CENTER FOR ReSource CONSERVATION

SLOW the FLOW COLORADO

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Slow the Flow Colorado 2006
Colorado Water Conservation Board Final Report

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Prepared by the Center for ReSource Conservation

Purpose of an Irrigation Inspection

The purpose of an irrigation inspection is to evaluate and report irrigation system efficiencies, identify and list repair items, and formulate a site-specific watering schedule. Recommendations are based upon data collection, including soil samples, water pressure tests, catch cup tests, and site inspections. An accurate watering schedule for the zone(s) evaluated at the site can then be determined from these tests and may be implemented during a non-restrictive year.

2006 Results

Participants	# of Audit Hours
Aurora	800
Boulder	407
Erie	200
Lafayette	220
Longmont	392
Golden	150
Greeley	215
Thornton	411
Westminster	797

Total # of properties visited and tests performed

Property Type	# of Properties Visited	# of Tests Performed
Residential	1428	2036
Large Audits*	46	210
Total	1474	2246

* Large audits (properties such as parks, HOA, or commercial sites) take a much longer amount of time to complete than residential audits do).

Property Type	# of Tests on Spray Zones	# of Tests on Rotor Zones
Residential	1310	726
Large Audits	101	109
Total	1411	835

Distribution Uniformity

Distribution Uniformity(DU) is a measurement of how evenly an irrigation system is applying water. If each point in the area being water received the exact same amount of water in a given amount of time, then the DU would be 100%. It has been determined by the Irrigation Association that an efficient irrigation system should operate at a minimum of 70% Distribution Uniformity. An irrigation system operating at a Distribution Uniformity below 55% is considered to be in poor working condition. Any irrigation system operating at a Distribution Uniformity below 40% is essentially considered to be non-functional and as such, a recommended watering schedule cannot be provided. Please view the tables below for a break-down of our findings:

Tested zones with a distribution uniformity below 70%

Property Type	% of Spray Zones w/ DU<70%	% of Rotor Zones w/ DU<70%	Total % of Zones w/ DU<70%
Residential	(1147/1310) **87.6%**	(555/726) **76.4%**	(1702/2036) **80.0%**
Large Audits	(92/101) **91.1%**	(94/109) **86.2%**	(186/210) **90.0%**
Total	(1239/1411) **87.8%**	(649/835) **77.7%**	(1888/2246) **84.1%**

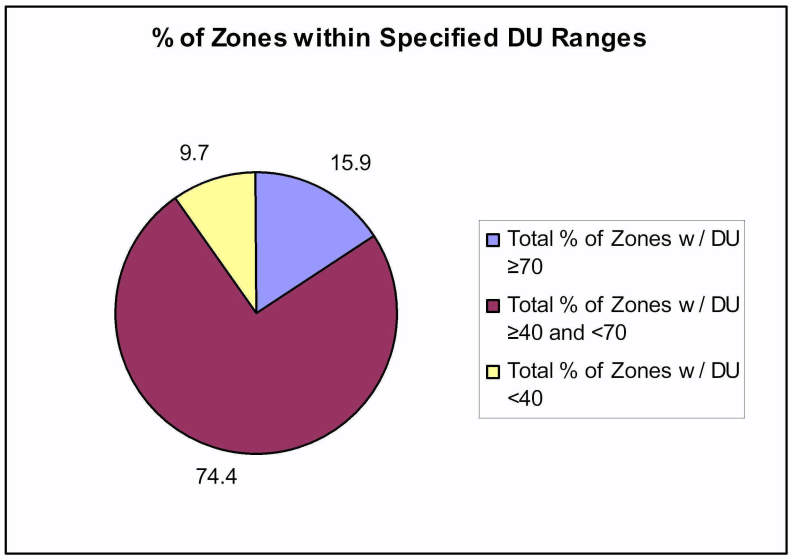
Tested zones with a distribution uniformity below 55%

Property Type	% of Spray Zones w/ DU<55%	% of Rotor Zones w/ DU<55%	Total % of Zones w/ DU<55%
Residential	(671/1310) **51.2%**	(289/726) **39.8%**	(960/2036) **47.2%**
Large Audits	(58/101) **57.4%**	(39/109) **35.8%**	(97/210) **46.2%**
Total	(729/1411) **51.7%**	(328/835) **39.3%**	(1057/2246) **47.1%**

Tested Zones with a distribution uniformity below 40%

Property Type	% of Spray Zones w/ DU<40%	% of Rotor Zones w/ DU<40%	Total % of Zones w/ DU<40%
Residential	(123/1310) **9.4%**	(65/726) **9.0%**	(188/2036) **9.2%**
Large Audits	(21/101) **20.8%**	(9/109) **82.6%**	(30/210) **14.3%**
Total	(144/1411) **10.2%**	(74/835) **8.9%**	(218/2246) **9.7%**

The pie chart below displays the DU of the zones inspected in 2006. Note that only 12.5% of the zones were operating at an acceptable distribution uniformity of 70% or greater.



Range:

- Range of DU for spray zones: 10% - 90%
- Range of DU for rotor zones: 9% - 96%

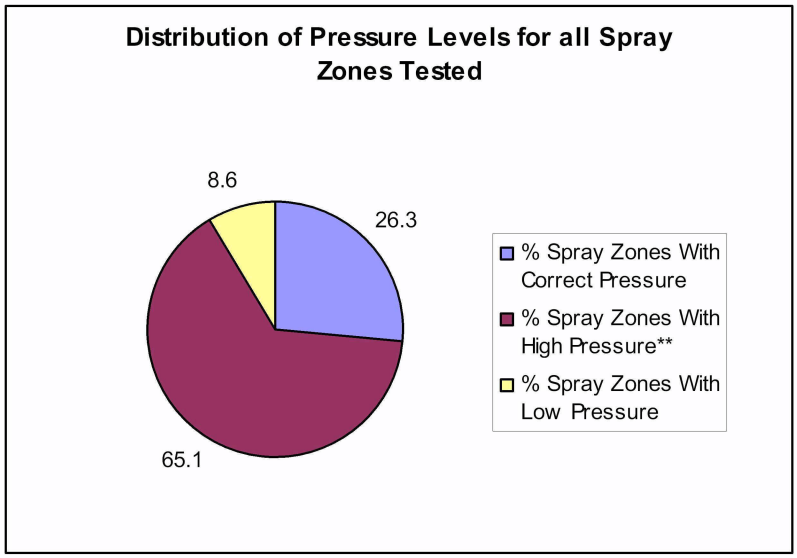
Pressure Readings

The desired pressure range for spray zones is 20-30 PSI. However, certain brands are able to function on slightly higher pressure, particularly if they have a Pressure Regulating Stem or PRS because they can compensate for the higher incoming pressure. We have found that typically the maximum pressure that a spray head can operate efficiently at is 50 PSI (given the brand can compensate for slightly higher pressure). The desired pressure range for rotor zones is 40-70 PSI. However, some newer residential models allow for rotors to operate at pressure levels between 30-40 PSI. In both head types, if the pressure is too high it will cause the heads to emit mist, but if the pressure is too low, the heads will not be able to cover the desired area.

Sprays

Property Type	% Spray Zones With Correct Pressure	% Spray Zones With High Pressure**	% Spray Zones With Low Pressure
Residential	(338/1232) **27.4%**	(782/1232) **63.5%**	(112/1232) **9.1%**
Large Audits	(12/101) **11.9%**	(86/101) **85.1%**	(3/101) **3.0%**
Total	(350/1333) **26.3%**	(868/1333) **65.1%**	(115/1333) **8.6%**

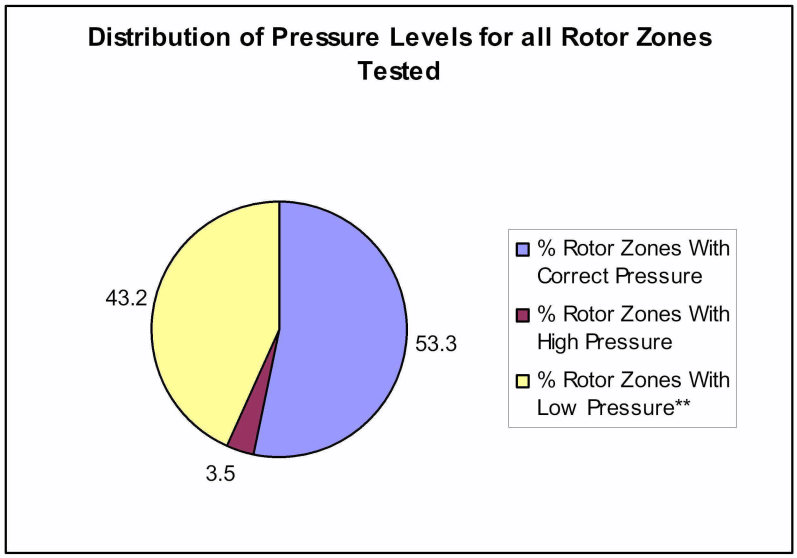
Of the 65.1% of spray zones with high pressure (exceeding 30 PSI), over 35% of those zones had significantly high pressure and were operating above 50 PSI. In other words, 22.7% of all spray zones tested had significantly high pressure.



