

Water Efficiency

Water Management Options



Landscaping



In North Carolina, outdoor water use annually averages 20-30 percent of the total water used in a facility. This amount can peak during the summer growing season up to 70 percent. North Carolina's rainfall is generally consistent throughout the year with no pronounced wet or dry seasons. Thirty years of records show that everywhere in the state gets between 40 and 60 inches of rain a year. Landscape irrigation is used to supplement this rainfall. Based on historical averages, supplemental watering of the landscape would be required about 20 percent of the time. Averages are notoriously fickle so this section will review ways to plan, plant and maintain a water-efficient landscape.



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Starting From Scratch

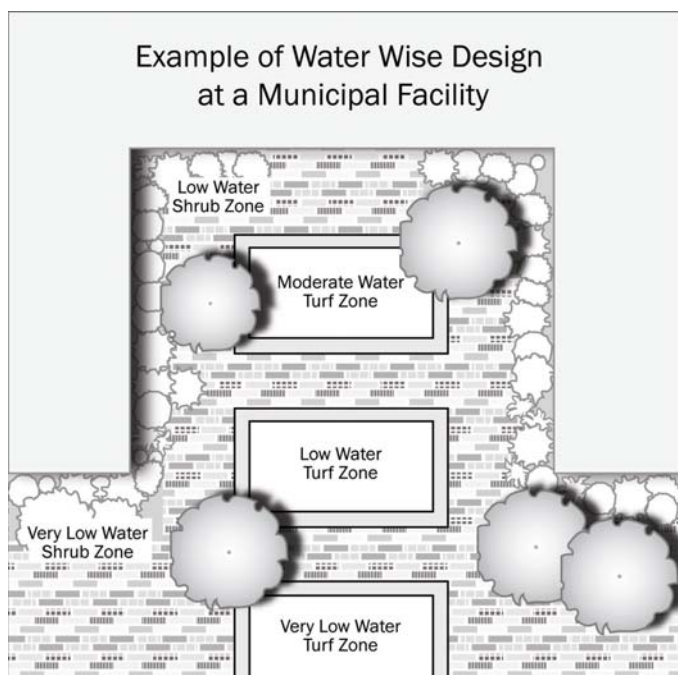
When considering a new or revised project, keep in mind these practical steps to get an attractive and low water use landscape:

(A) Planning and Design

A comprehensive design plan is the initial step to a water-efficient landscape. A well-thought out and researched design will minimize cost and attain a proper strategy for plant and sprinkler placement. These factors should be considered:

- Site conditions such as drainage, soil type, sun exposure/shade, aesthetic preferences, existing plantings, slope/grade and water availability are all crucial elements of an efficient plan.
- Intended use of the site must be carefully considered, including recreation, habitat and traffic.
- Trees, shrubs and grass all require different amounts of water. Plants should be placed in groups according to their respective water needs, called hydrozones. This way, an irrigation system can be designed to properly match the needs of the plants, soils and weather conditions.

FIGURE 4-14



- A proper irrigation design should have a base calculated schedule that includes projected sprinkler run times and weekly frequency for each month of the growing season. This base schedule is used as a starting point for an irrigation manager.
- Incorporate high water demanding plants at the bottom of slopes.
- Incorporate the use of existing trees, plants and wildlife areas to help add value to the site.
- Consider creating shade areas, which can be 20 degrees cooler than non-shaded areas.
- Minimize the use of impervious surfaces to reduce runoff and subsequent stormwater pollution.
- Consider using porous materials such as porous concrete or permeable paving methods.
- Consider grading and directing surface run-off and rainfall gutters to landscaped areas as opposed to drainageways that exit the property.

(B) Soil Analysis and Improvement

- Soil testing will help determine soil quality, nutrients present and absorptive capacity. Choose plants based on these findings. Most soils require some adjustment of the pH (acidity or alkalinity). Your county cooperative extension offices can provide more information about how to conduct soil testing. The N.C. Department of Agriculture and Consumer Services provides free soil testing and improvement recommendations.
- Organic matter such as compost, mulch or manure increases the water holding capacity of soil and can help improve water distribution.
- When improving the soil of a given area, it is important to treat a large area

around the planting to allow ample space for root systems.

- Do not allow heavy construction equipment to compact soil around existing trees or other sensitive natural areas.

