CONSERVATION TECHNOLOGIES FOR TURF-RELATED FACILITIES

The Department conducted a study of conservation technologies available to turf-related facilities. These conservation technologies are categorized into:

A. Landscape design
B. Irrigation systems
C. Management practices
D. Education

A. LANDSCAPE DESIGN	DESCRIPTION / CONSERVATION POTENTIAL
1. General	Develop a master plan for the design (for new facilities) or redesign (for existing facilities) that incorporates water conserving elements. An important element of a facility designed with water efficiency in mind is adequate irrigation design. A well designed and properly installed irrigation system reduces water use and results in a high quality and attractive turf and landscape. In addition to what is listed below, the irrigation technologies, turf selection, and pond/reservoir construction guidelines outlined below are all relevant for designing or redesigning turf-related facilities with water conservation as a goal.
2. Golf Courses	
a. Minimize and level turf; install cart paths	Design measures include: narrow fairways, reduced fairway length, more tee choices per hole, less rough area, smaller greens, flatter courses, fewer slopes, no turf in front of tees, a complete cart path system, and zero lot line fairways placed side by side. Smaller greens, tees, roughs, and fairways reduce total irrigation water demand. Flatter courses have less water loss from runoff than sharply sloped courses. A cart path system reduces soil compaction and wear and tear on the turf.
b. Water harvesting	Use catch basins to divert storm water and runoff to storage ponds; perforate the pipe collection system to funnel water to storage ponds; slope fairways toward ponds; design cart paths to drain into lake; and collect water from adjacent developments. Water harvesting allows for increased reuse of irrigation water and the retention of "free" water on-site.
c. Zone areas of different water demand separately	Areas to zone: level and sloped areas; windy and protected areas; tees, greens, fairways and rough; turf and non-turf areas; soils with different percolation rates; separate, difficult-to-manage areas; shady and non-shady areas. Incorporate separate valving for zoned areas. This reduces the amount of water lost to evaporation, runoff and percolation below the root zone and eliminates over-wateri- to accommodate dry or hard-to-irrigate areas. It is especially important for new design.
d. Use of vegetative or other wind barriers	Reduces evaporation.

2.	**Heads**	There are a wide variety of head and nozzle choices available to fit specific irrigation needs. Properly selected heads and nozzles determine the uniformity of coverage and eliminate overspray, water application in excess of infiltration rates, runoff, and evaporation. Matched precipitation rates allow uniform application of irrigation water. Select head size according to turf area.
a.	Valve in head sprinklers or one valve – one head	Allow for pinpoint irrigation accuracy for large turf areas and irrigation zoning. Drawbacks are that they reduce the ability to use rain shut-off switches and do not allow the controller to regulate/ coordinate with the rest of the system.
b.	Low volume/low pressure spray heads	Prevents runoff, wind distortion, and evaporation from standing water in areas with a low infiltration rate for smaller turf areas; improves uniformity; reduces application rates; and allows larger areas to be irrigated with a given amount of water. Lower differential between wettest and driest spots.
c.	Low trajectory heads	Prevents wind distortion, evaporation.
d.	Gear driven heads	More uniform water application.
e.	Pressure compensating bubblers	More uniform water application in non-turf areas.
f.	Matched precipitation rate heads	Allows more uniform irrigation coverage when grouped with similar pattern heads.
3.	**Valves**	
a.	Electric valves	Precise irrigation timing.
b.	Check valves	Prevents low head drainage, wet areas around heads, and backflow.
c.	Master valve	Opens when system is operated; closed system completes cycle. Installed above all automatic valves. Valve prevents discharge of water, except when system is in a running cycle, as in the case of a break in the line or a malfunctioning valve.
4.	**Sensors**	
a.	Automatic rain shut-off switch	System shuts down when rainfall exceeds a preselected amount with automatic return to schedule when water in collector evaporates; prevents overwatering. Interfaces with central controller or satellite controllers.
b.	Wind sensor	System shuts down when wind speed reaches a preset velocity at which wind draft and evaporation are excessive. Cycle resumes when wind speed tapers off.
c.	Soil moisture sensor	Allows more precise adjustment of time and frequency of irrigation. Eliminates excessive water application. Low utility on large turf areas because of too much variability. Can be directly wired to controller for more automatic use. Portable soil probes useful for checking localized dry spots. Good for an analysis of system efficiency.

e. Involve golf course superintendent in original design	Application of water conservation methods and techniques gained through hands-on experience.
f. Use native or low water use landscaping in non-turf areas	Low water demand plant materials reduce amount of water needed to irrigate non-turf areas.
g. Design facility to ensure compliance with Department requirements	Minimizes probability that facility will use more than the maximum annual allotment.
h. Design facility to accommodate effluent as source water	Separate turf/landscaping distribution system from potable distribution system. Select valves, heads, emitters, etc. that are able to function easily with effluent quality water.
3. Non-Golf Course Turf Facilities	
Maximize areas of low water use plants and inorganic mulches in non-play/minimal use areas	Less turf area being used; less area to irrigate.