Rotors

Property Type	% Rotor Zones With Correct Pressure	% Rotor Zones With High Pressure	% Rotor Zones With Low Pressure**
Residential	(331/670) **49.4%**	(26/670) **3.9%**	(313/670) **46.7**
Large Audits	(84/108) **77.8%**	(1/108) **.90%**	(23/108) **21.3%**
Total	(415/778) **53.3%**	(27/778) **3.5%**	(336/778) **43.2%**

Of the 43.2% of rotor zones inspected that had low pressure, 48% of those zones had pressure levels below 30 PSI. In other words, over 20% of all rotor zones tested had significantly low pressure



Range:

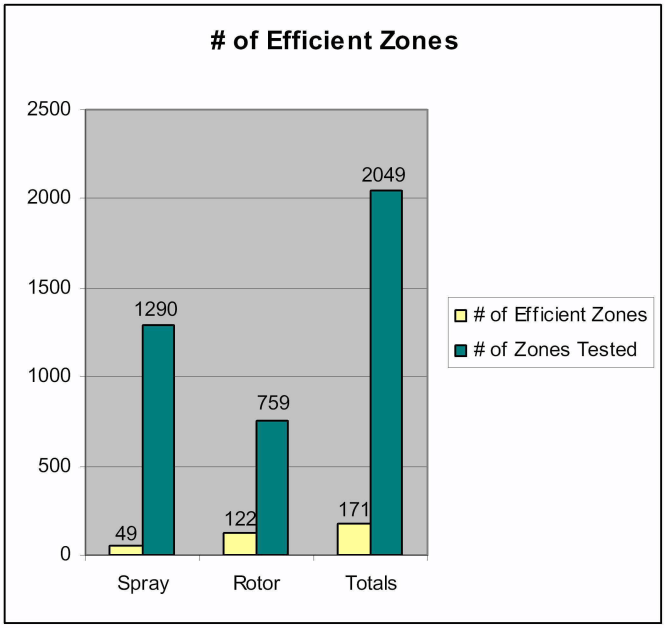
- Pressure Range for Spray Heads: 10 PSI - 100+ PSI
- Pressure Range for Rotor Heads: 10 PSI - 100+ PSI

% Total of inspected zones with correct pressure levels: 36.2%

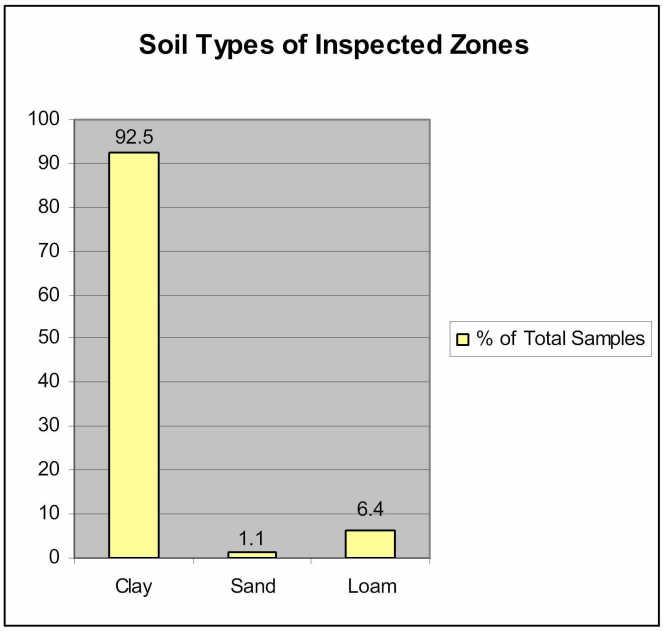
"Efficient Systems"

For the purpose of this analysis, an "efficient system" is defined as an irrigation zone that has 70% or greater DU and has proper operating pressure.

Property Type	% of Spray Zones	% of Rotor Zones	% Total of Efficient Zones
Residential	(34/1189) **2.9%**	(81/651) **12.4%**	(115/1840) **6.3%**
Large Audits	(15/101) **14.9%**	(41/108) **38.0%**	(56/209) **26.7%**
Total	(49/1290) **3.8%**	(122/759) **16.1%**	(171/2049) **8.3%**



Soil Types



Soil Type	% of Total Samples
Clay	92.5
Sand	1.1
Loam	6.4

Root Depths

As previously stated, a healthy lawn should have roots 6-12 inches deep. However, it is often difficult to get a deep enough soil sample, due to highly compacted clay soils frequently found in the area. In order to account for the possibility that the root depths may be deeper than the soil probe readings showed, we have established a 2 inch margin

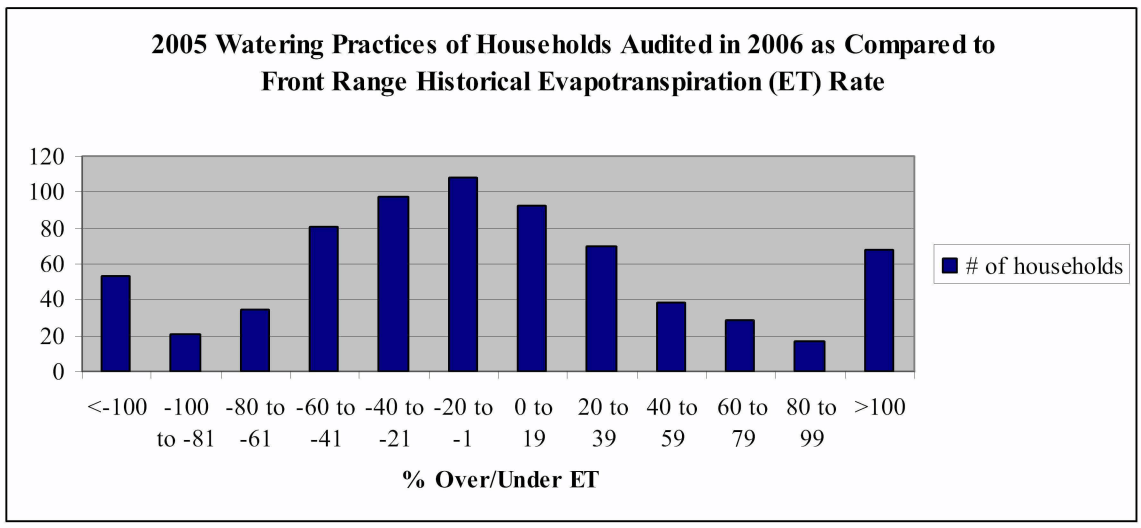
of error. As such, any roots that are less than 4 inches deep are considered to be in extremely poor health. In this case, poor health refers to the inability of the grass to withstand extreme temperatures, drought, and disease.