(C) Proper Plant Selection

- The selection of native species can greatly reduce maintenance costs.
- Consider plants' water demand, pest tolerance, soil nutrient and drainage requirements.
- Native species are adapted to work together in similar soils and benefit each other's growth by forming symbiotic relationships.

(D) Practical Turf Areas

- Turfgrass has the highest water consumption of any plant group. Typically, turf in North Carolina requires one inch of water per week.
- Plant grass only where it will provide optimal functional and aesthetic benefits.
- Avoid very small turf areas under 10 feet wide.
- Proper watering of turf (less frequent and deeper vs. frequent and light watering) will promote deep root development, which will make the turf more drought resistant.
- Turfgrass should be cut to the maximum recommended height for its type, generally a minimum of two inches to a maximum of four inches for optimum water use.
- Whenever possible, plant alternative groundcovers that require less water, or consider the use of patios and decks, further reducing water demand.

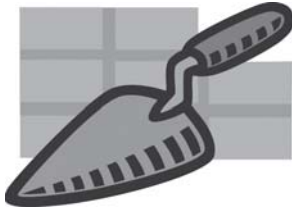
(E) Efficient Irrigation

- The proper design, installation and maintenance of both the irrigation system and the landscape will lead to effi-

cient irrigation. No amount of good maintenance can overcome the inefficiencies of poor design.

- Additional irrigation will be needed on newer transplanted landscapes.
- Automatic controllers are a cost-effective time-based method to save labor and consistently deliver water. It is important to adjust controllers regularly for weather changes and plant growth.
- Drip irrigation and microsprays place water at the base of the plant. This reduces evaporation and saves water by not wetting the entire ground surface. This technique is good for trees, shrubs and ground covers.
- Uniformity of the water being applied by the irrigation system is the key ingredient in irrigation efficiency. Sprinkler uniformity is affected by the operating pressure, the nozzle used and the sprinkler spacing, as well as external forces such as wind.
- Plants transpire moisture through their leaves and the soil allows water to evaporate into the air. This condition is called evapotranspiration. Replacing the plant's ET will allow the plant to thrive. Rain will replace some of the moisture, irrigation will do the rest. Tensiometers measure soil moisture in a plant's root system. The measurement is very close to ET and a practice tool to use when needing to know how much irrigation is necessary.
- Rain shut-off devices on automatic systems cut off the power to the controller during rain events and won't allow the system to operate until the unit has dried out and irrigation may be needed again.
- Overspray that covers concrete or other impervious areas can waste water by running off the property.
- Over-watering landscapes is a more common problem than under-watering. People tend to think that if a little is good, a lot is even better.

(F) Use Mulches



Mulches are various organic materials, such as pine/oak bark, pine straw, aged wood chips and compost mixtures that are placed around the root zone of a plant.

- The use of mulches around planting is highly effective in retaining soil moisture and reducing the need for watering and maintenance.
- Three to five inches of mulch reduces the level of evaporation from the soil, insulates root systems from heat and limits the germination of weeds around beds and flora.
- Fine textured mulches help retain more moisture than coarse mulches.

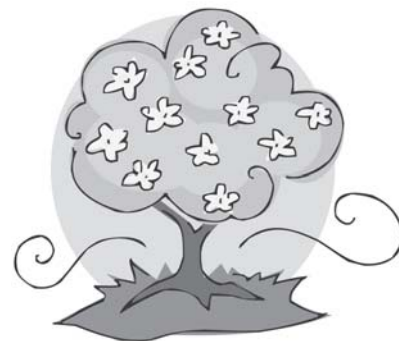
(G) Proper Maintenance

The most crucial element in sustaining water efficiency in any landscape site is ensuring that a regular maintenance schedule is met. Attention to the landscape and irrigation system at regular time intervals will lower the cost of maintenance, and increase the effectiveness of water for landscaping.

- Mow grass at a proper height. No more than one-third of the leaf blade should be removed during mowing.
- Regular aeration of clay soils will improve water holding capabilities and prevent runoff.
- Monitor irrigation schedules to replace evapotranspiration.
- Analyze the soil several times during the season to be sure nutrient levels are maintained.
- Inspect, adjust and replace sprinklers, filters, valves and emission devices for proper operation once a month.

