LANDSCAPE IRRIGATION AUDITING:

A MOBILE LABORATORY APPROACH FOR SMALL COMMUNITIES[1]

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INTRODUCTION

Landscape irrigation is one of the first water resource uses to be affected by designated drought or water restriction conditions. Odd/even watering (based on the last digit of an address), time periods of allowable water use (such as no outside watering between 10 a.m. and 6:00 p.m.), and complete outside water use restrictions are logical approaches that communities have used to help manage limited water resources. In large cities, personnel and funds may be allocated to help encourage improved approaches to outside water use. However, many small communities lack the funds to hire personnel to help with their outside water management and must revert to "system-wide bans". Obviously, outside watering bans have a direct and long-term potential impact on some of our most dynamic and thriving industries: landscape plant nurseries and turf/sod farms.

The opportunity to tap the extensive information and technology alternatives for urban landscapes and landscape irrigation, package this information in a comprehensive program that is oriented toward small communities, and then determine the best approaches to present this information, provide a foundation for a good rural extension program.

Landscape irrigation is notoriously inefficient because irrigation systems can rarely be designed, installed, and maintained at the highest level attainable (unless available funds are not limited and the owner is very conscientious and knowledgeable).

The information provided in this paper is not new. In fact, any community that is interested in improving their landscape irrigation can find good resources to help manage their landscape water use, if they are willing to take the time and investigate alternatives. Unfortunately, many small and large communities may not be using the resources that are available. A large percentage of homeowners and business owners are unfamiliar with current landscape irrigation technologies. The need to provide a mechanism for direct investigation and education about good landscape irrigation practices is real. This paper presents an approach that could be implemented by

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extension service personnel or other groups for improving landscape irrigation efficiency, with direct alternatives that can potentially save water. Most of the ideas presented are being tested in South Georgia. Since Georgia is in the humid region, precipitation is an essential component of the water used by landscapes. In most years, precipitation is sufficient to supplement the irrigation required for landscape areas. Landscape irrigation is extensively used to keep turf green and provide supplemental water to landscape plants. For most areas, little effort has been spent to ensure "sustainable landscapes" or to maintain an efficient irrigation system. Within the past four years, drought conditions have caused severe water shortages across the state. In 2001, outside watering restrictions were implemented state-wide for the very first time. These restrictions remain in effect for the majority of the state. For many communities with limited water supplies, their only alternative to meeting their water needs was to restrict outside watering (some were restricted 24 hours a day, seven days a week).

PROCEDURES

The steps indicated in this paper are those that are expected to be viable for Georgia communities. For areas where conditions are not similar, particular steps can be removed or changed to meet specific needs.

Overall Goal

The mobile laboratory approach was designed as a resource to small communities that could be moved into a community for a short period of time, do evaluations, make reports, and then move on to another community. The ability to have personnel "in a community" indicates the commitment of the sponsoring and funding organizations toward the needs of that community. The mobile laboratory approach (personnel and equipment) should logically be funded through some type of state appropriation. Specific recommendations that are tailored to a community can improve overall water use and provide incentive programs for the future.

Developing the Initial Team

For this particular effort (with a lack of substantial outside funding), it was essential to involve the County Extension Specialist from the community that is interested in water conservation. The knowledge of a local county extension specialist can include essential contacts and the potential for acceptance of the ideas (local politics). If a local extension specialist is unavailable, the Soil and Water Conservation Commission, Natural Resources Conservation Service, or a Rural Development Cooperative may be good alternatives. Having the mobile audit team in good communication with a local person is essential to "buy-in" and the potential for success of the effort. In addition, the participation of a local agency can create a local contact person who will be knowledgeable about landscape irrigation practices.

Approaching the Water System Purveyor

The organization that is involved in distributing the water to customers is an essential component to the success of a landscape auditing program. Since their direct revenues are usually associated with the amount of water being distributed, the idea of "reducing" that water is not always met with a positive reaction. It is important to assure the local water system purveyor that recommendations will include approaches to maintaining their economic viability while reducing overall water use.

