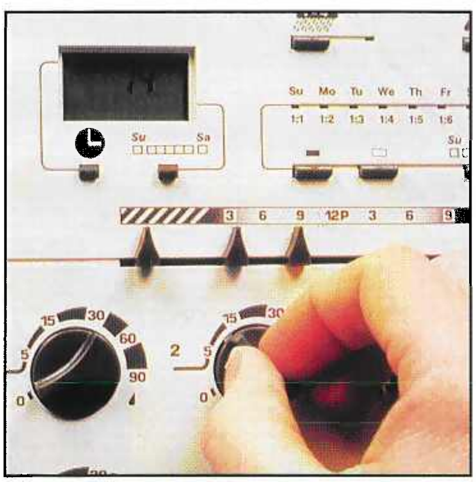
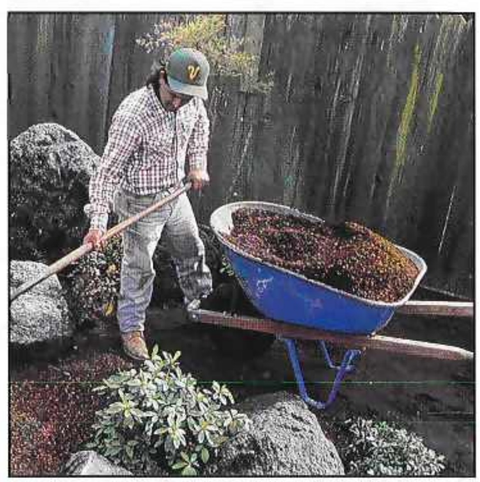
DRIP IRRIGATION GUIDELINES









EBMUD

EAST BAY MUNICIPAL UTILITY DISTRICT

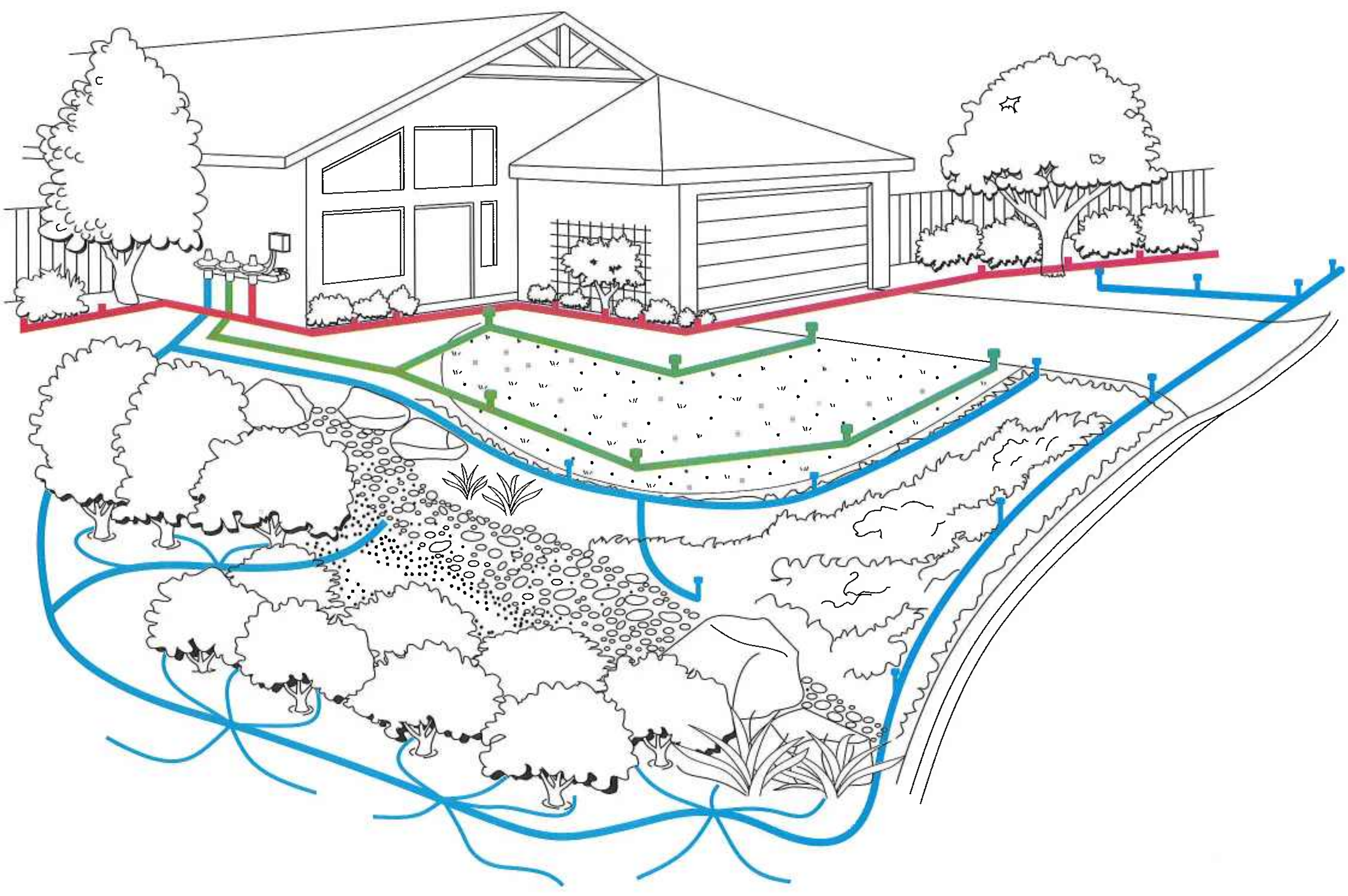
What is Drip Irrigation?

Drip irrigation — also known as micro, low-flow, low-volume and trickle irrigation — is the slow application of water to a plant's root zone. Drip irrigation technology has grown in the last decade with new products being developed every year. Manufacturers may use different terminology, but the principle of accurate, slow application of water characterizes drip. While the concept of drip is simple, the design, installation and management of an efficient system requires planning and attention to detail. This brochure can help you decide if a drip system is right for you and your landscape.

Drip systems can be constructed from poly-vinyl chloride (PVC) pipe or polyethylene tubing. PVC pipe is a rigid plastic material that is usually buried about one foot below the surface. Smaller pipes called risers bring the water to the surface where it is delivered to the plants by devices called emitters. Polyethylene tubing is a flexible plastic material that is usually installed on the surface and covered with mulch. Emitters are connected directly to the tubing or to smaller lateral distribution tubing.

Drip emitters vary in type and form, but all must operate under reduced pressure in order to deliver water at a specified rate. Water flows from a drip emitter in gallons per hour (gph). Sprinkler irrigation, by comparison, delivers water in gallons per minute (gpm). The most commonly used emitters dispense water in drops or fine streams, but other types will spray small droplets or dispense a fine mist.