Xeriscape, Water-Wise, Water-Smart or Low-Water Landscapes

All of these words are used to describe a plan for landscapes that seek to use native plants or low-water use plants to reduce water demand, lower maintenance requirements with little or no reliance on lawn and garden chemicals. Xeriscape, from the Greek word Xeros, which means to dry, originated in Denver in the early 80s. The concept is valid in the humid east, but the word Xeriscape has a more western connotation; therefore, water-wise, water-smart or low-water are synonymous words used in North Carolina. The planning principles mentioned in this chapter are the foundation of a water-wise landscape.



CASE STUDY

Planning Receives Recognition

The town of Cary has received national recognition for its water conservation activities. The town has done comprehensive water planning to map its future requirements. It has set up public education programs, school lessons aimed at teaching children about water conservation and a local block leader program that gets the whole community involved. Cary has instituted a permanent alternative day watering ordinance, a water waste ordinance and passed a rain sensor ordinance. This central North Carolina town was one of the first to offer reclaimed water for outdoor irrigation uses and now has 10.4 miles of dedicated distribution lines providing 176,000 gallons per day for this purpose. Conservation pricing in its water rates and irrigation system audits are also some of the tools the town used to reduce water consumption. Cary's active leadership is viewed as a model for North Carolina local governments.

Benefits

Benefits of ecologically-based, water-conserving landscapes include:

- Reduced off-site water consumption.
- Lower HVAC requirements.
- Provision for pedestrian movement and habitat needs.
- Maintained nutrients on site.
- Lower energy use and pollution.

- Reduced water pumping and water treatment.
- Lessened runoff of stormwater and irrigation water.
- Lower maintenance and labor costs.
- Increased quality of landscape and surrounding habitat.

Tips For Existing Landscapes

Practical steps can be taken to reduce water use and improve plant conditions in mature landscapes with a little effort and attention to detail. Managing an irrigation system is much like the management of other mechanical devices. Proper settings, operation and maintenance equate to proper results. Understanding the system is the first step. Locate the original design of the system and check it against the system that is actually on the property. Significant changes may have been made over the years to the facilities that make what was originally installed much less efficient. Outside professional assistance may be warranted in this review stage. The Irrigation Association tests and certifies individuals in various specialties such as design, contracting, water management and system auditing. North Carolina individuals with these certifications can be located on the association's Web site at <http://www.irrigation.org>.

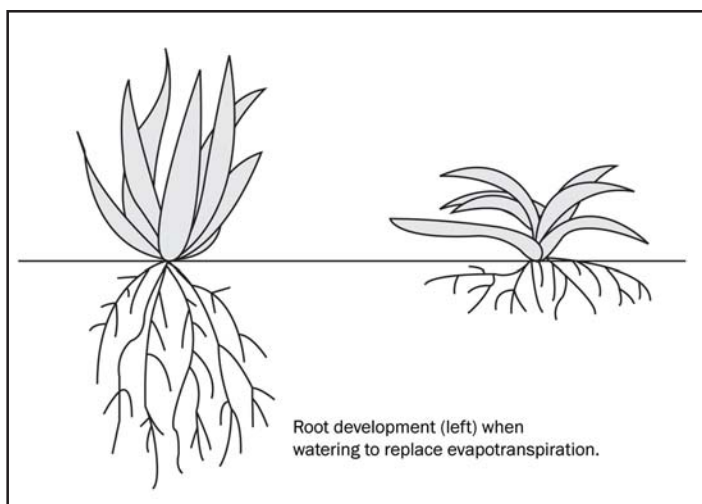
How to Water

- Water in the early morning or late evening to maximize absorption and minimize evaporation
- Water only when wind is less than 10 miles an hour.
- Peak water demand occurs with summer temperatures and plant demand is much lower in the spring and fall seasons.
- Be sure irrigation system is balanced, especially in turf areas. A balanced or matched system provides the same precipitation rate whether using a quarter

inch circle pop-up spray head or a full circle rotor type sprinkler. There is an old adage that everyone waters to take care of the dry spot. If the system is in balance no dry spots appear and the balance, of the turf is not over-watered.