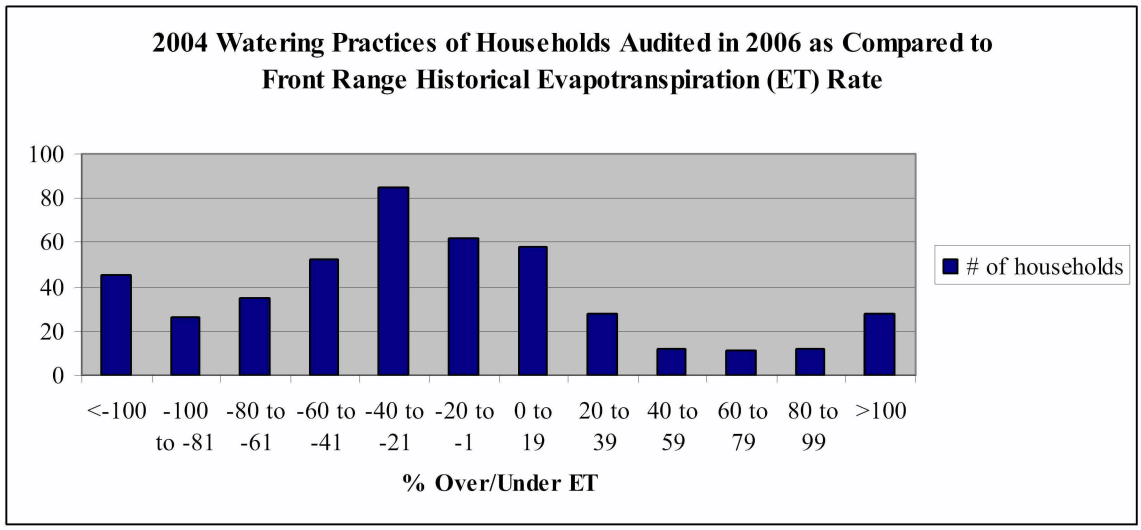
Head Type	% ≥ 6 inches	% ≥ 4 inches	% < 4 inches
Sprays	17.8	64.5	35.5
Rotors	13.5	57.5	42.5
Total	16.2	61.8	38.2

Evapotranspiration (% Over/Under-watered)

Evapotranspiration (ET) is the loss of water by evaporation from the soil and transpiration from plants. *Historical climatic averages* show that Kentucky Blue grass along the Front Range needs 27 inches of water during the growing season (May – Sept) to replace the amount of water lost to evapotranspiration. By utilizing individual water records to derive outdoor water use, the amount over/under-watered (% ET) in a given year for each household can be *estimated.*

The graphs below display the watering trends for select years for households that received an irrigation inspection in 2006. The cities of Golden, Greeley and Westminster were eliminated from this analysis due to unusable water records for these years. Also note that in 2005 more households were analyzed as compared to 2004. This is partly due to an increase of new households in 2005 as well as a lack of information available for 2004.





As shown by the graphs, the watering trends of households audited in 2006 follow a fairly normal bell curve, peaking somewhere between -40% to 0% of ET. The two exceptions in both years, however, are the classes <-100 and >100.

Notable Conclusions

Less than 10% of all inspected zones were operating efficiently (had a DU ≥70 and had correct pressure)

More than 4/5 of the zones inspected had an undesirable distribution uniformity

- The percentage of spray zones with an undesirable DU was consistently higher than the percentage of rotor zones with an undesirable DU

Almost 2/3 of the zones inspected were not operating at proper pressure levels

- The percentage of spray zones that had improper pressure was two times higher than the percentage of rotor zones that had improper pressure

Clay soil was the most common soil type, followed by loam.

About 1/3 of the properties visited had turf with shallow roots

98.7% (472/478) of mail-in evaluations indicated that the irrigation inspection either met or exceeded their expectations

98.1% (469/478) of mail-in evaluations indicated that the irrigation auditor "displayed knowledge and skills necessary to perform the inspection effectively."

These results were consistent amongst all cities

Methodology

Perform a visual inspection: A visual inspection of all sprinkler heads within functioning zones was performed during operation to 1) identify head type such as rotor, fixed, or drip; 2) list damaged, misaligned, or other malfunctioning heads; 3) note any other issues that negatively impact efficiency or creates waste. Control systems, such as timer clocks, were also inspected. The homeowner/property manager is always encouraged to join the auditor on the visual inspection.

Appendix A: Irrigation Glossary
Appendix B: Common Problems

Perform Catch Cup Tests: Catch cup tests were performed on designated zones. A catch cup test utilizes calibrated cups (designed by the Bureau of Reclamation), set in a grid pattern on the landscape to collect water from an irrigation system. The amount of water collected can be used to determine distribution uniformity and precipitation rates. The zones tested are intended to serve as a general representation of the irrigation system as a whole.

Distribution uniformity (DU) is a measurement of an irrigation system's ability to apply water uniformly over the surface of a landscape and directly influences the amount of water required to keep the landscape green. If the amount of water put out by an irrigation system is not completely uniform, some parts of the landscape will receive more water than others. Efficient systems operate at a DU of 70% or greater and minor adjustments to most systems can significantly improve the DU.

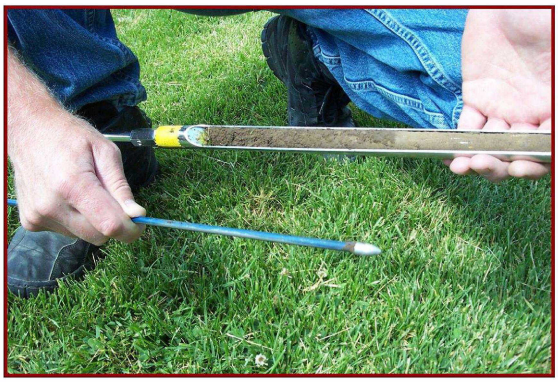
Precipitation rate (PR) is the amount of water emitted from an irrigation system measured in inches of water per hour. Different head types have different precipitation rates. The precipitation rate determines how long you need to run a sprinkler system. A spray head usually emits 1-2'' (on average 1.4") of water per hour, while a rotor head emits .5 – 1" (on average .9") of water per hour. Precipitation rates for each type and model of head will vary depending on the manufacturer.

Take Pressure Readings: Utilizing a pressure gauge along with the proper attachments, pressure readings were taken on spray zones as well as rotor zones. When reading the pressure for a spray zone, the pressure gauge is screwed directly on top of the sprinkler riser. When the water is turned on, it pushes water through the riser and moves the

measurement needle on the pressure gauge. For rotor zones, a pitot tube is attached to the pressure gauge and is then placed into the stream of water that is emitted from the nozzle. It is sometimes problematic to get an accurate pressure reading for rotor zones due to the nozzle design (there is usually more than one hole that emits water).
Visual indicators can also be useful when determining pressure levels. For example, if the pressure is too high, the heads will emit a fine mist. Conversely, if the pressure is too low, the heads will not be able to reach the designed distance (i.e. a spray head that has a nozzle designed to throw 8 feet will only be throwing 3 feet).
The proper pressure for fixed heads is between 20 and 30 PSI, while the proper pressure for rotor heads is between 40 and 70 PSI. Drip systems should never be higher than 30 PSI. Each manufacturer will provide proper pressure recommendations for all of their products, as they will vary depending on the model of the head.

Pressure gauge on a fixed spray head

Determine Soil Type and Root Depth: A soil sample was collected using a soil probe to determine soil type and root depth. Soil type was categorized as clay, sand, loam or some combination thereof. Soil type directly affects the infiltration rate of water and needs to be considered when determining the frequency and duration of watering times. For a healthy lawn, roots should be a minimum of 6 inches deep. This is accomplished by deep infrequent watering that greatly enhances a lawn's ability to withstand drought conditions and increased intervals between watering. This practice will also make the turf more resistant to disease.



Auditor taking a soil sample using a soil probe

Appendix C: Soil Characteristics

Perform Calculations: In order to find the precipitation rate and distribution uniformity for the zones tested, calculations must be made using the measurements acquired from the catch cup tests. The following are the formulas used:

- Precipitation Rate = (Average of the total number of catch cup volumes x 60) / number of minutes the test ran

- Distribution Uniformity = Average of the lowest 25% of catch cup volumes / Average of the total number of catch cup volumes X 100

Determine an appropriate watering schedule: Using the information gathered throughout the irrigation inspection, an appropriate watering schedule was developed for the customer for their current irrigation system. Watering intervals change throughout the season because the water requirements change for plants as the seasons progress. Through analysis of historic Evapotranspiration (ET) data and soil type, it has been determined that turf should be watered every four days in May, every three days in June, July and August, every six days in September and every ten days in October or until the end of the irrigation season. The duration of watering should be kept the same, with only the intervals between watering changing.

When turf is grown in clay soil, is planted on a slope, or is watered by sprinklers with a high precipitation rate, water infiltrates the soil more slowly than it is delivered. This in turn, causes runoff and/or puddling, creates waste, and prevents the turf from receiving all of the moisture and oxygen it requires. Therefore, depending on the type of soil, the severity of slope found on the site, and the precipitation rate of the sprinklers, cycling may be recommended.
The term *cycling* refers to running sprinklers repeatedly within an irrigation interval to allow for better water absorption. When a system is cycled, the total number of minutes being watered is divided into several shorter watering times. Individual zones are turned on and off multiple times within an irrigation interval, with rest periods of about an hour between each cycle; this practice allows the water to percolate deeper into the soil profile.