B. IRRIGATION SYSTEMS	**DESCRIPTION / CONSERVATION POTENTIAL**
1. Controllers	Controllers regulate irrigation scheduling. The controller activates a valve at a preset time and turf is irrigated for a preset period of time. Each valve controls one set of sprinkler heads. The number of controllers and valve stations depends on the area of turf, the size of the valve, and the design of the irrigation system. The use of controllers does not guarantee water savings, but when programmed and operated by an experienced manager they are a good conservation tool.
a. Electromechanical controllers	A motor turns rotary switches that activate relays. While the least efficient of the controllers, these low cost controllers can result in a 30 to 40 percent water savings over quick coupler systems.
b. Centralized system controller	Quick, accessible control over entire facility's irrigation scheduling.
c. Solid-state controllers	Electronic accuracy -- precision irrigation application and timing, individual station programming, multi-cycling, multiple programming, longer station timing for drip irrigation, capability to interface with a rain shut-off switch or wind sensor.
d. Computerized controllers	The most sophisticated and accurate method of irrigation timing available, but costs make it appropriate only for larger facilities. Real-time water budgeting capabilities are its most important feature. Specific features include: (1) individual stations can be controlled, (2) operator can precisely limit water to desired saturation point eliminating runoff and percolation below the root zone, (3) historical evapotranspiration (ET) rates can be programmed into scheduling, (4) can interface with weather monitoring system and current reference ET and soil moisture information, and (5) pinpoints excess flows by station.

d. Infrared sensor	Allows assessment of plant water needs through use of infrared light.

5. Other	
a. Drip irrigation of non-turf areas	Water applied where needed. Non-turf application. Eliminates evaporation. Significant water savings. Also yields improved plant growth.
b. Excess flow-sensing device/ low pressure shut off switch	Prevents water waste. Sensitive to low pressure caused by breaks in the line or a missing head. Shuts system down in event preset pressure is reached.
c. Flow meter	Permits accurate measurements of water use to facilitate irrigation scheduling and budgeting.
d. Pressure regulators	Permits maintenance of design pressure, eliminates evaporation and wind drift because of head misting. Especially important for drip systems.
e. Individualized head layout that responds to facility configuration	Use small heads on tees and greens, 1/2-circle heads at edge of turf area. Eliminates runoff and over-irrigating to compensate for dry areas.
f. Looped lateral system	Has a lower pressure differential than a linear irrigation system. Improves the uniform distribution of irrigation water. Lower differential between wet and dry spots.

C. MANAGEMENT PRACTICES	DESCRIPTION / CONSERVATION POTENTIAL
1. Irrigation Program Techniques	An effective combination of the following irrigation techniques will help eliminate evaporation, runoff, and water application in excess of the infiltration rate.
a. Deep irrigation and longer periods between irrigations to develop root system	Turf with a well developed root system can endure more stress. Turf can exploit more stored water. Good soil infiltration and percolation is required.
b. Deficit irrigation	Deficit irrigation involves keeping turf somewhat stressed to develop a deep root system. Irrigation frequency can be adjusted to reduce consumptive water demand of turf. Turf with a well developed root system can endure more stress and can exploit water stored in deeply wetted soil profile. Research is needed to determine which turf types adjust the most favorably to deficit irrigation. Turf under deficit regime can survive more easily if no other stress is added. Requires careful management. Especially appropriate for less intensely used areas such as roughs and fairways.
c. Short, repeated irrigation cycles (cycle and soak)	Prevents runoff on sloped areas. Prevents evaporation of standing water in areas with low infiltration rates. Eliminates excess water applications. More effective in cool season because of low evaporation rates. Can only be done efficiently with a solid state controller. Useful on compacted soils and for germinating rye grass.