Approaching the Water Users

If a community has separate water meters for outside landscape irrigation, it may be very easy to approach those who can benefit from irrigation conservation alternatives. In the pilot study in Coffee County, Georgia, that was the case. A letter was sent to each individual with an outside water meter indicating the opportunity to receive an audit of their landscape irrigation system. This letter contained information about the program, who was doing the activity, what would be expected of the participants, and what they would receive in return.

For each potential water user, their personal audit information was to be maintained as confidential. However, a community report would be created that consolidated information from all the individual reports. None of the information in that report was to be identified with any individual audit.

If a community does not have separate water meters for outside irrigation, the initial contact with potential participants is very critical and essential. A community- or county-based meeting is a recommended approach to initiate the audit program. This meeting would provide essential information about the audit process, why it will be important to consider water saving alternatives, and who would be involved in the audit program. Typical and innovative contact approaches (mass media) are essential to good participation in such meetings. "Incentives" could be provided by the water system purveyor to help encourage community attendance at the meeting. In this paper, "incentives" can be both positive and negative. We have encouraged positive approaches to participation, but the typical response of a community may require negative incentives. Examples of positive incentives for attending the first meeting include a small water rebate for a coming month, a coupon to be used with excessive future water bills, raingages to help determine water use. The raingages could be provided by a local irrigation dealer who is also interested in water conservation in landscape systems. Brochures about landscape water use, landscape planting (Xeriscaping, etc.) could also be available at this initial meeting. Potential negative incentives could be an added charge to a water bill if participants with outside irrigation do "not" attend the meeting.

UGA
WATER RESOURCES TEAM

Figure 1. Logo used on shirts for the water auditing program.

<u>The Audit</u>

After a time was scheduled for the team to meet the water user, the audit team visited the irrigation system directly. For our and the customer benefit, we developed a particular shirt to help identify our team members with the University of Georgia (UGA) and the water auditing effort (Figure 1). It was our perception that elderly and young women may be reluctant to visit with the audit team until they are confident of the groups identity. The logo was generic enough to allow other water-related programs at UGA to use the same shirts.

During the audit, the system was operated through each of the different zones. One member of the team recorded the zone information (sprinkler types, number of sprinklers, nozzles, areas covered, i.e., full circle and part circle) while another team member observed individual sprinklers on zones for off-site applications, other maintenance problems, and pressure conditions at near and far sprinklers. A third team member usually asked questions to the water user while recording information on the time clock. In most cases, digital pictures were obtained to help illustrate problems or good characteristics of the irrigation system.

Figure 2. Water team member visiting with a homeowner.

These images would be essential to helping explain particular characteristics to the water user in their report.

The water user was requested to be present during the audit (turn system on and answer questions, Figure 2). Many of the observed problems with the system could be discussed directly with the water user. In most cases, the water user was armed with sufficient information to make some initial changes for direct water saving and to improve water use efficiency, prior to submitting a formal report.

Figure 3. Installing catch-cups for a uniformity analysis at one of the audit sites.

<u>Uniformity Analysis</u>

A uniformity analysis was performed on a selected number of irrigation audit sites (Figure 3). The uniformity was of main concern for irrigation applications from rotating sprinklers in turf areas. If the water user indicated the presence of "wet" or "dry" spots during irrigation, a uniformity analysis was useful for visual and quantitative analysis of the problems. In most cases, a uniformity analysis was not required. The uniformity analysis included installing catch cups at ground level on a reasonable grid interval. More than one zone area may be required to water the uniformity area, but the purpose was to demonstrate to the water user whether water was being used wisely.

The computer program used for the uniformity analysis is available from the University of Georgia (Harrison, 2002). This uniformity analysis program provides the three basic uniformity calculations that are used most in analyzing irrigation systems: the Christiansen uniformity coefficient, low quarter, and Heerman-Hein equation (Keller and Bleisner, 1990; ASAE Standard, 1994), and is applicable to solid set and center pivot irrigation systems (landscape and agricultural applications). The Heerman-Hein equation is used only for center pivot irrigation system analysis. The three different uniformity calculations are provided because different groups like particular numbers.