As a result, the grass roots are encouraged to grow downward instead of outward to find water. As mentioned above, deep roots allow for the drought tolerance and disease resistance of the grass to be increased.
In order to implement cycling using a control clock, the clock operating the system must have multiple start times available (virtually all new control clocks have at least three start times).

Appendix D: Irrigation Scheduling

Recommended watering schedule for a zone with clay soil and a PR of .9"/hr.

Month	Times/week	Cycles	Minutes	Total Minutes per watering	Total Minutes per week
May	1.5	3	12	36	54
June	2	3	12	36	72
July	2	3	12	36	72
August	2	3	12	36	72
September	1	3	12	36	36

Share test results and recommendations (residential only): In this part of the inspection, the auditor reviews all of his/her findings with the homeowner. The auditor informs him/her of pressure levels, soil type, root depth, precipitation rate, and distribution uniformity. At this time the auditor also provides the homeowner with a recommended watering schedule and explains the importance of cycling. Additionally, the auditor will reinforce the findings of the visual inspection and explain how these findings affect the distribution uniformity of the system. The auditor will then provide the client with recommendations on how the system could be improved upon. Upon finishing the inspection, the auditor will answer any questions that the homeowner may have and will also leave him/her with several resources that provide the homeowner with useful information on matters such as: choosing an irrigation specialist, sustainable landscaping, drip irrigation, pest management, etc.

Appendix E: Homeowner Sheet
Appendix F: Additional Resources
Appendix G: Media publications (not all instances of press were known or received)

Appendix A: Irrigation Glossary

100% Coverage: The design goal of all sprinkler system designers. Sometimes used (incorrectly) in place of the term "head to head coverage". 100% coverage is the objective of head-to-head coverage. But head-to-head coverage does not always result in 100% coverage.

Angle Valve: A type of valve in which water enters through the bottom inlet, turns 90 degrees, and then flows out through a side outlet. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Anti-Siphon Valve: A control valve with a built-in atmospheric vacuum breaker (backflow preventer). Most commonly used in residential irrigation systems where code allows them. Must be installed above ground.

Arc: The part of a circle that the sprinkler covers with water. Arc is expressed in degrees i.e. a sprinkler that has an arc of 360 degrees covers a full circle; 180 degrees covers a half circle. (Rain bird CD-ROM: What is an Irrigation System?: Components)

Atmospheric Vacuum Breaker (AVB): Least expensive type of backflow preventer. One must be installed downstream from every control valve; AVB's cannot remain continuously pressurized. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Backflow Preventer: A device that prevents contaminated water from being sucked back into the water source should a reverse flow situation occur. (This happens more often than you realize). In most places backflow preventers are required by law on all irrigation systems. Back flow preventers are assemblies consisting of two check valves and two shut off valves. They are generally installed on the mainline upstream from the control valves.
(http://search.globalspec.com/ProductFinder/FindProducts?query=Check%20Valves)

Booster Pump: A device to increase the water pressure in a system where some pressure already exists. For example, if water comes from a water company at 40 PSI of pressure but you need 80 PSI of pressure for the irrigation system, you would use a booster pump to increase the pressure.

Check valves: Mechanical valves that permit gases and liquids to flow in only one direction, preventing process flow from reversing. They are classified as one-way directional valves. Fluid flow in the desired direction opens the valve, while backflow forces the valve closed.
(http://search.globalspec.com/ProductFinder/FindProducts?query=Check%20Valves)

Diaphragm: The part of the valve that controls water flow. When the diaphragm is raised, the sprinklers in that zone emit water. When the diaphragm is lowered, the

sprinklers in that zone stop emitting water. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Dynamic pressure: The pressure at a given point in an irrigation system with water flowing. (Rain bird CD-ROM: What is an Irrigation System: Components)

Electromechanical controller: A controller that uses motors and gears, and is usually programmed by pushing in pins on a dial. (Rain bird CD-ROM: What is an Irrigation System?: Controllers)

Electronic controller: A controller that uses a microprocessor and has a display. (Rain bird CD-ROM: What is an Irrigation System?: Controllers)

Emergency Shut-off Valve (Master Valve): A manual valve located on the irrigation main that turns the system's water on or off if the system needs to be repaired. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Emitter: A term used with drip irrigation. The emitter, or dripper, is a small device that controls the flow going to the soil. Emitters come in many different flow rates and styles.

External bleed: A feature which allows an automatic valve to be opened manually (without controller) by releasing water from above the diaphragm to the outside of the valve. Useful during installation, system start-up and maintenance operations.

Fittings: Fittings attach pipes with other irrigation components. They can be made of plastic, brass, steel and may be threaded, glued, or soldered to the lateral pipes.

Field Wires: Waterproof wires used to connect a controller to its valves (Rain bird CD-ROM: What is an Irrigation System?: Intro to Valves)

Fixed Riser: A fixed riser is a pipe that connects the sprinkler head to the pipe underground. They should only be used in areas where foot traffic is not an issue because the pipe remains above ground whether or not the sprinkler is emitting water. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Flow control: A valve component that allows adjustment of the outlet water flow and pressure by controlling how far a valve will open. (Rain bird CD-ROM: What is an Irrigation System?: Valves).

Flow control handle : Lets you adjust the outlet water flow and pressure by controlling how high the diaphragm can rise. (Rain bird CD-ROM: What is an Irrigation System?: Valves).

Globe Valve: A type of valve in which the inlet and outlet openings form a straight line. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Globe/Angle Valve: A valve in which water either flows straight through the valve (Globe valve) or at a 90 degree angle (Angle Valve). The unused port is plugged. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Head to Head: In irrigation "head to head" refers to the situation where sprinklers are spaced so that the water from one sprinkler throws all the way to the next sprinkler. Most sprinklers are designed to give the best performance when head to head spacing is used.

Hydro-Zone: An area of an irrigation system where all the factors that influence the watering schedule are similar. Typical factors to be considered would be the type of plants, the precipitation rate of sprinklers or emitters, solar radiation, wind, soil type, and slope. See the related term "valve zone".

Impact rotors: Rotors that are driven by the force of water hitting a spring-loaded "arm", causing it to impact the sprinkler body and rotate slightly upon each impact. (Rain bird CD-ROM: What is an Irrigation System?: Rotors).

Inlet Port: The part of the valve where water flows in from the mainline. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Internal bleed: A feature which allows an automatic valve to be opened manually (without controller) by releasing water from above the diaphragm to the downstream side of the valve internally. Useful during installation, system start-up, and maintenance operations when it is undesirable for water to escape into the valve box. (Rain bird CD-ROM: What is an Irrigation System: Valves).

Isolation Valve: A valve used for isolating all or part of the irrigation system for repairs, maintenance, or winter shut-down (winterization). Common types of isolation valves are the ball valve, butterfly valve and the gate valve.

Lateral pipe: The name given to the pipes which go from the control valves to the sprinklers or drip emitter tubes. Lateral pipes on residential sites generally range from 3/4"' to 2"; lateral pipes will generally be larger on commercial sites.

Lower Chamber: The part of the valve that connects to the outlet port. When the diaphragm is raised, water flows from the upper chamber to the lower chamber and out the outlet port into the lateral pipes. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Mainline: The pipe that brings pressurized water from the property's service line to the irrigation system. An irrigation main is usually continuously pressured and therefore needs to be composed of a pipe that is thicker and stronger than the pipe used for lateral lines. It runs from the point of connection to the control valves. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Matched Precipitation Rotators (MP rotators): A multi-stream rotor the size of a spray nozzle. It fits any conventional spray head body or shrub adapter, transforming it into a high uniformity, low application rate sprinkler with matched precipitation, even after arc and radius adjustment. The MP Rotator's low application rate helps to significantly control runoff on slopes and tight soils. (http://www.mprotator.com/) Many cities offer rebates for MP rotators.

Nipples: Short pieces of pipes that are threaded on both ends that connect the sprinkler heads to the lateral pipes. (Rain bird CD-ROM, What is an Irrigation System?: Irrigation Components).