d. Daily visual inspection to assess water needs	Irrigation can be evaluated by micro-areas, irrigation adjustments can accommodate area differences. Instant adjustments can be made to accommodate wet spots and dry spots. Dew patterns can be observed in the early morning to detect abnormal head spray patterns.
e. Night irrigation	Less wind distortion, less evaporation, ET rate at the lowest point of the day. Need automatic controllers to be effective.
f. Daily logging of local or on-site weather conditions or use of a controller that is linked to an on-site weather station	Assesses irrigation needs to permit a more exact irrigation application on a daily basis. Allows application of water to exactly compensate for water used that day. Permits long-term irrigation scheduling and budgeting.
g. Use of soil tests to determine soil characteristics, especially percolation rate, available water capacity, degree of soil compaction, and nutrient requirements	Knowing soil characteristics permits matching of percolation rate and irrigation rate, reduces evaporation and runoff, and avoids applying more water than can be held in the root zone or deeper than necessary. Signals need for treatment of soil compaction. Provides accurate information for computation of gypsum or sulphur requirement and for precise replacement of nutrients.
h. Manually irrigate small dry spots – use quick coupler hose or other manual method	Eliminates overwatering by using a set of heads or one large radius head to wet a small area.
2. Irrigation equipment maintenance	A routine preventative maintenance program for irrigation equipment results in the decrease of water loss and misapplication of water.
a. Heads	Check for wear, clogging, check pattern for consistency. Check after mowing for breaks. Adjust nozzles and heads as needed. Replace broken or worn parts.
b. Pipes	Check for leaks or breaks. Repair or replace as needed.
c. Valves	Check for leaks, sticking, buried or exposed wires, protect wiring. Replace or fix as needed. Promotes exact station timing control.
d. Controllers	Check for correct timing, sticking, non-functioning. Fix or replace as needed. Replace backup batteries at least once a year (or after each power failure).
e. Meters	Check meters for accuracy and sticking. Repair as necessary. Prevents mismeasurement of irrigation water. Improves water budgeting capability.
f. Pressure	Maintain design pressure. Readjust valve flow or replace pressure regulators as necessary. Prevents water loss through leaks, evaporation.
3. Water Use Planning	
a. Water budgeting	Use historical weather patterns, use local ET rate for turfgrasses, measure use against budget, adjust use accordingly. Regulates water use at a prescribed level. Allows operator to ensure compliance with annual allotment.

b. Accurate measurement	Daily measurement of water use using pump flow meter (gallons per minute), measurement by computerized controller system, or hour meter in conjunction with flow capacity. Allows manager to keep accurate water use records. Use to compare with established goal and to evaluate performance.
c. Accurate records	Daily logging of water use and weather conditions. Monthly water use reports. Allows manager to assess historical water use and weather data for use in future irrigation budgeting.
d. Establish irrigation priorities for periods of water shortage	Enables manager to plan for seasonal water requirements.
e. Separate metering of landscape water use	Allows manager to keep accurate water use records.
f. Use landscape water management software	Software can calculate an efficient irrigation schedule.

4. Non-Groundwater Source Water

Use effluent whenever feasible	Replacing groundwater pumpage with effluent use constitutes a water conservation management option. Existing nutrients in effluent (especially nitrogen) may reduce fertilizer needs. Operational concerns associated with effluent use (additional leaching needs due to salts, clogged emitters, etc.) require special attention. Many existing facilities are successfully using effluent in place of groundwater.

5. Turf Selection

a. Select turf for low water demand	Hierarchy of turf types from highest to lowest water demand: (warm season grasses) bent grass, hybrid bermuda, common bermuda, desert and range grasses; and (cool season grasses) annual rye and perennial rye.
b. Select non-traditional turf or non-turf alternatives for rough and non-play areas	Choose blue gramma, schismus, three-awn, buffalo grass, vine mesquite, curly mesquite, and/or giant mesquite, and/or giant bermuda
c. In cool seasons, select non-turf alternative for fairways and rough	Options include: Leave turf dormant; use ferrous sulfate; dye dormant turf green; apply liquid fertilizer to turf to aid chlorophyll production in frost-free areas. Eliminates late fall/winter water use associated with overseeding with rye. Some irrigation necessary to keep dormant grasses tough and wear resistant. Keeps bud nodes from drying out, prevents desiccation. Rye grass uses approximately 8-10 inches of extra water per year.

6. Winter Overseeding

a. Time winter overseeding by soil temperature, not calendar dates	Most favorable soil temperature for overseeding is between 72 and 78 degrees Fahrenheit, at a 4-inch depth. Overseeding at these lower temperatures decreases water use and evaporation, leads to a minimal fall transition period with less competition from bermuda.