<u>Reports</u>

An individual report was prepared for each audit site. This report contained general information that relates to most irrigation systems, as well as, specific information on the system being audited. For example, some water saving technologies were illustrated (rainfall cut-off switches). Particular off-site application or maintenance problems were also identified. Specific recommendations for the irrigation system (nozzle changes, time of application within a zone, etc.) were described for calculating direct water savings. These potential water savings were reported to the water user as a way to encourage changes in the system.

A community report was also prepared to illustrate the overall water savings that could be expected by instituting water saving alternatives. Most results were reported in percentages with direct reference to potential gallons saved during a period of time. The opportunity to save water was indicated in combination with alternatives to maintain income for the water purveyor. Incentive programs are essential to the potential buy-in by the water purveyor and the customers. Recommendations for nozzles to be available for retrofitting rotating sprinklers, raingages to help keep track of current conditions, and other water saving practices were provided in the community report.

RESULTS

The pilot study in the Douglas community in Coffee County Georgia was the initial location for implementing this mobile landscape auditing program. Douglas is located at about 31º 31' N and 82º 50' W in South Georgia. Ground water is the primary source for the drinking and landscape water supply. Water is supplied from Upper Floridan aquifer wells with pumps located about 35 m from the ground surface. Douglas has about 186 meters on outside watering systems. Total city water use to household water uses (excluding industry) is about 2 million gallons per day (mgd). The city of Douglas uses a block rate structure for their water users (Table 1). The current block rate structure does not specifically encourage water savings since the cost per 1,000 gal. decreases with increased gallons used. Most water users with operating irrigation systems would be in blocks 3 or 4, depending on the lot size (area being irrigated). For example, a 1/3 acre (14,500 ft^2, or 1,350 m^2) irrigation area that is irrigated 1.5 inches (38 mm) per week would result in about 53,500 gallons used in a month. Water use would include block 5, and the water bill would be about $59.00 for that month. The potential to address income questions is a reality if water audit results are to have an effect on total water use.

Table 1. Block rate pricing structure for monthly water use in Douglas, GA

Block	Rate, $/1,000 gal.*	Description, gal.* used	Potential Monthly Bill, $
1.	$6.68+	≤ 4,000	$6.68
2.	$1.26	4,000 to10,000	$14.24
3.	$1.08	10,000 to 20,000	$25.04
4.	$1.02	20,000 to 50,000	$55.64
5.	$0.89	50,000 to 100,000	$100.14
6.	$0.79	100,000 to 200,000	$179.14
7.	$0.71	> 200,000	>$179.14

*For SI conversion, use 3.8 liters/gallon

+This is a base charge regardless of amount used below 4,000 gal.

Audits were performed on 14 different systems in the community (>7% sample). The selection was based entirely based on those who requested an audit after receiving a notice in the mail. Half of the audits were on commercial or municipal sites, the rest were residential customers.

The Douglas community currently is under an odd/even watering restriction (based on address). That means that water users may irrigate every other day. There is also a 6+-hour time restriction during allowable irrigation days (4 p.m. to 10 p.m.) that has been initiated in many locations across the state. In practically all sites analyzed in this pilot study, the time-clocks were set to allow irrigation during early morning hours, thus reducing losses due to evaporation. Unfortunately, early morning hours (12 a.m. to 5 a.m.) creates the largest potential for other losses. Offsite applications, maintenance problems (broken sprinklers), and small leaks (if the evidence of the leak is not substantial) are not easily observed during those hours of operation.