Nozzle: The part of a sprinkler that the water comes out of. Usually a very carefully engineered part to assure a good spray pattern. In most cases the nozzle is removable so that it can be easily cleaned or replaced. With plastic nozzles replacement is generally preferred over cleaning as small scratches in the plastic can cause big problems with water distribution uniformity. Available in many different spray patterns and throw radii. Spray head nozzles contain: orifice(s), filter screen, radius adjustment screw

Nozzle Trajectory: The angle at which water leaves the nozzle, relative to the ground. Low trajectory nozzles are useful in areas of high wind or with large slopes. (Rain bird CD-ROM: Intro to spray heads)

Orifice: The opening in the nozzle where the water actually comes out. Sprinkler head nozzles can have one orifice or several orifices. (Rain bird CD-ROM: Intro to spray heads)

Outlet port: The downstream side of the valve where water flows out to the lateral pipes. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Pilot Plunger: The part of the valve, that when activated, raises to allow the water to escape from above diaphragm. When it is not activated, it remains lowered and traps water above the diaphragm. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Point of Connection (POC): The place where the irrigation main taps into the property main's water source. The POC can connect to a service line, well, pond or other type of water source. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Polyethylene (poly) pipes: Usually black and are much more flexible than PVC pipes. Poly pipes are connected using barbed fittings and clamps and do not require glue. Poly pipe is often used in places that have rocky soil because of its flexibility. It is also used in areas with harsh winters because it resists freezing better than PVC. Poly pipe is usually rated by water pressure. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Polyvinylchloride (PVC) pipes: Usually white or gray and semi-rigid. Most PVC pipes are connected using PVC fittings that are glued on. PVC pipe is rated in by the pipe's width and the pipe's operating pressure. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Pop-Up Sprinkler Head: A sprinkler head that retracts below ground level when it is not operating. Both sprays and rotors are available in pop-up heads.

Precipitation Rate: A measurement of water application. The measurement is given in the depth of water applied to the soil. In other words the depth that the water would be if it didn't run-off or soak into the soil. In the USA precipitation rate is measured in inches per hour. In metric countries it is measured in millimeters per hour.

Pressure Gauge: A device used to measure water pressure. The best pressure gauges are "liquid filled", however most cheap gauges work well enough for irrigation use. If you do use a cheap gauge, don't leave it connected to the water pipe. The constant pressure will ruin it.

Pressure Reducing Valves: Provide a steady pressure into a system that operates at a lower pressure than the supply system. A reducing valve can normally be set for any desired downstream pressure within the design limits of the valve. Once the valve is set, the reduced pressure will be maintained regardless of changes in supply pressure (as long as the supply pressure is at least as high as the reduced pressure desired). (http://www.tpub.com/content/engine/14105/css/14105_96.htm)

Pressurized Vacuum Breaker (PVB): Similar to an AVB, but only one needs to be installed on the irrigation main; it can remain constantly pressurized. (Rain bird CD-ROM: What is an Irrigation System?: Components).

PSI: Pounds per square inch

Radius Adjustment Screw: Allows the radius of a head to be reduced by up to 25 %. (If reduced more than 25% an irregular water pattern will result) The radius adjustment screw on a spray head can be turned with a flat blade screwdriver. Turning the screw to the right reduces the throw radius while turning the screw to the left yields the maximum throw radius

Radius of Throw: The distance a sprinkler throws water. (Rain bird CD-ROM, What is an Irrigation System?: Irrigation Components).

Reduced Pressure Backflow Preventer: A very effective type of backflow preventer that is used for commercial and high-hazard sites. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Riser: The connection between a sprinkler or other irrigation device and the pipe that supplies the water to it

Rotor: Type of sprinkler that rotates as it emits water. Most rotors have separate part circle or full circle models. Full circle models do not have adjustable arcs. Part circle models generally have adjustable arcs (between 20 and 360 degrees). Rotors operate optimally between 50 and 80 psi and are used to water large areas because the radius of throw is between 15 and 150 ft. Rotors have a lower precipitation rate than sprays. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Seal-A-Matic (SAM): Feature available for Rain bird heads. It is an in stem check-valve that prevents drainage from sprinkler heads at low points of the irrigation system. (Rain bird CD-ROM: Intro to spray heads)

Solenoid: The part of the valve that controls the pilot plunger. When the solenoid receives an electrical signal from the controller, it activates the pilot plunger to raise

Service Line: The water pipe that connects the water main to the property. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Spray head: A type of sprinkler that sprays a fixed sheet or stream of water without rotating; often referred to as a "pop-up" or "fixed spray head." Spray heads operate optimally at 30 psi (in-between 20-40 is ok) and are used to water small areas because the radius of throw is between 5 and 22 ft. Spray heads have a higher precipitation rate than rotors. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Spring: The coiled metal device that retracts a sprinkler head or helps a hydraulic valve close.

Square Spacing: The term given to a sprinkler head layout pattern where the sprinklers, when viewed from above, appear as more or less a square with one sprinkler in each corner. See also the more efficient "triangle spacing".

Swing Joint: A flexible connector used to attach sprinklers to lateral pipes. Traditional fittings are inflexible and if they are used to connect the sprinkler to the lateral pipes problems could arise. If the sprinkler heads are run over by maintenance equipment or if they are stepped on, then the pressure will break the lateral pipe; swing joints allow the sprinkler and connecting fittings to flex rather than break. Swing joints also make it easier to adjust the height of the sprinkler head when trying to make the head flush with the ground. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Triangle Spacing: The term given to a sprinkler head layout pattern where the sprinklers, when viewed from above, appear as a more or less equilateral triangle with one sprinkler in each corner. Triangular spacing results in the most uniform and efficient water application using sprinklers.

Upper Chamber: The part of the valve the traps water and applies pressure to the diaphragm, keeping the valve closed. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Valve: A device that opens and closes to allow pressurized water to flow through. (Rain bird CD-ROM: What is an Irrigation System?: Components).

Valve boxes: Used to conceal and protect the valves, fittings, wiring and manifolds that comprise an irrigation system by housing those components within an underground box. They are also a very efficient way to maintain those components.

Valve circuit: A single valve and all the pipe, fittings and sprinkler heads downstream from it.

Valve Zone: An area where the irrigation is all controlled by a single control valve. Each valve zone should be within only one hydro-zone

Variable Arc Nozzles (VAN's): Nozzles that can be adjusted to spray in a full circle or a partial circle. Useful in odd-shaped areas. (Rain bird CD-ROM: Intro to spray heads)

Water Budget: A controller programming feature that lets you change your usual station run times without resetting each station. One hundred percent equals the normal programmed watering time. On most Rain Bird controllers you can set the water budget from 0% to 300%. (What is an Irrigation System?: Glossary)

Water hammer: A shock wave created by a fast closing valve. Also referred to as surge of pressure. (What is an Irrigation System?: Glossary)

Water meter: Device that measures the amount of water flowing from the water main to the service line on a property. (What is an Irrigation System?: Glossary)

Wiper Seal: This is a soft plastic seal around the pop-up riser stem that seals the riser so it won't leak. The wiper seal also is responsible for keeping dirt out of the sprinkler body, and is the most important part in determining how long the sprinkler will last.

***All information was derived from Jess Stryker's irrigation glossary unless otherwise noted. http://www.irrigationtutorials.com/glossary.htm March 2006

Appendix B: Common Problems and General Recommendations*

**Solutions are described in the italicized paragraphs*

Misting:

- It is inefficient when heads are emitting mist because the water can easily be blown away or the mist may end up evaporating. As a result, watering times must be increased because a large portion of the water emitted does not actually reach the turf. When heads are consistently under too high of pressure, it will cause them to wear out prematurely. If heads are misting, a pressure reducer should be installed.

- *The pressure reducer can be installed in three different places. If the pressure needs to be reduced for the entire system, then a pressure reducer should go on the pipe feeding the sprinkler system. If the pressure does not need to be reduced for the entire system, but still needs to be reduced for one or more zones, a pressure reducer can be installed in one of two places. Determining which of the two places the reducer should be installed on will depend on cost. If there are a lot of heads, it will most likely be more economical to install a pressure reducer on the valve for each zone needing a pressure reduction. However, if the zones needing lower pressure only have a few heads, it may be more economical simply to install pressure reducing stems on each head within those zones.*

Tilted and sunken heads:

- Over time heads tend to sink and tilt due to the natural settling of the earth, as well as wear and tear from foot traffic and lawn maintenance. These heads, though still operational, are either not spraying water onto the turf or are spraying in an undesirable pattern. These are seemingly minor issues, but actually have the potential to greatly reduce the efficiency of the system. In many cases, it results in severe alteration of the spray pattern for that sprinkler head and can result in brown spots, misting, and wasted water. These problems are relatively inexpensive and easy to fix and once it is addressed, can increase the system's efficiency dramatically.