While drip systems can be manually operated, maximum efficiency is achieved by connecting the system to an automatic controller. It is very important, however, to monitor the irrigation schedule and to maintain the equipment. The rewards of a healthy landscape and reduced water consumption are well worth a relatively small investment in drip irrigation.



In the illustration above there are three separate irrigation circuits. The lawn is watered by sprinklers two or three times a week during the summer (green). The shrubs in the foreground are watered by drip irrigation once a week (blue). The trees and other shrubs in the background are also watered by drip irrigation once every 1 to 2 weeks (Red).

Benefits of Drip Irrigation

Water Efficiency

Accurate delivery reduces evaporation and eliminates overspray. With proper design and scheduling, water is used only when and where it is needed. Drip irrigation meets water efficiency regulations for new landscapes.

Optimum Growing Conditions

Plants thrive on an optimum balance of oxygen and moisture around their roots. Slow application rates maintain this optimum condition, and proper scheduling will eliminate wet/dry fluctuations that stress plants. Slow application of water also minimizes erosion and compaction of the soil.

Reduced Pest Problems

Water-borne pests, especially fungal diseases, are reduced because foliage is kept dry when the pests may be most active.

Reduced Weed Problems

Since water is applied to the root zone, areas between plants remain dry and germination of weed seeds is reduced. Weeds compete with your plants for water and nutrients.

Versatility

Drip irrigation is an excellent solution to a variety of irrigation problems, and can easily be modified to accommodate changes in a landscape.

Economy

A relatively small investment in drip irrigation can save you money by lowering water consumption.

When and Where to Use Drip

New Landscapes

A drip system is ideal for a new landscape because plants with similar water requirements can be grouped and irrigated together.

Existing Landscapes

The ease of installing a drip system on the surface makes it very practical for existing landscapes. Where digging would damage plant roots, the use of flexible poly-tubing covered by mulch is a good solution.

Retrofit of Existing Sprinkler Systems

If you have a sprinkler system in place, water efficiency can be dramatically increased by retro-fitting irrigation heads with specially designed drip emitters.

Narrow and Odd Shaped Areas

Sprinkler irrigation is usually very inefficient when applied to narrow and odd shaped areas such as median strips and narrow planting beds. Wasteful spray onto streets and walkways can be avoided through the use of drip.

Vegetable Gardens

Creating optimum growing conditions — as well as weed, pest and labor reduction — is especially valuable in vegetable gardening. Planting in rows also simplifies the layout and installation of irrigation lines.

Slopes

Water on a slope will quickly run off and possibly cause erosion. The low flow rates of drip emitters minimize this problem.

Windy Sites

Even a small amount of wind will cause sprinklers to miss their target, waste water, make seating areas unusable and possibly damage buildings.

During Times Of Drought

An increase in irrigation efficiency may be necessary to minimize landscape loss.

Cautions to Observe When Using Drip.

Drip is generally not recommended for lawns and continuously rooting ground covers. Uniform wetting throughout the entire root zone, required for these types of plants, is difficult to achieve with drip emitters. However, new subsurface drip irrigation technology has recently become available for this application. It requires careful installation and exact scheduling to be effective, and improper functioning is difficult to detect and repair. Subsurface drip has potential for water savings, but should not be attempted without consulting a knowledgeable irrigation specialist.

Polyethylene tubing on the surface in areas of heavy foot traffic or children's play areas can easily be broken, disconnected or vandalized. A gardener may unintentionally break or dislodge polyethylene parts. Systems constructed from rigid PVC pipe are more suited to these situations.

Dogs, raccoons, gophers and other animals can chew tubing and emitters. Use of rigid pipe and protection for emitters may be necessary where this is a problem.

When selecting pre-packaged drip irrigation kits, be sure the components are of high quality and appropriate to the job.

Drip irrigation requires proper scheduling and routine maintenance and is not for those who want merely to install a system and forget about it.

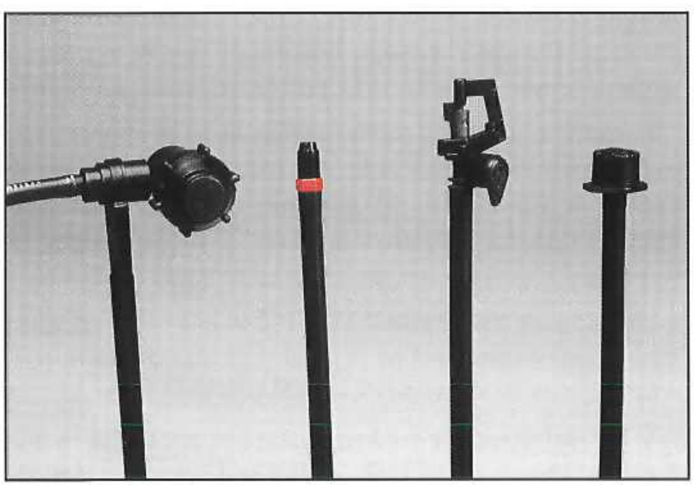
Drip Irrigation Components

The wide variety of available components can be confusing. When selecting parts for a system, choose the highest quality available and stay with a single manufacturer to insure compatibility. An irrigation supply specialist can help you select the best components for your needs.

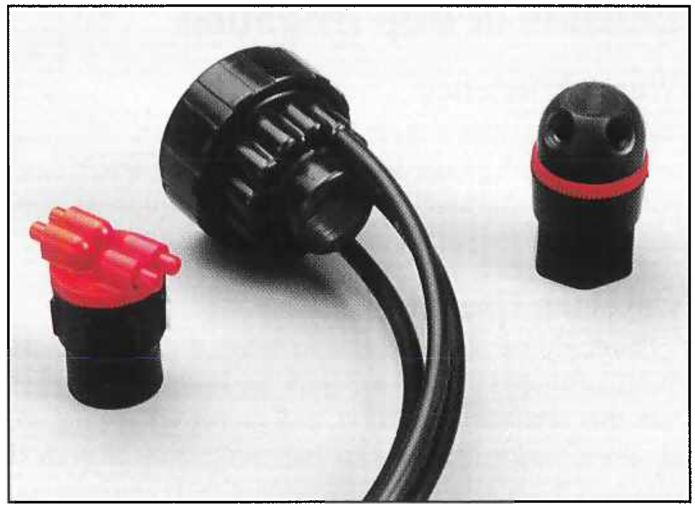
Emitters

Emitters are the most important part of a system. They should deliver water at a predictable rate and resist clogging. To account for variations in water pressure, especially on hilly sites, an emitter should be "pressure-compensating," meaning it will deliver water at the same rate over a range of operating pressure, usually 10 to 30 pounds per square inch (psi).