- Use evapotranspiration data to help determine the plant's water needs. N.C. State University's Web site "Turfgrass Irrigation Management System," provides information about ET demand and the irrigation requirements of N.C. turfgrasses (<http://www.TurfFiles.ncsu.edu/TIMS>).
- Measure the amount of rainfall at various locations throughout the facility. Maintain a record of this rainfall and adjust the operating time of the irrigation system to replace the ET minus the weekly rainfall. This is sometimes called the "checkbook" method.
- Alternatively, use tensiometers which measure soil moisture; set the controller to replace the water needed to bring the tensiometer gauge to "moist."
- Water once or twice a week using an automatic sprinkler system. Drip irrigation requires more frequent longer duration runs.
- Note any areas where the sprinklers are over-spraying buildings, sidewalks or pavement and adjust the spray pattern to avoid these areas. A system that was poorly designed initially will immediately give itself away by watering hardscape areas.

FIGURE 4-15



Amount of Water Plants Require

- Use evapotranspiration data to help determine a plant's water needs.
- Water deeply once or twice a week instead of lightly every day. (See Figure 4-15.)
- To prevent runoff or deep percolation below the roots, never apply water faster than the soil can take it in or more than the soil can hold. (See Figure 4-16, next page.)
- Assess the characteristics of a site through a water audit. Audits evaluate the specific water needs and conditions of an existing site.
- Consider that every square foot of watershed hardscape can shed more than 25 gallons of irrigation water every year.

Check Out These N.C.-based Landscaping Links

Going Native: Urban Landscaping for Wildlife with Native Plants -
<http://www.ncsu.edu/goingnative/index.html>

TurfFiles - <http://www.turffiles.ncsu.edu/Default.aspx>

Industrial/Commercial Horticultural Information Leaflets -
<http://www.ces.ncsu.edu/depts/hort/hil/landscape-index.html>

FIGURE 4-16

| Maximum Sprinkler Run Time Minutes Per Application | | |
|---|----------------|----------|
| Soil Type | Sprinkler Type | |
| | Spray | Rotor |
| Sand | 15 to 20 | 45 to 60 |
| Loam | 10 to 15 | 30 to 45 |
| Clay | 7 to 10 | 20 to 30 |

System Maintenance Considerations

- Use the same size nozzle when replacement is needed.
- Replace sprinklers with the same brand of sprinklers. Spray heads should not operate on the same valve with rotors.
- Ensure spray heads are aligned with grade.
- Replace worn spray nozzles.
- Regulate pressure properly for system demands.
- Many times a rotor or spray head will be mounted incorrectly in an attempt to cover a greater area. Replace with proper unit for the job.
- Post the current controller schedule inside the door of the controller.
- Check for leaking valves.
- Inspect low-volume emitters for any stoppage.
- Inspect sprinklers for clogged nozzles which distort the spray pattern.
- Adjust sprinklers to water plant material and not sidewalks or roads.
- Adjust the operating time (runtimes) of the sprinklers to match the seasonal or monthly requirements.
- Monitor plant leaves and take soil samples to confirm proper system operation.

Irrigation System Operations

- Consider adding a rain shutoff device to your automatic irrigation control system.
- Consider alternative sources for irrigation water, including the use of wells as opposed to city water, water reuse options from air conditioning condensate, storm water retention ponds, cisterns or non-contact cooling water.
- Reclaimed water from the local water treatment facility may be available for use at a lower cost.
- Use electronic controllers with precise timing, multiple irrigation zones, multiple cycles and attached rain shut-off devices.
- Incorporate separate irrigation zones for all irrigated plant hydrozones, and use separate irrigation zones for turf areas.
- Use dedicated water meters for landscaping water use.
- Use drip or other low volume irrigation wherever possible.
- Have a catchment, or distribution uniformity, test performed on-site to determine how evenly water is applied when sprinklers are in use.

Water Supply Expectations

Most landscape irrigation systems use potable water supplied by the local water purveyor. These firms are in the conflicting business of selling water and shepherding local water resources at the same time. When dry periods occur and demand accelerates, the water purveyors must limit access to their finite resource. Most have policies in effect as to what steps will take place in water-short periods. These policies may include limiting outdoor watering to certain days a week, increasing rates on high water users or barring outdoor water use altogether. It is important to know what to

Untreated Gray Water

The North Carolina Plumbing Code defines gray water as “waste discharged from lavatories, bathtubs, showers, clothes washers, and laundry sinks.” The disposal of sewage/wastewater is regulated by North Carolina law, which can be found online at http://www.deh.enr.state.nc.us/osww_new/new1//images/Rules/1900RulesJune2006.pdf.