b.	Eliminate total scalping of summer turf	When scalped, bermuda has a difficult time coming back in the spring and requires more water and fertilizer to do so, especially hybrid bermuda. Aerate and apply gypsum if needed to reduce salts before seeding to improve infiltration rate. Reduces runoff, evaporation from standing surface water. Increases water, air, fertilizer penetration into the root zone.
7.	**Turf Removal**	
	Develop a master plan for turf removal	Turf alternatives include: desert revegetation, drought tolerant ornamental planting, desert and range grasses, and desert flowers. Permanently reduces turf water use on specific areas.
8.	**Fertilizer**	Healthy, well-fed turf tends to have a better developed root system to balance fertilizer needs with water demand. This reduces overall water demand. Over fertilizing, however, can result in higher water requirements because of faster growth rate.
a.	Use less nitrogen to retard turf growth	Turfgrass ET rate decreases with slower turf growth rate. Water demand decreases as ET rate decreases.
b.	Use slow release fertilizers during warm season	Reduces growth spurts that increase water demand. Eliminates peaks and valleys of turf growth.
c.	Use soil tests to assess fertilizer needs	A more precise application of fertilizer reduces growth spurts that increase water demand.
d.	Apply nitrogen in the fall to cool season turfgrasses	Avoid application at time of spring green-up of warm season turf. Decreases early water demand of warm weather turf.
e.	Monitor potassium levels and keep readily available in periods of high temperature and drought stress	Permits turf to resist stress. Reduces turfgrass wilting tendency.
f.	Apply dry fertilizers when feasible	Avoids water needs associated with liquid applications.
g.	Apply growth regulators as fertilizer	Grass blades grow horizontally rather than vertically, reducing ET rate.
9.	**Soil Compaction and Low Permeability**	Compaction is a problem for all turf areas, except areas with very sandy soil. Infiltration, percolation, aeration, and plant available moisture are altered by soil compaction. Water use efficiency is enhanced in non-compacted soils. Changes in soil structure cause water loss by evaporation and runoff, in addition to influencing plant growth. Causes reduced root growth.
	To alleviate soil compaction and improve soil permeability:	
a.	Aerate	Soil cultivation enhances infiltration, percolation, and soil moisture content. Permits water, air, and chemicals to reach root zone of turf.
b.	Use soil tests to assess soil salinity and pH	High salinity increases potential for runoff, reduces infiltration and percolation rate. High pH increases water demand.
c.	Apply gypsum	Replaces sodium in the soil and allows it to leach out. Improves infiltration and percolation.

d. Apply sulphur or sulfuric acid	Lowers pH of soil.
e. Control high traffic areas	Reduces compaction. Options include: Change traffic pattern; restrict traffic from specific areas; restrict carts to cart paths; smaller, more frequent applications in high traffic areas.
f. Apply wetting agents	Can be applied manually or injected automatically through the irrigation system. Increases infiltration rate. Especially useful for sandy soils that have developed a hydrophobic condition.
g. Use geotextiles, plastic, or concrete pavers cut out for turf	Relieves wear and tear on soil structure and turf. Reduces soil compaction.
h. Apply rules, such as the 90E rule, to minimize cart traffic on fairways	Reduces compaction.
10. Turf Damage	
a. Keep carts off turf during hot periods to reduce tire wilt	Wilted turf has a higher water demand. Damaged turf requires water to bring it back.
b. Control number of golf rounds played on hot days	Relieves stress on turf; reduces use of extra irrigation water to bring turf back.
c. Allow for maximum recovery time of turf before using muddy or damaged areas	Reduces damage from soil compaction; reduces use of extra irrigation water to bring turf back.
11. Thatch Control	
Institute a systematic thatch control program	Methods to control thatch include: verticutting, slicing, and spiking. Thatch increases the potential for runoff, decreases the infiltration rate, raises water demand.
12. Mowing Practices	
Incorporate turf mowing practices that reduce ET rate	A few practices are: mow turf at prescribed height; use reel mower; use sharp mower blades; mow frequently; do mowing late day or night. Mowing practices are dependent on use and budget. Turf grass water use increases with mowing height and declines with mowing frequency.
13. Surface Area	
a. Eliminate ponds or reservoirs that are not being used for storage	Reduces evaporation and seepage.
b. Decrease pond surface area to depth ratio	Reduces evaporation.
c. Use chemical surface coating or mechanical covers	Reduces evaporation.
14. Seepage	
a. Drain pond and reline with heavy duty plastic film and/or concrete	Most efficient method to eliminate pond leakage. PVC liners completely eliminate seepage.
Convert open streams and channels that deliver irrigation water to covered pipelines	Eliminates evaporation and seepage.

D. EDUCATION	DESCRIPTION / CONSERVATION POTENTIAL
15. Staff Hiring, Retention and Education	Good management involves all staff members at a facility.
a. Staff education	Staff education should focus on water conservation, irrigation techniques, and irrigation technology. Encourage, support financially, and give time off for seminars and workshops on water conservation and irrigation techniques.
b. Promote in-house	Staff retention yields more employees skilled in water conservation techniques.
c. Pay adequate salaries	Decreases staff turnover, retains staff skilled in water conservation techniques.
d. For large turf-related facilities, hire an irrigation manager whose sole responsibility is irrigation and turf management	Irrigation manager can concentrate on irrigation and water conservation.
e. Create conservation incentive for facility operator(s)	Give bonus calculated on water saved.
f. Hire staff with education and experience in agronomic area	Irrigation and turf management skills and education assist in successful water conservation efforts.