These drip emitters for shrubs and trees provide full or partial pressure compensation and have flow rates of 1/2, 1 or 2 gph. Emitters with flow rates of 1/4 gph are available for containers or slopes where water may run off.



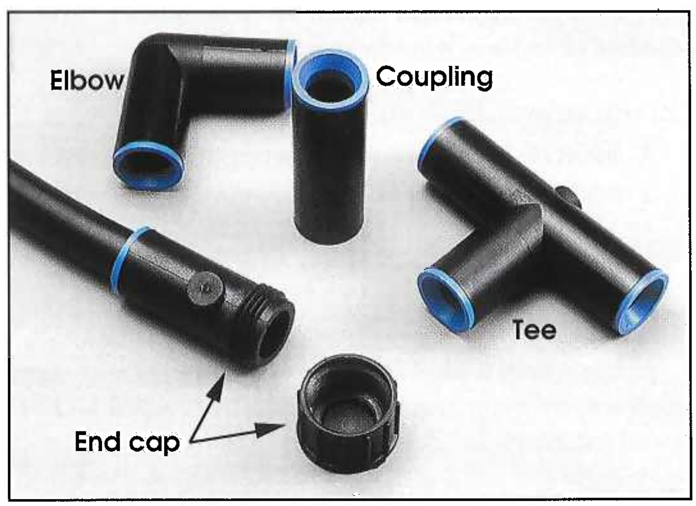
These spray emitters deliver water over larger areas and are used for small bedding plants or in containers where an emitter at the base of each plant is not practical. Pictured from left to right are a mister, a sprayer, an adjustable sprayer and an adjustable bubbler.



Multiple-outlet emitters deliver water from up to twelve points. Tubing is used to carry water where it is needed. Some of these devices reduce pressure and are used to retro-fit high pressure sprinkler irrigation systems.

Driplines

By combining emitter and pipe into one piece, driplines simplify design and installation. They are useful for long narrow beds and row vegetables. Porous pipe oozes water along its entire length, laser-drilled lines have many precisely drilled holes, and the "dripline" has factory installed emitters. For hilly sites and long runs of tubing, factory installed emitters are most water-efficient and reliable.



Poly-tubing fittings pictured include an elbow, tee, coupling and an end cap.

Polyethylene Tubing

"Poly-tubing" is the black flexible pipe usually associated with drip irrigation. It is often installed on the surface and held in place with u-shaped stakes. Compression fittings connect tubing without threads, clamps or adhesives, but must be operated under low water pressure. Tubing size depends on the amount of water needed and the steepness of the slope where it is installed.

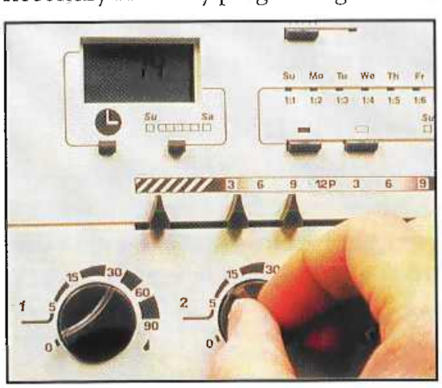
Poly-Vinyl Chloride Pipe (PVC)

PVC is generally rigid, white pipe commonly used for sprinkler systems. PVC can be used for drip irrigation where a more durable system is needed. PVC should be buried, since it becomes brittle when exposed to sunlight. For proper durability, use thicker-walled "Class 200" and "Schedule 40" materials. Flexible PVC is also available for tight spots where rigid pipe is awkward to bury. Gray "Schedule 80" PVC is used for pipes that are exposed above ground. PVC fittings are threaded or require glue for assembly.