- *To fix the problem of sunken and/or tilted heads, the head will most likely have to be dug out and manually lifted and/or straightened by placing soil around the head. If the sprinkler system was installed correctly, a swing joint should attach the sprinkler heads to the lateral line. Swing joints are flexible pieces of pipe that allow the sprinkler head to be slightly moved without damaging the lateral line.*

Non-uniform heads:

- A mixed zone refers to a zone that has multiple types of sprinkler heads on one zone (i.e. rotor, spray, or drip) Fixed spray heads are designed to emit an average of 50% more water than rotor heads. Since watering times can only be controlled zone by zone and not by individual heads, the areas being watered by fixed sprays will be receiving an average of 50% more water than the areas being watered by rotors. The optimal operating pressure levels for fixed sprays versus rotors are very different. Fixed spray heads are designed to operate best between 20 and 30 psi, while rotors are designed to operate best between 40 and 70 psi. Therefore, if the time and pressure is correct for one type of head, it will inherently be wrong for the other type of head. For the above reasons, sprays and rotors should never be located on the same zone. A direct result of this type of design is turf that has spots of overly wet and/or overly dry areas.

- Each rotor type/brand is manufactured to have a different precipitation rate as well as a different oscillating speed. Therefore, it is inefficient to have different types of rotors on the same zone.

- Drip irrigation should never be attached to a zone containing different types of sprinkler heads (i.e. rotor or spray heads) This is an extremely inefficient design that has the potential to create serious problems. As noted above, sprays and rotors have different precipitation rates and are also designed to operate at different pressure levels. Similarly, drip lines are designed not only to have different precipitation rates and different operational pressure levels than sprays and rotors, but are also designed specifically to water non-turf material. The precipitation rate for sprays and rotors is significantly higher than for drip system and is measured in gallons per minute versus gallons per hour for drip. Therefore, zones with rotors and sprays usually run for shorter periods of time. Conversely, it is not abnormal for a drip system to run for one to two hours at a time. Also, turf only needs to be watered two to three times a week, while many plants need to be watered every day. Therefore, if they are being controlled by the same zone, either the watering schedule for the turf or the watering schedule for the plants will be incorrect. Additionally, the desired pressure level for sprays is between 20-30 psi and the desired pressure level for rotors is between 40-70 psi. Drip systems on the other hand, should operate at a maximum of 20 psi. When a drip system is operating at too high of pressure, it will result in the emitters being continually blown off and will also result in the system prematurely wearing out. The zones containing both rotors/sprays and drip should be broken up so that each zone would contain either all drip or all rotors/sprays.

- *Generally, switching the type of head will necessitate either adding additional heads or removing existing heads; this has the potential to greatly influence the entire irrigation system design. A certified irrigation professional should be consulted and/or utilized when addressing these types of problems.*

Poor spacing

- Heads that are spaced too far apart cannot get adequate head to head coverage. Head to head coverage is when the spray from one head reaches the heads next to it and visa versa, which ensures a uniformly green landscape.

- *The nozzles may need to be changed, additional heads may need to be added, or the spacing of heads may need to be altered. Replacing the nozzles will only be effective if sufficient pressure is available. It is important not to cause overspray in one direction simply to reach a greater distanc in another direction. A certified irrigation professional should be consulted and/or utilized when either adding additional heads or changing the placement of existing heads.*

Inappropriate spray patterns

- If the arc* on a head is too wide, it leads to overspray onto undesired areas. If the arc is too narrow it leads to dry spots and poor coverage.

  *Arc refers to the horizontal spray pattern of a sprinkler head. For example, a head can have a 90 degree arc, 180 degree arc, 270 degree arc, etc.

- *Replace the nozzle with one that has the correct throw radius and arc. Variable arc nozzles can be helpful where a custom arc is needed. Variable Arc Nozzles should be avoided when not absolutely necessary. The spray patterns tend to be slightly irregular, taking away from uniformity. It is recommended to replace VAN's with standard fixed arc nozzles where appropriate. (Variable arc nozzles should be used on areas that have circular edges or irregular angles)*

- The screw on top of the sprinkler heads is designed to reduce the throw radius of the nozzle a maximum of 20%. When the radius reduction screw is used to reduce the radius more than 20%, it results in misting as well as an irregular spray pattern from the nozzle.

- *If the radius needs to be reduced by more than 20%, it is better to replace the current nozzle with one that has a smaller radius rather than trying to reduce it using the radius adjustment screw.*

Thatch and aeration

- Thatch is an interwoven mat of live and dead root and plant matter found under the grass, but above the soil. Thatch is hydrophobic, which makes it difficult for water to penetrate the soil, thus causing run-off.

- *Thatch should occasionally be removed to allow healthy turf growth. It is recommended that de-thatching using a power rake and/or aerating be performed in late fall and/or early spring when turf grass is dormant.*

Check valves

- After a system is turned off, water often continues to run out of lower elevation heads. This is simply because the water left in the system is draining. It is possible to prevent this by installing heads that have check valves. Not only will this eliminate the loss of water from the system after it has been turned off, but it will also prevent excess wear on the system's pipes, which results from air being pushed through the pipes at the beginning of each watering.

- *There are several types and brands of heads that can be purchased with pre-installed check valves. The existing heads without check valves can either be replaced with new heads that already contain check valves, or depending on the type and brand of head, a check valve may be retrofitted into the existing head.*

Clogged Nozzles

- Clogged nozzles can easily occur over time (particularly in spray heads). It is important for each sprinkler head to have the correct filter in place in order to prevent the head from clogging. If a nozzle is clogged, the result will most likely be an irregular spray pattern.

- *To unclog the nozzle, unscrew the cap (the cap houses the nozzle) and clean it out. When the cap is off, check inside the sprinkler head riser to make sure that a filter is present. If there is a filter, take it out of the sprinkler and clean it out. If there is not a filter, purchase the corresponding filter and place it in the sprinkler head riser. After this has been accomplished, screw the cap back on and make sure that the sprinkler is aligned properly.*

General Recommendations

- Align sprinkler heads in such a way that the end of the spray of one head reaches the next head. This head-to-head pattern creates "double coverage," increasing efficiency and ensuring a more consistently green turf.

- Space heads evenly to apply water efficiently. For example, heads that spray an eight-foot radius should be spaced a **maximum** of eight feet apart. Uneven spacing lowers the efficiency and doesn't allow for the double coverage mentioned above.

- Check heads for correct spray pattern. Spray patterns should match physical characteristics of site, such that patterns do not spray concrete, asphalt, fences, or buildings.

- Repair or replace sunken, tilted, broken, or clogged heads to improve the distribution uniformity. Such problems are relatively easy to fix and greatly improve the efficiency of a zone when repaired.

- Match precipitation rates of each rotor head within a zone to avoid over or under watering. Quarter-turn heads should emit half the amount of water as half-circle heads. Likewise, a full-circle head should emit double the amount of water as a half-circle head. For example, if the corner heads in a square area deliver 2 gallons of water per minute, the heads along the edges of the square should deliver 4 gallons of water per minute, and the full head in the center should deliver 8 gallons of water per minute. If all heads are delivering the same volume of water, the center area won't receive enough water while the corners will get too much.

- Replace irrigation heads within a zone so that all heads are of the same type (i.e. same brand, same type, same model).

- Address incorrect pressure levels if necessary.

- Install check valves where appropriate

- It is <u>not</u> recommend to remove mature trees and shrubs. Where possible, trees, bushes and plants should be pruned and trimmed to allow the sprinkler heads to function properly. In some instances where pruning may not be feasible, it is recommended to relocate the affected sprinkler heads.

- The majority of drip systems are not visible, which makes visual inspections difficult to utilize. However, the moisture levels of the plants should be checked on a regular basis to make sure that they are receiving the appropriate amount of water. Oftentimes, plants that are receiving too much water look similar to plants that are not receiving enough water, so a visual check is not always sufficient. Also, make sure emitters are in beneficial locations and that the capacity of the drip line is not being exceeded by the number and caliber of emitters. Check precipitation rates for emitters to see that they match the needs of the plants.