15NCAC 18A.1935 Definitions: “Sewage” means the liquid and solid human waste and liquid waste generated by water-using fixtures and appliances, including those associated with food handling. The term does not include industrial process wastewater or sewage that is combined with industrial wastewater.

expect in a drought emergency, so check with your local water purveyor to see what plans it has in place.

Many jurisdictions can provide reclaimed water (treated effluent water suitable for plants) that can be obtained through a contract with the purveyor. Separate pipelines are needed to get this water to your facility and this infrastructure problem may be the prime obstacle. If reclaimed water is available, it is generally lower cost and available in periods of water stress.

Water Efficient Technologies

Automatic Irrigation Timer

A simple-to-operate automatic timer or controller can be installed on an existing manual irrigation system. The controller automatically will operate the sprinklers on the proper day of the week for the correct amount of run time. This will meet the plant’s water needs as well as apply the water in off-peak night or early morning hours. More elaborate controllers offer extra flexibility to manage larger sites with many different hydrozones and site conditions. Any controller can use a rain or soil moisture sensor to prevent the sprinklers from operating when natural precipitation has met the plants’ water needs.

“Smart” Controllers

A new class of “smart” controllers is now available on the market. Unlike traditional controllers, which are really just timers, “smart” controllers work by monitoring and using information about site conditions (such as soil moisture, rain, wind, slope, soil, plant type and more), and applying the right amount of water based on those factors. These climate based “smart” controllers are available from many manufacturers and the irrigation industry has created an evaluation program to set standards of performance for this class of product.

CASE STUDY

Rainwater Cisterns

UNC-Chapel Hill installed a 70,000-gallon underground cistern and gravel storage field at a sports field on campus. The cistern system captures rainwater from the roofs of nearby buildings, and stores the water until it is used to irrigate the field. Various other cistern systems on UNC-CH’s campus, can be used for both irrigation and flushing toilets.

Centralized Irrigation Controllers

To manage many irrigation controllers spread out among many sites, a centralized control system will save labor costs as well as increase water efficiencies. A typical central irrigation control system utilizes a computer to create, adjust and save irrigation schedules for multiple controllers at various locations. The computer then communicates to the controllers by radio, hardwire, telephone or a combination of two or more methods. A computer-central system can also monitor and react to different alarm situations like broken heads or pipes, valve malfunctions or many other water-saving sensors.

A central control system does not relieve the water manager from monitoring and adjusting the equipment. It allows them to quickly adjust multiple controllers to the monthly or daily changes in conditions that affect the water needs of the plants. These units can be economically justified for larger and multiple site operations.

PC Software

Software programs have been developed to assist the designer and water manager in the analysis of the efficiency of an existing or newly-designed irrigation system. Two of the primary programs were developed by the Center for Irrigation Technology at California State University, Fresno. The program used to generate graphic representations of sprinkler efficiencies is called *Hyper-SPACE™*. The software that analyzes the costs versus the benefits of improving irrigation efficiencies is called *SPACE Irrigation Survey™*. Many certified water auditors and certified irrigation designers use these software programs extensively.

New Sprinkler Type

Install a multi-trajectory rotating stream sprinkler with high application uniformity. This friction resistance head operates at lower pressures and fills the product range between spray heads and rotors.

CASE STUDY

Wastewater Reuse

Aurora, Colo., eliminated more than one billion gallons of water needs by the construction of a wastewater reclaimed system that uses industrial wastewater for irrigation.

Flow Control Nozzles

Sprinklers with a uniform application rate that use the lowest possible water pressure are the goal. One method that helps achieve this goal is the use of flow-control nozzles. Each sprinkler nozzle is equipped with a flow-control device that compensates for flow changes and maintains a uniform pressure. This can be a desirable feature on slopes. The flow control also acts to reduce flow should a sprinkler head be broken.

Sensors

Several types of sensors are available that take the human factor out of irrigation system operation.

- Rain shut-offs
- Freeze sensors
- Wind sensors
- Flow sensors
- Soil moisture measurement
- Weather stations

Rain shut-offs have the single largest impact on water savings in automatic irrigation. North Carolina has regular and balanced rains, making this sensor a valuable tool as it cuts off the controller when a pre-set rain level is reached. When the weather conditions dry out, the rain shut-off allows the controller to resume normal operation without affecting the programming of the controller.