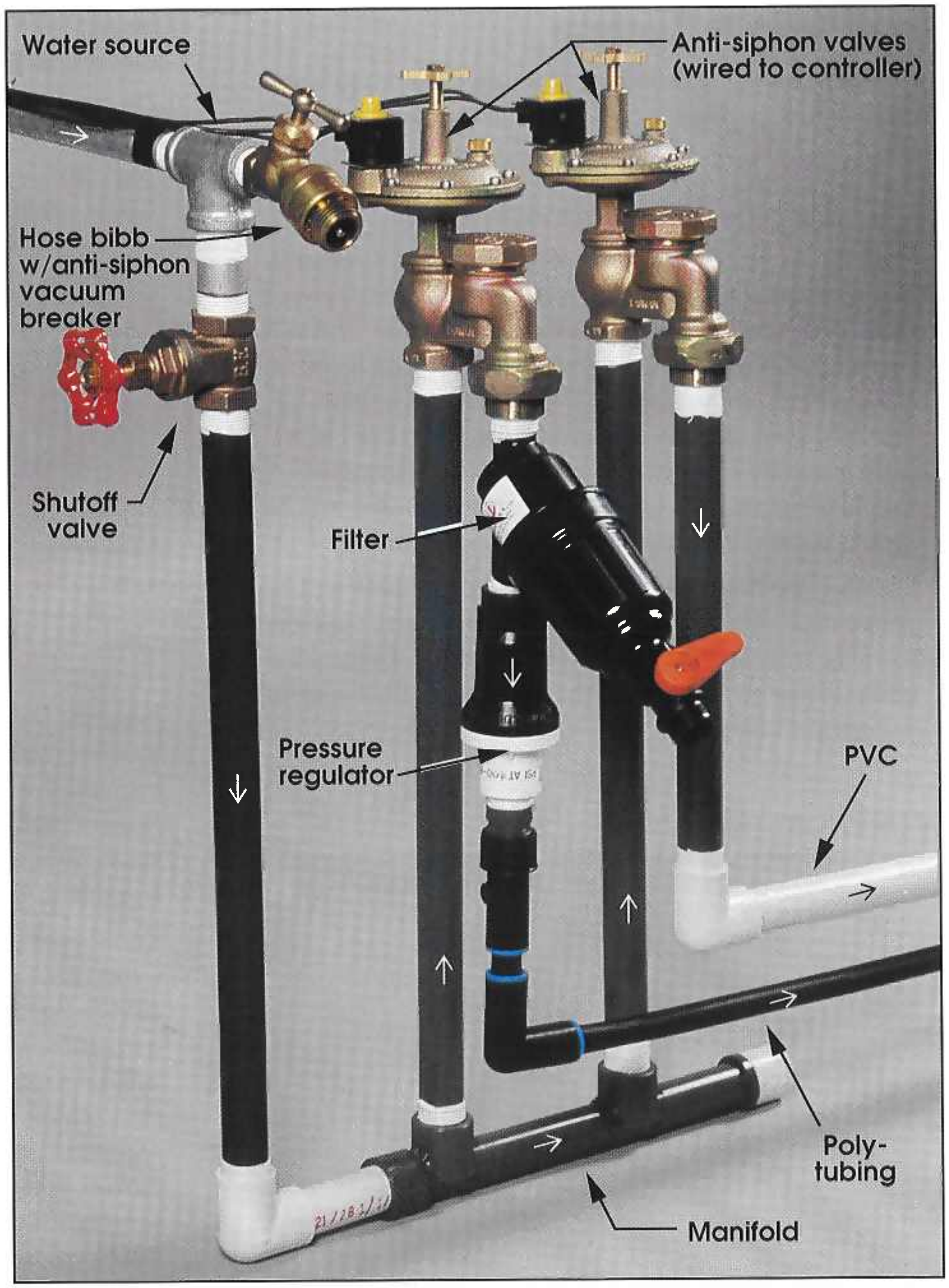
Controller

The controller, or timer, is wired to the electrically operated valves and can be programmed to run the system automatically. A controller should have capacity for one or two more valves than required by a system; you may want to add more valves. Each valve is programed to open and close at predetermined times.

Optional features are available to facilitate efficient scheduling. When a system has more than one valve (each valve serves one irrigation circuit), multiple programs are valuable. Multiple programs allow each circuit to operate on its own schedule. Other water-saving features are a 14-day calendar to program a two-week schedule, and a percent switch to reduce water use without having to reprogram the controller. A percent switch makes necessary monthly programing easier.



Accurate controller programming is key to water-efficient irrigation.



The Valve Assembly

The valve assembly controls the flow of water to the irrigation lines. An automatic valve opens and closes electrically for a programed amount of time. Each valve allows water to an irrigation circuit. The assembly pictured above includes two anti-siphon valves, one controlling flow to a reduced-pressure poly-tubing circuit and the other controlling a high-pressure PVC hard pipe circuit.

Anti-siphon valves prevent water in the lines from flowing backwards into the drinking water system, and are required by building codes. To function properly, anti-siphon valves must be installed at a higher elevation than all of the emitters; when emitters are higher than the valve, a special back-flow prevention device is required by code. A filter prevents clogging of emitters by particles in the water supply. A pressure reducer provides the correct water pressure to a circuit. The entire valve assembly may be attached to a hose bib, and should be separated from the water source by a shutoff valve. This allows the irrigation system to be isolated from other plumbing for installation, maintenance and repairs.

Designing A System

Care at this stage is important to assure water savings and prevent future problems. This step-by-step approach will help.

Begin with the existing conditions.

1. Draw a plan to scale and note landscape features: location of the water source, slopes and their direction, paved areas, decks, retaining walls, and plant material. This will require measuring the area you wish to irrigate if you do not have architectural plans. Using graph paper with 1/4" squares will make drawing to scale easier. 1/4" = 1' or 1/8" = 1' scale is usually appropriate for residential landscapes. A simple diagram with landscape features labeled will be greatly appreciated by your irrigation specialist.
2. Measure the flow rate where the valve assembly will be connected. With the faucet completely open, time the seconds it takes to fill a one-gallon container. Refer to the chart below to determine the maximum flow rate in gallons per hour.

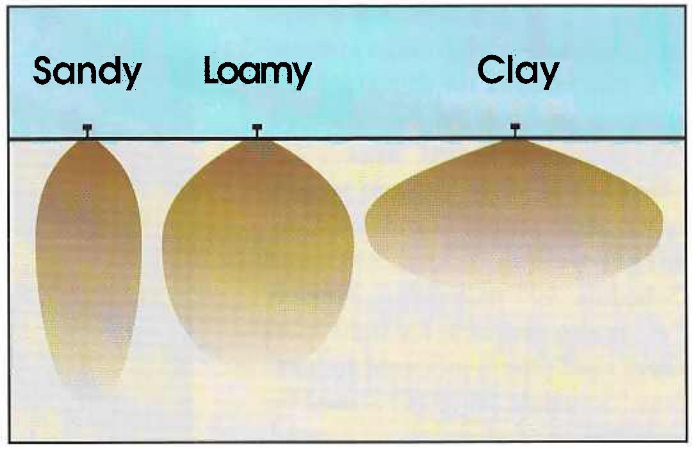
Maximum Flow Rates

SECONDS*	GPM**	GPH***
4	15.0	900
6	10.0	600
8	7.5	450
10	6.0	360
12	5.0	300
14	4.3	257
16	3.75	225
18	3.3	200
20	3.0	180

* Seconds to fill a 1 gallon container ** Gallons per minute
*** Gallons per hour

Emitters should operate under the range of pressure specified by the manufacturer. The water pressure for most residences will need to be reduced to between 10 and 30 psi, depending on the type of emitters being used. Multiple-outlet emitters designed for high-pressure operation may not require a pressure reducer. If the pressure seems unusually high or low, it can be measured easily with a pressure gauge.

3. Determine the soil type. This is important because it affects how the water will move through the soil.



In sandy soils, water travels downward more readily than it does laterally. In clay soils, water tends to move laterally, creating a broader, shallower wet zone.

A simple test of soil type is to squeeze some damp soil in your hand and release your grip. Sandy soil will crumble; loamy soil will hold together but easily break apart, and clay soil will mold to different shapes without breaking apart. When clay soil is dry it will be hard and lumpy and crumble to dust when crushed.

4. Know your plant material. Plants vary widely in their water requirements. For example, Rhododendrons and Azaleas have high water requirements, while a California native like Ceanothus requires little water. All plants will need regular water to get established. Note on your plan which plants have high, medium and low water requirements. Good sources for this information are the **Sunset Western Garden Book,** EBMUD's **Water Conserving Plants and Landscapes for the Bay Area,** and your local nursery. Emitter selection will depend on the type of plant (Tree, Shrub or Ground Cover) and its size (height, diameter of the canopy or container size).

Designing for a new landscape.

Group plants according to water requirements so they can be irrigated by the same circuit. Plan enough capacity for a mature landscape. Initially, fewer emitters and shorter but more frequent watering will be necessary.

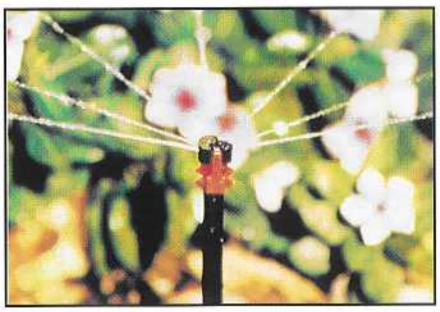
Designing for an existing landscape.

Mature water-conserving plants may not need any irrigation and may even be harmed by it. Note the location and type of any existing sprinklers. Retro-fitting a system may involve replacing sprinklers with emitters, but that is generally much easier than replumbing.