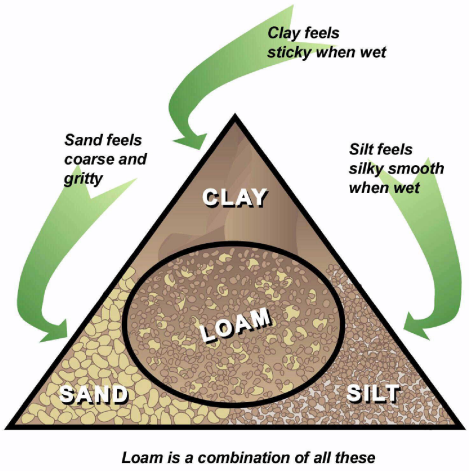
- Aerate or de-thatch your lawn regularly

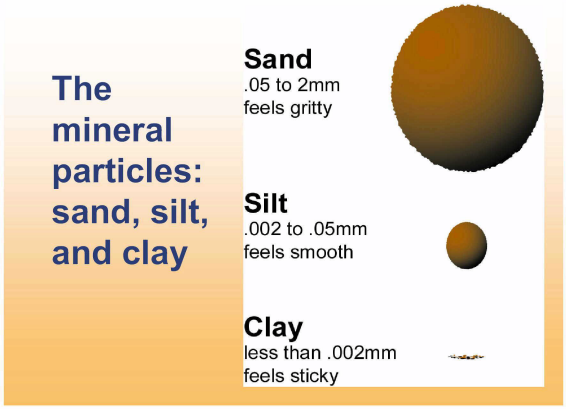
- Most control clocks have batteries in them for backup in case of power outages. It is recommended that batteries be replaced once a year.

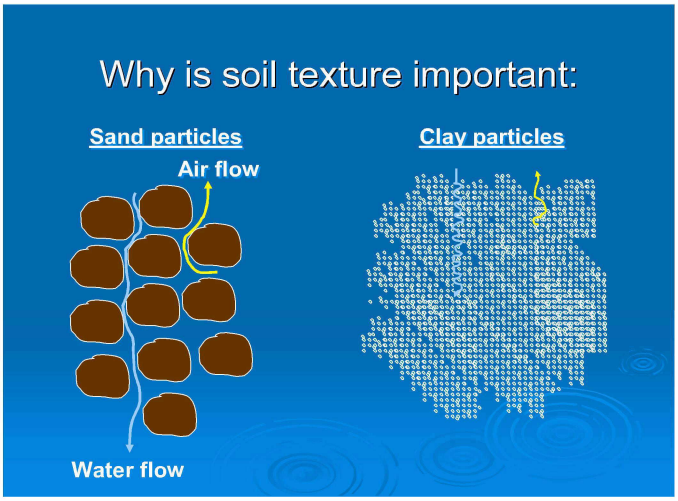
- Replace turf, where appropriate, with hardscape or water-conserving plants.

– Always try to use the services of a certified irrigation professional to ensure quality work.

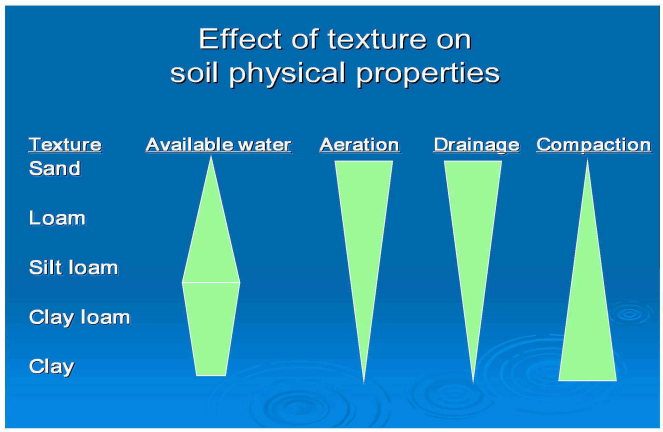
Appendix C: Soil Characteristics







As demonstrated, the clay particles are much more compact than the sand particles, making it more difficult for water and air to flow through the clay soil. As a result, water will take significantly longer to penetrate the clay soil versus the sandy soil.



This diagram profiles each soil type to demonstrate how soil texture influences important factors such as: available water, aeration, drainage, and compaction.

Appendix D: Irrigation Scheduling

Watering Grass in a Drought Year

How Long to Water

Based on Soil Texture

Time Required To apply 1/2 Inch of Water

Precipitation Rate (Inches Per Hour)	**Clay Soils** (Cycles) **x Minutes**	**Loam Soils** (Cycles) **x minutes**	**Sandy Soils minutes**
4.0	(3) **3**	(2) **4**	**8**
3.5	(3) **3**	(2) **5**	**9**
3.0	(3) **3**	(2) **5**	**10**
2.5	(3) **4**	(2) **5**	**12**
2.0	(3) **5**	(2) **7**	**15**
1.5	(3) **7**	20	**20**
1.4	(3) **7**	21	**22**
1.3	(3) **8**	23	**24**
1.2	(3) **8**	25	**25**
1.1	(3) **9**	27	**27**
1.0	(3) **10**	30	**30**
0.9	(3) **12**	33	**35**
0.8	(3) **14**	37	**40**
0.7	(3) **15**	43	**45**
0.6	(3) **17**	50	**50**
0.5	(3) **20**	60	**60**
0.4	(3) **25**	75	**75**
0.3	(2) **50**	100	**100**
0.2	(2) **75**	150	**150**

Tune up your sprinkler system to 70% efficiency. Stop water from running into the storm drain.

Each time you water, apply about 1/2 inch of water that penetrates the soil at least 8 inches deep.

Learn to adjust the timer (controller) on a monthly basis for the correct interval.

Do not water everyday-- this keeps the turf root zone shallow.

Do not water the landscape from 10a.m. until 6 p.m. because of the increased evaporation during the hottest part of the day.

How Often to Water		
Month	**x per week**	**Minutes pending on Precipitation Rate**
April	**Spring**	
May	**1.5**	
June	**2**	
July	**2***	
August	**2***	
September	**1**	

***In the July and August months, x per week can increase to 3 times in a non-drought year.**

Appendix E: Homeowner Form

1702 Walnut St.
Boulder, CO.
80302
303.441.3278

Irrigation Inspections

A landscape Irrigation Inspection is a series of tests performed on your watering system to determine how much water your system puts out (precipitation rate), the soil infiltration rate (absorption), and the evenness (distribution uniformity or efficiency) of the water application.

Tune Up Your System

You can tune up your system by fixing the maintenance problems identified in a visual inspection. Turn the system on at least once a month and watch each zone run to make sure the system is working properly. Check for broken, tilted, clogged, or blocked heads and make any needed repairs. Take the time to adjust sprinklers that are not covering the desired area and learn how to change your timer.

Root Depth

For a healthy lawn, roots should be 6 to 12 inches deep. This is accomplished by deep infrequent watering that greatly enhances your lawns ability to withstand extreme temperatures and increased intervals between watering.

Your root system is about _____ inches deep.

Water Infiltration Rate

Many times irrigation systems apply water faster than the soil can absorb. It is important to know your soil type and adjust your watering to minimize run-off. Slope and thatch also affect run-off.
Soil Type_____, Slope _____

Precipitation Rate

Precipitation rate (PR) is a measure of how many inches of water per hour your irrigation system is applying. Different head types have different precipitation rates. The precipitation rate determines how long you need to run your sprinklers.
Your precipitation rate is _____inches/hour (fixed), _____inches/hour (rotor).

Distribution Uniformity

The distribution uniformity (DU) is a measurement of an irrigation system's ability to apply water uniformly over the surface of a landscape. Since the amount of water put out by an irrigation system is not completely uniform, some parts of the landscape will receive more water than others. Minor adjustments to most systems can improve distribution uniformity and green up the dry spots.

Your Distribution Uniformity is _____***% Fixed*** _____***% Rotor***.

Water Pressure

Most sprinkler heads apply water more efficiently at a water pressure between 30 (fixed pop-up heads) and 50 (rotor heads) pounds per square inch (psi). Sprinklers can't cover the desired area if the pressure is either too low or too high. If your pressure is low, try watering when less people are watering or modify your system so there are fewer sprinklers on each valve. High pressure causes misting and wears out your sprinklers faster. If your pressure is high, pressure regulating heads or a pressure regulator can be installed to lower pressure, minimize misting, and maximize irrigation efficiency.

Your Sprinkler head pressure is fixed _____*psi., rotor:*_____*psi.*

Evapotranspiration

Evapotranspiration (ET) is one of the most important things to consider when scheduling run times for your irrigation system. ET is a conversion of water from liquid to vapor and is the amount of water needed for the plant to survive. This is a simple concept that may help conserve water.