Freeze sensors are specialized sensors that stop all irrigation when a pre-set temperature is reached.

Wind sensors cut off irrigation as wind velocities reach certain levels. This sensor would be most commonly used in coastal areas or where wind velocities vary throughout the growing season.

Flow sensors respond to high flow situations caused by broken sprinkler heads or a pipe-line break. The sensor shuts off the irrigation until repairs can be made. This is especially important on hillsides that could wash away.

Soil moisture measurement sensors are devices that measure soil/water tension and function as an artificial root. These devices can use various methods to report soil moisture, including tensiometers, gypsum blocks and electrical resistance devices. All are designed to signal when there is not enough moisture in the root zone of a plant. The sensors can activate

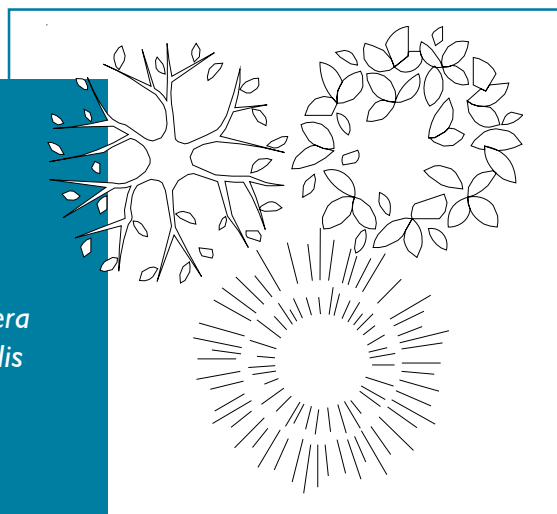
a control device such as a valve or controller to turn on.

Weather stations that are situated at a facility include all of the sensors mentioned plus data logging of weather conditions at the site. On-site weather stations can record and advise “smart” controllers about real time local conditions.

Water-Efficient Plants

A major factor of water-efficient landscapes is the selection of plants. Plants’ watering needs are divided by hydrozones. The use of drought-tolerant and native plants not only minimizes runoff concerns, but also can strategically make the most use of rainfall patterns. In addition to the lists of drought-tolerant plants (see next two pages), the N.C. Cooperative Extension Service can provide further information and assistance for selecting water-efficient plants.

| T R E E S | Common Name | Botanical Name |
|-----------------------|------------------|--------------------------------|
| | Lacebark elm | <i>Ulmus parvifolia</i> |
| | Japanese zelkova | <i>Zelkova serrata</i> |
| | Tulip poplar | <i>Liriodendron tulipifera</i> |
| | Sycamore | <i>Platanus occidentalis</i> |
| | Laurel oak | <i>Quercus laurifolia</i> |
| | Live oak | <i>Quercus virginiana</i> |
| | Pin oak | <i>Quercus palustris</i> |
| | White oak | <i>Quercus alba</i> |
| | Crepe myrtle | <i>Lagerstroemia indica</i> |
| | Hollies | <i>Ilex spp.</i> |
| | Chaste tree | <i>Vitex agnus-castus</i> |
| | Sweet gum | <i>Liquidambar styraciflua</i> |



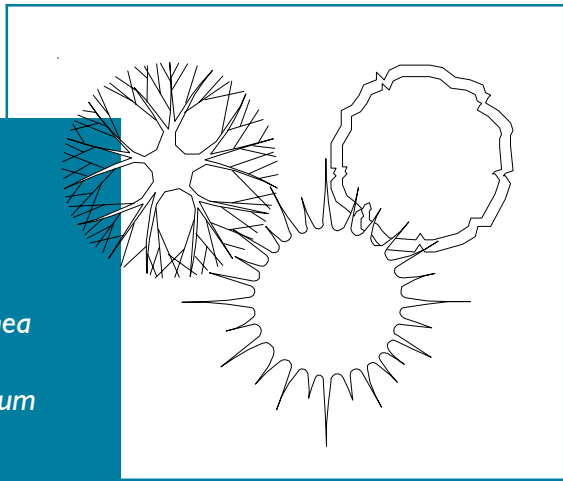
SHRUBS

Common Name

- Chinese photinia
- Elaeagnus
- Firethorn
(pyracantha)
- Japanese privet
- Junipers
- Yaupon holly
- Mahonia
- Nandina
- Chinese holly
- Strawberry bush
- Forsythia
- Barberry
- Quince
- Viburnum
- Euonymus
- Spirea
- Glossy abelia
- Jasmine