Component Selection and Layout

The type, number and location of components can be determined from a plan drawn to scale. Start from the plants and work toward the water source.

1. Select the type of emitter — sprayers or drippers — according to the plant type. To maximize efficiency, use drippers rather than spray emitters. Small areas of continuously rooting ground cover and bedding plants may require sprayers or bubblers. Misters are appropriate for plants that benefit from moist foliage. Unless plants are in a protected location, wind will disrupt spray patterns.



This spray emitter dispenses water in fine streams and is useful for small bedding plants.

2. Use the emitter selection chart to determine the flow rate and number of emitters per plant.

   Larger plants require more emitters at higher flow rates to deliver water to the larger root zone. Smaller plants should have fewer emitters at lower flow rates to avoid watering below the root zone. Plants on a slope may need more emitters with lower flow rates to prevent run-off.

3. Group emitters to form circuits based on similar plant water requirements and location. A circuit is a group of emitters operated by the same valve. You must be able to connect all these emitters to the same lateral line. The exact location of emitters is primarily determined during installation, rather than on the irrigation plan.

Emitter Selection Guide

PLANT MATERIAL	SOIL TYPE	NO. OF EMITTERS*	FLOW RATE (gph)
SMALL SHRUBS** (to 2′ high)	Sandy	1	2
		2	1
	Loamy	1	1
		2	1/2
	Clay	1	1/2
		2	1/2
MEDIUM SHRUBS*** (2′–4′ high)	Sandy	2	2
		4	1
	Loamy	2-3	1
	Clay	2	1
		3	1/2
SMALL TREES & LARGER SHRUBS*** (6′–8′ canopy)	Sandy	6-8	2
	Loamy	3-6	2
		6-8	1
	Clay	3-4	1
		6-8	1/2
LARGER TREES & SHRUBS*** (10′–15′ canopy)	Sandy	8–16	2
	Loamy	8–16	2
	Clay	6–10	2
		8–16	1
CONTAINERS	Potting Soil	Varies w/ size	
< 6" Deep	↓	↓	1/4
6"–12" Deep	↓	↓	1/4 to 1/2
12" or Deeper	↓	↓	1/2 to 1

* A multiple-outlet emitter can serve one or more plants; each outlet acts as one emitter. More than two emitters per plant can be installed in feeder tubing connected to the lateral line.

** When small shrubs are closely spaced, use 1 emitter per plant or use a dripline. Otherwise, use 2 emitters per plant to evenly moisten the root zone and to prevent plant loss if one of the emitters becomes clogged.

*** For deeply rooted plants use the lower number of emitters with higher flow rates. To deeply water large trees and shrubs, use a separate irrigation circuit and double the minutes per day (MD) indicated on the scheduling chart (Page 11–12).

Poly-tubing Distribution Line Layout

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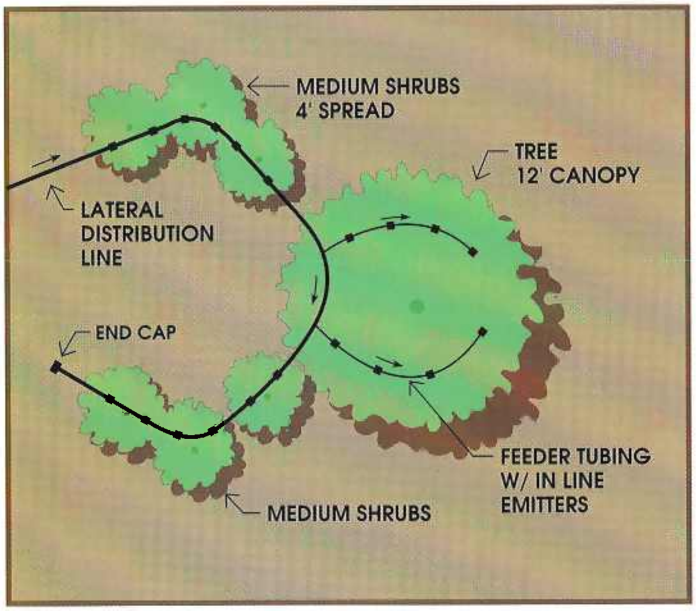

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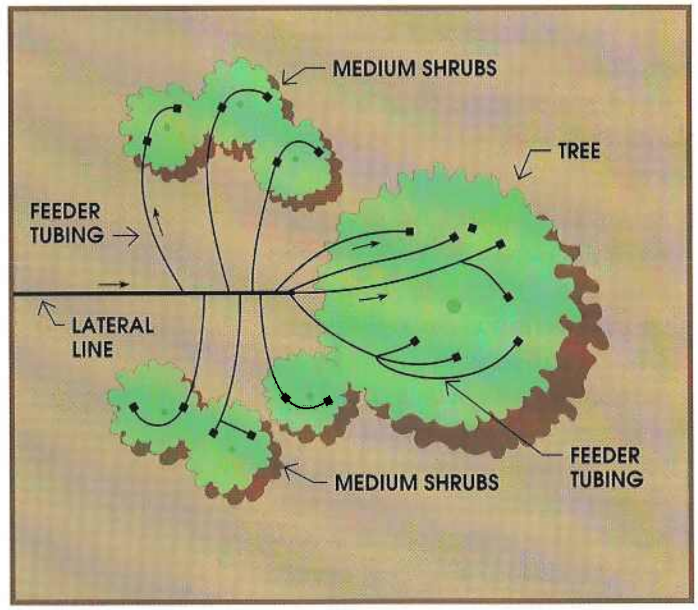


4. Choose the most direct way to connect emitters to a lateral line. Minimize the use of 1/4" and 1/8" feeder tubing by directly connecting emitters to a lateral line wherever possible. Tubing size depends on the total flow of the emitters served.

5. Total the flow rates of all emitters on a circuit and compare the total with the maximum flow rate of the water source. If the flow rate of any circuit is more than 75% of the source's maximum flow , re-group the emitters or add a circuit.

Pipe Size

Flow Rate (gph)	Size (DIA.)
POLY-TUBING	
0–4	1/8"
0–15	1/4"
15–100	3/8"
15–320	1/2"
320–600	3/4"
PVC	
0–300	1/2"
0–480	3/4"
480–720	1"

6. Size the pipe. The pipe — PVC or poly-tubing — must be large enough to handle the flow. Too large pipe increases cost and may make installation more difficult. Total the flow rates of all the emitters served by a given length of pipe, and use the chart to determine the required pipe size. Most circuits will require no more than two different pipe sizes.

7. A valve assembly usually includes an anti-siphon valve, a filter and a pressure regulator. A more sophisticated back-flow prevention device is required if the valves are lower than the emitters. Include a shutoff valve to separate the entire system from the water supply. Check with an irrigation specialist to be sure your valve assembly is complete and meets local building codes.