Irrigation Scheduling

The following schedule has been completed based upon your soil type, distribution uniformity precipitation rate and estimated evapotranspiration. It is meant to serve as a guide --- keep an eye on your lawn and make adjustments as needed.

Short cycle watering is important in heavy soils, slopes, or when sprinklers have a high precipitation rate. Run through all zones at one-half or one-third the total time needed then re-run the zones again by adding additional start times. This will help prevent puddling and runoff.

Recommended Watering Schedule

This schedule can be used during non-restrictive years.

SPRAY ZONE:

Month	Times/week	Cycles	Minutes	Total Minutes per watering	Total Minutes per week
May	1.5				
June	2				
July	2				
August	2				
September	1				

ROTOR ZONE:

Month	Times/week	Cycles	Minutes	Total Minutes per watering	Total Minutes per week
May	1.5				
June	2				
July	2				
August	2				
September	1				

Appendix F: Additional Resources

DRIP TIPS

FOR DRIP IRRIGATION INSTALLATION
BY LAURENCE BUDD, CLT, CLIA. AKA "DR. DRIP"
ALLISON IRRIGATION, FT. COLLINS, 970-490-1080,
WWW.XERISCAPE.NET

FIRST, THE GOLDEN RULES OF DRIP:

Any drip system must have a filter and pressure reducer

One drip line can have many different types and sizes of emitters for different plant types.

The most common problem is too much water! Don't rely on visual- stick your hand in the soil!

A drip line can be changed easily, emitters added, exchanged, or removed.

All drip is measured in Gallons Per Hour (GPH). Lawn sprinklers are measured in Gallons Per Minute (GPM)- be careful!

There is a finite amount of water in a drip line: a ½ inch line has 150 Gallons Per Hour (GPH); a ¾ inch line has 450 GPH. You can't cheat the laws of physics. We recommend using 3/4 inch tubing.

Plan your zones before installation to avoid placing too many emitters per zone.

When using mini sprayers, use ones with large droplets, never "misty" sprayers. Water the ground, not the air.
Distance- Try to keep any one drip line to 200-300 feet max. Add more zones as needed.

INSTALLATION TIPS:

Install lines above weed fabric, stapled down, below mulch, or buried.

Snake the line through a bed, not in a straight line. Do not kink the line. If you do kink it, work it out, or cut and add a coupler or elbow

Plan for future expansion, spur lines are easily added later.

Drip systems controlled by automatic valves and timers do best, plants do better with a regular watering schedule

Don't worry about line freeze- drip lines above ground do not freezebreak. However, the timer, reducer and filter CAN freezebreak. Take them inside for the winter.

Use good quality components and keep it simple.

Plan for high traffic areas; kids, pets, public places.
If dirt gets in the line, take off the end caps and flush the line before running again

BEST COMPONENTS (by our testing):

Tubing: Toro (irritrol) blue stripe drip tubing, ½ and ¾ inch. Vinyl 1/4" spaghetti tubing.
Connectors: Tees, elbows, endcaps, etc.: Agrifim (gray and black)
Emitters: Netafim PC emitters, in 1/2, 1,2,4, 8, 12, 24 GPH, or Rainbird emitters
Emitter line: Netafim Techline or Mini Techline, 6 or 12 inch spacing.
Mini bubblers and sprayers: Antelco spectrum "shrubblers", in various patterns
Sprayers: Antelco varijets and vari rotors (spinners).
Hose timers: Melnor and DIG timers

COMMON APPLICATION RATES FOR THE FRONT RANGE OF COLORADO:

Most installers run drip zones 3 or 4 times per week, 30 to 40 minutes per watering during Summer months. The goal is to provide even amounts of moisture but not drown the plant. [Some desert plants like infrequent water, such as pinon and cactus. These should be on a separate system or handwatered.]
A typical xeric one gallon perennial is set to receive approx. ½ to 1 GPH, or 1-2 gallons per week.
A typical 5 gallon shrub, such as lilac, is set for 4 GPH, or 8 gallons per week
A typical large shrub is set for 4-10 GPH, or 10-20 gal. per week.
A typical tree is set for 10 gal. per week per caliper inch. So, a 4" tree would be set for 40 gal. per week, at 10-20 GPH.

You now know more facts about drip irrigation than most installers. Please tell your friends and neighbors. Given our watershed and population, we must all learn to manage our water use.

Fun facts: A typical full circle irrigation pivot, watering corn, can use 650,000 gallons per 24 hours; 3 times what a typical Colorado household uses per year.
According to NCWCD, approx. 90% of all fresh water in the front Range is used for AG, 10% for cities. Colorado lags far behind other Western states in the use of drip for crops, and, most irrigation ditches in Colorado are unlined, allowing 50% of the water to seep out enroute. Lining those ditches would save an amazing amount of water.
Water is Colorado's gold.

Sustainable Landscaping Information

A sustainable landscape is designed to be attractive and in balance with the local climate and environment. It requires minimal resource inputs such as fertilizers, pesticides, and water. Some aspects of sustainable landscaping and information sources are listed below.

Composting is the process of decomposing wastes such as grass, leaves, and food scraps to make a rich soil amendment that will improve soil quality.

- Workshops and Master Composter Training

www.co.boulder.co.us/recycling/compost/comphome.htm

- Composting Fact Sheet

www.ext.colostate.edu/pubs/garden/07212.html

Fertilization should be based on soil analysis and the growth phase of the turf or garden. Slow-release fertilizers minimize runoff of nutrients to waterways.

- Fact Sheet on Fertilizing the Organic Garden

http://www.ext.colostate.edu/drought/fertilize.html

Grasscycling is the practice of leaving grass clippings on the lawn when mowing. It returns valuable nutrients to the soil.

- Mowing tips, mower types, and other information

www.co.boulder.co.us/recycling/grasscycle/grashome.htm

Integrated Pest Management (IPM) focuses on long-term prevention or reduction of weeds and insect pests using (in order of preference) cultural, mechanical, biological, and chemical controls, and emphasizing the most environmentally sound approach.

- Fact Sheet on IPM

http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=1287&Itemid=406

Plant Selection involves choosing plants suited to our climate which need less water and are less prone to diseases and pests.

- Colorado Native Plant Society

www.conps.org

- Colorado Plant Select® Program

http://plantselect.org/

Turf area should be minimized based on recreations needs of the property. Drought-tolerant, slow growth turf should be used for all turf areas.

- Lawn care info and links to turf resources

http://csuturf.colostate.edu

Watering and Irrigation

Colorado is subject to drought, as we have experienced beginning in 2002. Use water wisely!

- Water-saving irrigation and drought management

www.watersaver.org

- Waterwise Tips for Colorado Landscapes

www.greenco.org

Xeriscape is water-conserving landscaping.

- Xeriscape Colorado

www.xeriscape.org

- Boulder Energy Conservation Center Xeriscape Workshops

www.conservationcenter.org or 303-441-3278

General Sustainable Landscaping Resources

Colorado State University Cooperative Extension offers fact sheets on a wide range of gardening topics, including plants for mountain communities. Master Gardener volunteers are available to answer questions and provide information.
www.coopext.colostate.edu/boulder or 303-678-6388

Green Industries of Colorado (GreenCo) is an alliance of nine landscape-related trade associations. They offer extensive information on water use and an on-line manual of Best Management Practices.
www.greenco.org

Partners for A Clean Environment (PACE) provides training in sustainable landscaping and a list of landscapers who have completed the training.
www.pacepartners.com or 303-786-PACE

Plant*talk* Colorado™ is a 24-hour toll-free automated phone service for information on horticultural topics.
www.planttalk.org or 1-888-666-3063

Colorado State University Cooperative Extension

Putting Knowledge to Work

www.irrigation.org

Locate a certified irrigation specialist
Learn what to look for when choosing a specialist
Receive tips on efficient irrigation.

Address: The Irrigation Association
6540 Arlington Boulevard
Falls Church, VA 22042-6638
USA

Telephone: +1-703-536-7080

Fax: +1-703-536-7019

Appendix G: Media Publications

- **Colorado Water Wise Council Newsletter**
- **The Golden Transcript**
- **9News Website (interview with Aurora Water official)**
- **9 News (TV spot) with follow-up story on website**
- **Daily Camera (front page with picture)**