Botanical Name

- Photinia serrulata*
- Elaeagnus*
- Pyracantha coccinea*
- Ligustrum japonicum*
- Juniperus spp.*
- Ilex vomitoria*
- Mahonia spp.*
- Nandina domestica*
- Ilex cornuta*
- Euonymus americana*
- Forsythia intermedia*
- Berberis spp.*
- Chaenomeles japonica*
- Viburnum spp.*
- Euonymus spp.*
- Spirea spp.*
- Abelia grandiflora*
- Jasminum spp.*



COVERS/VINES

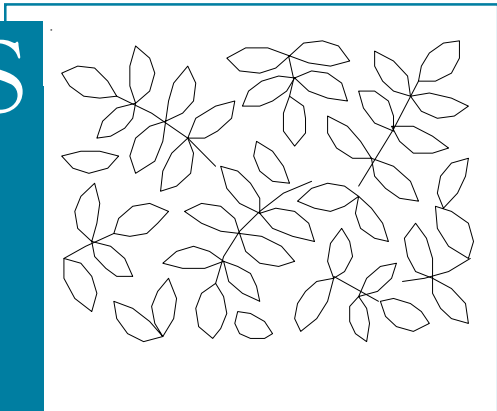
GROUND

Common Name

- Mondograss
- Liriope
- Junipers
- Thrift
- English ivy
- Clematis
- Trumpet honey
suckle
- Wisteria
- Wintercreeper
- Periwinkle

Botanical Name

- Ohpiopogon japonicus*
- Liriope spp.*
- Juniperus spp.*
- Phlox subulata*
- Hedera helix*
- Clematis spp.*
- Lonicera sempervirens*
- Wisteria spp.*
- Euonymus fortunei*
- Vinca spp.*



PERENNIALS

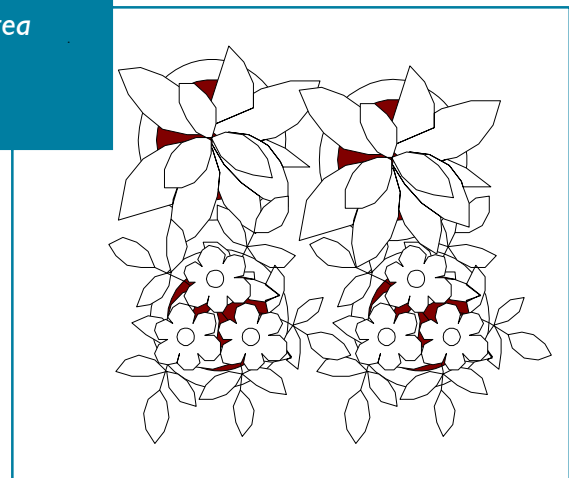
ANNUALS &

Common Name

Gazania
Annual vinca
Annual phlox
Baby's breath
Black-eyed Susan
Coreopsis
Cape marigold
Cornflower
Cosmos
Globe amaranth
Moss rose
Straw flower
Verbena
Butterfly weed
Gaillardia
Goldenrod
Liatris
Purple coneflower
Sedum
Stokes' aster

Botanical Name

Gazania rigens
Catharathus roseus
Phlox drummondii
Gypsophila spp.
Rudbeckia spp.
Coreopsis spp.
Dimorphotheca sinuata
Centaurea cyanus
Cosmos spp.
Gomphrena globosa
Portulaca grandiflora
Helichrysum bacteatum
Verbena spp.
Asclepias tuberosa
Gaillardia x grandiflora
Solidago hybrids
Liatris spp.
Echineacea purpurea
Sedum spp.
Stokesia cyanea



The North Carolina Division of Pollution Prevention and Environmental Assistance provides free, non-regulatory technical assistance and education on methods to eliminate, reduce, or recycle wastes before they become pollutants or require disposal. Telephone DPPEA at (919) 715-6500 or (800) 763-0136 for assistance with issues in this fact sheet or any of your waste reduction concerns.