8. Fittings such as couplings, elbows, and tees must all be the right type and size. Having extra fittings on hand will save trips to the store when changes in the plan are made during installation.

9. The controller should be easy to operate and provide for the appropriate number of irrigation circuits. It is usually installed indoors, near an electrical outlet and wired to the valves for each circuit. Select a location for the controller and determine the length of wire needed.

Note: Since automatic valves require a minimum flow rate to properly close, irrigation circuits with a total flow rate of less than 40 gph may not be adequate to automatically close the valve. Low-flow valves are available that will operate with flow rates less than 40 gph (2/3 gpm). Consult with an irrigation specialist to select an appropriate anti-siphon valve.

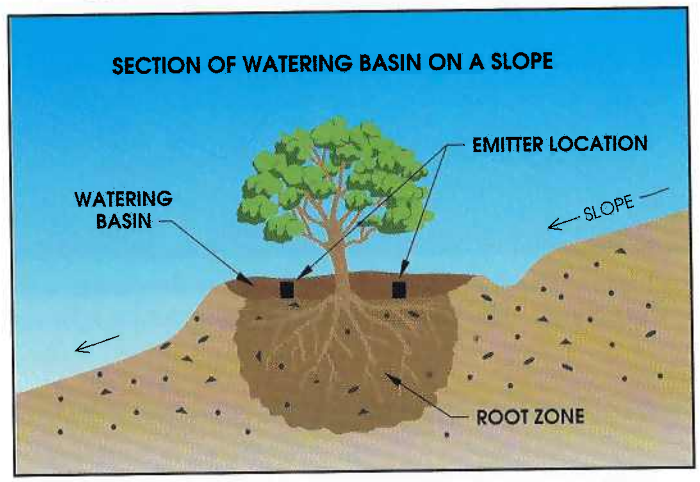
Installation Tips

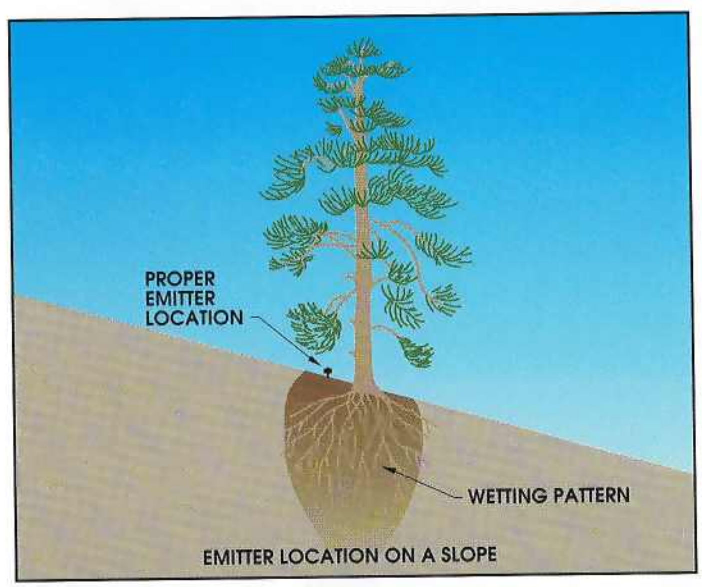
- Begin with the valve assembly, then install the distribution lines. In many cases, valves can be installed easily by removing a hose bib and using threaded fittings to connect the components. If the location of valves requires extending existing plumbing, consider using a professional.
- When burying PVC pipe, soil that is moist but not wet will make trenching easier.

- When assembling poly-tubing, soaking the ends of the tubing in warm water will make the fittings attach more easily.

- Before installing emitters, flush the lines to remove any soil, then cap the ends and check for leaks. After the emitters have been installed, test to see that they all operate properly.

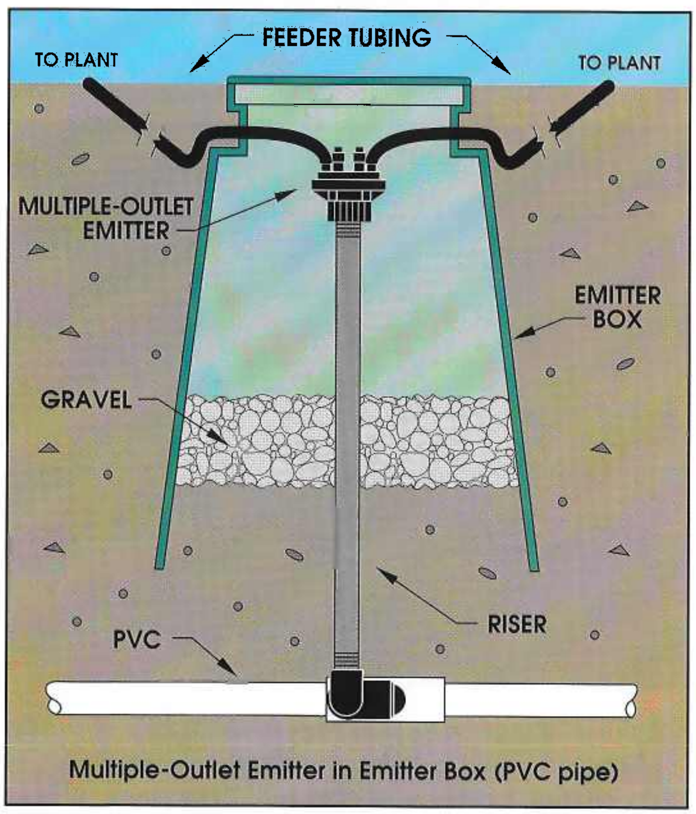
- Install emitters above the soil surface to prevent clogging caused by root intrusion and to simplify necessary observation.





- Emitters should be located away from the base of woody plants and spaced to deliver water to the roots evenly. On sloped sites, locate emitters up-hill of the plant. Where soil is slow to accept moisture, watering basins may be needed to prevent run-off.

- A layer of mulch, besides being good for the plants, will prevent direct sunlight from heating poly-tubing and loosening the fittings. The base of woody plants should not be covered by mulch.



Multiple-Outlet Emitter in Emitter Box (PVC pipe)

- Multiple-outlet emitters can be installed in a box to keep them from view and potential damage. The ends of the feeder tubing should be located above the root zone of the plants they serve.

