effective at clearing green water; maintain reliable clarity.

Disadvantages: Fragile due to the glass components; bulbs are expensive ($30-$75 ea.) and need regular replacement (every 1 to 2 years); can be detrimental to the pond if the biomechanical filter is not functioning properly; replacement transformers and quartz sleeves are expensive but usually last 5 to 10 years.

## Chemical Filtration

Chemical filtration effectively removes or neutralizes odors, discoloration, and dissolved compounds from the water. Borrowed from the aquarium industry, the use of carbon and zeolite offer limited application to the garden pond. Carbon adsorbs dissolved compounds onto its surface and requires rinsing, while zeolite performs a chemical reaction and absorbs ammonia. Recharge zeolite by placing it in a gallon of water overnight in which is dissolved one pound of non-iodized salt to form chemical bonds with the absorbed ammonia, thereby freeing up space within the zeolite for more ammonia absorption. While chemical filtration is applicable to some specialized systems, most pondkeepers should avoid filters which rely on such media, if only for the cost of frequent replacement.

## Ozone and Oxygen Ion Filters

These filters were designed for the pool and spa industries and are frequently promoted for use on ponds. Ozone and Oxygen Ion filters generate and inject various forms of oxygen and oxygen/hydrogen molecules into the pond water to create a chemical reaction to neutralize toxins in the water. Ozone filters produce an oxygen molecule called ozone ($O_5$). This large and unstable oxygen molecule contains two smaller, stable oxygen molecules ($O_2$+$O_2$) and an extra oxygen atom (O). The extra atom breaks from the ozone molecule and adheres itself to any available organic molecule. This process is called oxidization. When an organic molecule is oxidized in this manner, it is rendered harmless. So called "OXY" filters do something similar by producing chlorine hydroxide, or a similar product, to oxidize organic matter. Unfortunately this oxidizing effect is indiscriminate. It will destroy harmful as well as beneficial growth. Many people have reported a complete die-off in their biomechanical filters, as well as extreme irritation of the fish after using these filters. Other complaints are of little, if any, noticeable improvement of water quality or clarity with Ozone and Oxygen Ion filters. While they undoubtedly have a purifying effect on the water, they are best left to the pool and spa industry and specialized aquarium pursuits.

## Anaerobic Filtration

Anaerobic filtration or denitrating filtration is achieved by exposing pond water to an oxygen free or anaerobic filter bed. The filter bed is comprised of a densely packed media such as sand or fine gravel over which pond water is slowly circulated to allow resident anaerobic bacteria to remove nitrates. The anaerobic bacteria growing in the filter assimilate and remove nitrate form the pond. This process quite readily occurs in the pots of aquatic plants and in the dense root base of the plants themselves. A 6" to 12" bed of sand promotes the growth of anaerobic bacteria. Care must be taken with anaerobic filters. If the filter is disturbed, it may cause a rapid die-off of the anaerobic bacteria. The result is an increase in ammonia and subsequently nitrite which endangers the fish. Experimentation with this type of filtration will undoubtedly lead to improvements. However, for the most part, nitrate, even at high levels, has been proven to be relatively harmless to most pond inhabitants. Ammonia and nitrite are the most toxic chemicals in a pond. Anaerobic filtration does nothing to address the presence of these chemicals. Therefore, the addition of this type of filter holds little benefit for most ponds.

The optimum biomechanical filter incorporates either up-flow or horizontal-flow design and uses either brushes or mats as media.

The best filter styles for the majority of ponds are external biomechanical filters. Internal biomechanical filters are inadequate for ponds larger than 300 gallons. They typically are unable to provide good water quality and require frequent maintenance when used on large ponds. External biological filters are extremely efficient at controlling toxic chemicals in the pond but do not remove the debris that cause cloudy water.

A strictly biological filter requires the fitting of an additional, separate filter to perform mechanical filtration. In most situations a filter that performs both biological as well as mechanical filtration is the simplest and most effective means to filter.

UV filters are an excellent supplement to a biomechanical filter, but they should never be relied upon as the sole means of filtration. Chemical, mechanical, oxygen ion and ozone filters, when used on outdoor ponds, frequently prove ineffective, expensive, and difficult to maintain.

A filter's effectiveness depends not only on its design and the media used, but on proper sizing. The most common type of filter, biomechanical, should generally hold 7-10% of the total volume of water in the pond system. This size filter is necessary to achieve consistently good water clarity and quality. If the biomechanical filter does not meet this size specification, water quality may still be sufficient to support fish, but water clarity will suffer.

Many high-tech biomechanical filters, such as buoyant bead filters, are designed to hold less than 1% of the total volume of pond water and still achieve desirable water quality. However, they are often poor at attaining good water clarity without supplementation. Buoyant bead filters and undersized conventional biomechanical filters can be supplemented with an ultraviolet clarifier (UVC) to achieve better water clarity.

This three-fold approach of supplementing a dual function biomechanical filter with an ultraviolet clarifier is perhaps the best way to achieve excellent water quality while minimizing space requirements. The next and final installment in this filtration series will examine filter supplements, stocking capacity, pumps, how to select the best filter, and building or improving a filter.

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