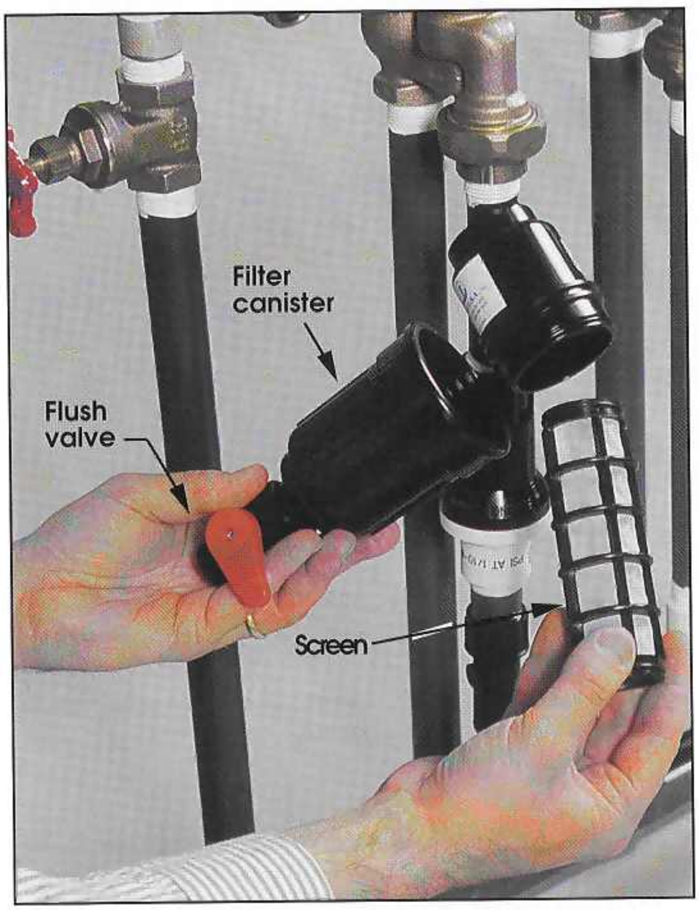
Installation Tools

Hand pruners are best for cutting poly-tubing, hole punches used for emitter installation should correspond to the size of the emitter barb, goof plugs allow for mistakes and changes in emitter location by plugging empty holes, and u-stakes are used to hold tubing in place.

Maintenance

Check the system periodically while it is running.

- Look for leaks and repair them immediately. The sun may soften poly-tubing and cause joints to separate. Breaks in a line need to be detected and repaired before damage to the plants has occurred. The appearance of the plants themselves can be a good early indicator of a problem. Soil erosion may also indicate a leak. Damaged poly-tubing can easily be repaired by using couplings to splice in new tubing.
- Poly-tubing held in place with u-stakes and covered with mulch can become exposed and pulled away from the ground, making it susceptible to damage. Secure loose tubing and replace mulch that has been worn away.
- Check the emitters regularly. They can become clogged by soil particles and insects. Clogging has been largely overcome by emitter design, but can be a maintenance problem if emitters are installed directly in the soil.



- Clean the filter(s) twice a year. Turn on the circuit, – electric valves can be manually activated by turning a screw on the top of the valve – and open flush valves for several seconds to clear out grit. Turn off the circuit, unscrew the filter canister, and inspect the screens. If they're dirty, rinse them off or scrub lightly under running water.
- Remove end caps and flush lines twice a year.
- Observe caution when using hand and power tools for weeding and trimming. Weed problems will be reduced by the use of drip, but weed seeds may germinate near emitters where the soil surface is moist.
- Build-up of algae can be a problem if well water or grey water is used. If algae regularly appears on the filter, the system should be flushed with granular chlorine or other products available specifically for this purpose. Don't use liquid chlorine: it moves through the system too quickly and may harm sensitive plants.
- The irrigation schedule should be adjusted monthly. The following section provides monthly scheduling guidelines. Water requirements vary extensively throughout the year and attention to scheduling is essential. Become familiar with programing the controller. If the controller has a "percent switch", it can be programed for the month of peak water consumption and reduced by an appropriate percentage for the other months of the year.
- Adapt the system to a changed or maturing landscape. Emitters may need to be moved, deleted or added. Goof-plugs can be used to seal holes left by removed emitters. Couplings allow tubing to be extended. Generally, a maturing plant will require more emitters placed further from the base.

Scheduling Chart

Minutes Per Day (M/D) and Days Per Week (D/W)*

PLANT WATER NEEDS	CLIMATE	SOIL TYPE	JANUARY		FEBRUARY		MARCH		APRIL		MAY	
			M/D	D/W	M/D	D/W	M/D	D/W	M/D	D/W	M/D	D/W
HIGH	Coastal	Sandy	10	1	10	2	15	2	20	2	20	3
		Loamy	20	1	30	1	25	2	35	2	60	2
		Clay	35	1	60	1	100	1	70	2	115	2
	Inland	Sandy	10	1	10	2	20	2	25	2	30	3
		Loamy	20	1	30	1	35	2	50	2	90	2
		Clay	35	1	60	1	70	2	105	2	120	3
MEDIUM	Coastal	Sandy	10	1	10	1	10	2	15	2	20	3
		Loamy	20	1	20	1	20	2	25	2	40	2
		Clay	25	1	40	1	70	2	50	2	80	2
	Inland	Sandy	10	1	10	1	15	2	20	2	20	3
		Loamy	15	1	20	1	25	2	40	2	65	2
		Clay	25	1	40	1	50	2	75	2	90	3
LOW	Coastal	Sandy	10	.5	10	.5	10	1	15	1	10	2
		Loamy	15	.5	20	.5	20	1	25	1	20	2
		Clay	25	.5	40	.5	60	.5	50	1	80	1
	Inland	Sandy	10	.5	10	.5	15	1	20	1	15	2
		Loamy	15	.5	20	.5	25	1	35	1	35	2
		Clay	25	.5	40	.5	50	1	70	1	65	2

To determine watering duration and frequency, select the appropriate plant water requirement, climate and soil type of the area served by a circuit. M/D is the minutes per day of irrigation, D/W is the number of days to water each week.

Scheduling

Manual operation of a drip system is not recommended. It is too easy to forget that the system is on, negating months of water savings. In addition, automatic controllers save considerable time and effort in maintaining a landscape. Invest in a reliable and understandable controller, learn how to schedule it and use its features. Manufacturers have recently made their products more "user-friendly".

Once a system is installed, decide the irrigation schedule and program the controller. Several factors determine how often and how long to water: plant water requirements; plant size, root depth and maturity; weather (temperature, precipitation, humidity, wind); and soil type. If similar plants are on the same circuit, it is easier to approximate an appropriate schedule. If they are not similar, some will be watered too much while others receive an appropriate amount.

Use the above chart to determine frequency and duration for each valve/circuit.

When the estimated frequency and duration is known for each circuit, program the controller using this information and the manufacturers' instructions.

JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
M/D	D/W	M/D	D/W	M/D	D/W	M/D	D/W	M/D	D/W	M/D	D/W	M/D	D/W
25	3	20	4	25	3	20	3	15	2	10	2	10	1
70	2	55	3	75	2	50	2	25	1	30	1	20	1
90	3	110	3	100	3	105	2	100	1	55	1	35	1
40	3	30	4	40	3	25	3	20	2	10	2	10	1
75	3	80	3	75	3	70	2	35	2	35	1	20	1
115	4	120	4	110	4	93	3	70	2	70	1	35	1
15	3	20	3	20	3	15	2	10	2	10	2	10	1
50	2	40	3	50	2	35	2	20	2	20	1	15	1
100	2	80	3	70	2	70	3	70	1	40	1	25	1
25	3	20	4	25	3	20	3	15	2	15	1	10	1
50	3	55	3	50	3	50	2	25	2	25	1	15	1
105	3	110	3	100	3	100	2	100	1	50	1	25	1
15	2	15	2	15	2	10	2	10	1	10	.5	10	.5
25	2	30	2	25	2	20	2	20	1	20	.5	15	.5
100	1	60	2	105	1	75	1	60	.5	40	.5	25	.5
20	2	20	2	20	2	15	2	15	1	15	.5	10	.5
40	2	40	2	40	2	25	2	25	1	25	.5	15	.5
80	2	80	2	80	2	50	2	50	1	50	.5	25	.5

This chart should be used in conjunction with the Emitter Selection Guide (Page 6) which establishes the number of emitters and flow rates needed for various soil types and plant size.

* D/W of .5 indicates watering once every two weeks.

Use this program as a starting point, but refine the irrigation schedule. Newly planted landscapes will need more frequent and shorter irrigation cycles. Large trees and shrubs may need less frequent and longer cycles. Where water runs off or puddles during an irrigation cycle, divide the total minutes per day (M/D) into shorter cycles with one hour between cycles. The controller must have multiple start times to do this automatically.

After allowing the system to operate for a few days, observe the soil and the plants. Observations are essential to the proper operation and scheduling of a system.

With a small shovel or trowel, remove some soil near several emitters to check the moisture content. Midway between irrigation cycles, the soil should be moist but not wet to the depth of the roots. If the soil is wet, decrease the frequency (D/W). If wetting is too shallow, increase the duration (M/D); if too deep, decrease M/D.

If plants show wilting or dullness of foliage color, increase the frequency of watering (D/W). On-going observation is necessary because many plants will not exhibit signs of stress after only a few days.

Resources

Information and advice can be obtained from the following sources:

- EBMUD Water Conservation Offices
  375 Eleventh St., Oakland, CA 94607
  Phone: (510) 287-0590

  Alamo Office
  3819 Danville Blvd., Alamo CA 94507
  Phone: (510) 820-2436
- Irrigation supply outlets and nurseries.
- Manufacturers' catalogs and guides, books and other available literature.
- Landscape professionals, including irrigation consultants, horticulturists, landscape architects, contractors, and knowledgeable gardeners.

Literature currently available from EBMUD business offices

Water Conserving Plants and Landscapes for the Bay Area - A practical guide to householders who want to select drought-tolerant plants (Call 510 • 287-0590 for price information).

WaterWise Gardening - A brochure about how to get more green in your garden per gallon of water (free).

The East Bay MUD Puddle Stopper's Handbook - A guide to saving water through basic home plumbing (free).

Water Conservation Services and Materials - A summary of materials and services offered by EBMUD's Water Conservation Offices.

Sunset Magazine reprints (free)

Drought Survival Guide for the Home and Garden (May 1991) - a 32-page guide about how to save water indoors and outdoors.

80 Little Things and One Big Thing You Can Do to Save Water (May 1990) - useful tips for reducing landscape water use.

Questions and Answers About Water and Gardens (May 1989) - how to water your garden with less water.

The Unthirsty 100 (October 1988) - details of 100 good-looking, water-sensible plants for California gardens.

How Much Water Does Your Lawn Really Need? (June 1987) - the true story about your lawn's water needs.

Frugality With Garden Water (June 1976) - how to be thrifty with water in your garden.

Please contact us 1-866-403-2683
or www.ebmud.com

Glossary

Anti-siphon valve – a valve used to control water flow to a circuit that, when installed above all of the emitters in a circuit, will prevent backflow into the potable water supply.

Circuit – pipe or tubing and emitters connected to and operated by a valve. A drip circuit usually requires a filter and pressure regulator.

Controller – programmable, electronic clock that electrically opens and closes valves at pre-set times.

Fittings – components used to connect pieces of tubing or pipe at various angles.

GPH – gallons per hour; the unit used to measure the flow of drip emitters.

GPM – gallons per minute; the unit used to measure the flow of sprinkler irrigation heads.

Hose bib – outdoor water faucet.

Maximum flow – the maximum rate of flow from the water source.

Multiple-outlet emitter – a drip emitter with two or more outlets, each functioning as a single emitter.

Poly-tubing – polyethylene tubing, usually installed above ground and covered with mulch.

PSI – pounds per square inch; static water pressure.

PVC – Polyvinyl chloride; rigid, plastic pipe usually buried; flexible PVC is also available.

Source – the point at which a system is connected to the water supply, usually a hose bib.

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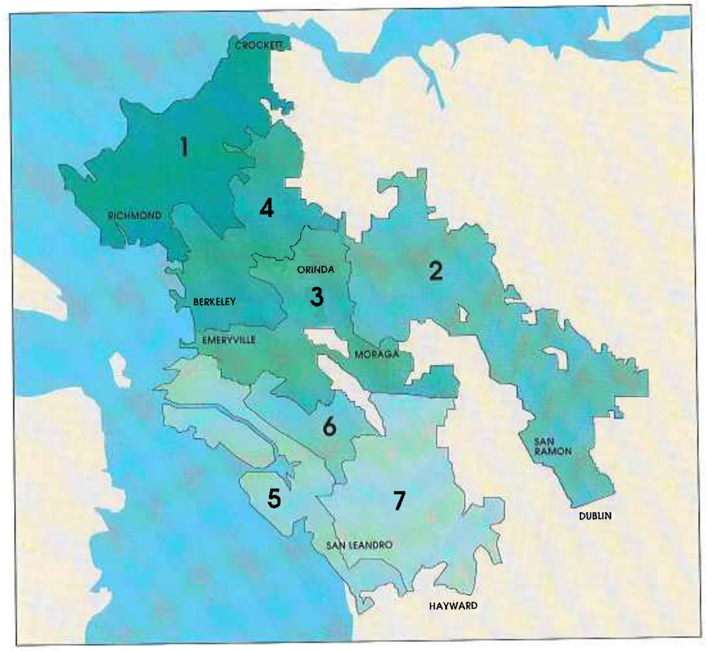

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Prepared by the Administration Department under the direction of the EBMUD Board of Directors.

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