Water Saving Opportunities

The largest problem observed within the audits was *selection of nozzles in rotating sprinklers*. Rotating sprinklers were defined as gear-driven or impact sprinklers that "rotated" across the area of irrigation need. Regardless of whether sprinklers were old or new, nozzles were not sized according to the area of coverage by the rotating sprinklers. For sprinklers that were operating over part circles, the same nozzles were typically used as compared to full circle sprinklers. This is not a problem if all full circle sprinklers are on the same zone, all part circle sprinklers are on a different zone, and the operating times are adjusted accordingly. Results from the Douglas community tests indicate that about 24% of the water used on rotating sprinklers could be saved by using the proper nozzles (based on those systems tested, with no other changes in operating schedules). This percentage translates into nearly 40,000 gallons of water per week that could be saved on the 14 systems tested, by using proper nozzles. For the individual systems tested, the water savings due to nozzle changes ranged from 0 to 45%.

Operating time was another concern illustrated from the irrigation audit results. In most cases, spray heads tend to put out three to five times the water application rate on a given area as compared to drip or rotating sprinklers. If the time is not adjusted accordingly for zones with spray heads, those areas will receive a much higher application of water. For those systems with spray head problems (60% of those systems with spray heads), about 19% of the water used through spray heads could be saved by adjusting the time to conform to a "recommended" amount that was consistent with the rotating sprinkler amounts. Turf needs about 1.25 in. (32 mm) per week during peak water demand periods (Tyson and Harrison, 1995; Wade et al., 2000). This water savings percentage translated into over 5,000 gallons of water saved per week for the systems tested.

On one single system, the operating time per irrigation was 180 minutes (with rotors). If this system is operated on an odd/even irrigation schedule, the application amount per week is nearly 2.0 inches (50 mm). By reducing the zone time to 120 minutes per irrigation, over 4,700 gallons per week could be saved on this system alone.

Off-site applications were a real problem in some areas. Spray heads and rotating sprinklers were observed putting water in roads, sidewalks, driveways, and parking lots; hitting nearby bushes and trees (significantly affecting the pattern); and even putting water into a swimming pool. Recommendations to save water were provided based on converting some full circle rotating sprinklers to part circle. Water savings based on off-site applications are "real" based on any application scenario because this water is not being used for any beneficial plant response. Off-site applications did represent a relatively small percentage of the overall water use. For one system tested, changing a full circle sprinkler to a 270 degree coverage would save about 210 gallons per week. For another system, changing a full circle sprinkler to a half circle sprinkler amounted to about 100 gallons per week in water savings. This was based on the current operating time that was set to provide 0.5 inches (12.7 mm) of water per week. All of the above savings were based on the current irrigation schedule (time of application in a zone) and the particular nozzles being used.

Changes were also recommended *based on the season*. In the majority of the audits no direct effort was identified by the water user to reduce water applications during the fall, winter or spring. In some cases the timing was modified if areas were observed to be too wet. Rarely were the seasonal adjust features (water budgeting) utilized on time clocks. The potential for educational efforts to help water users more effectively use their time clocks, was evident in almost all audit situations.

Efficiency improvements, but more water needed
In some cases, water application recommendations were provided to help meet potential plant water needs. Some irrigation systems were not providing sufficient water to meet plant water requirements at peak summer conditions. Recommendations that increase the amount of water to be applied to a particular area would result in increased efficiency, but also increased water use. Obviously, if the water user is satisfied with the condition of the turf and landscape plants, these recommendations should not be implemented (indicated in their report). Schools represent one type of irrigation system that may not need as much water during the summer. Most schools are not in session during the summer. Maintenance during the summer is desired to be low and visual appearance may not be as important (low application amounts may be acceptable). Unfortunately, the southern climate will encourage the encroachment of drought tolerant weeds if sufficient water is not available to the turf.

Application amounts for rotors seemed to be low for a large percentage of the systems evaluated (50%). These systems were putting out less than 0.6 in. (15 mm) in a week (based on an application "every other day"). These application amounts may need to be adjusted based on the stresses observed on turf and landscape plants. The amount applied can easily be corrected by adjusting operating time(s) per zone. However, this would result in increased water use (gallons) for those particular systems.

Alternative Water Rate Structures
The largest concern by the water purveyor, was the potential loss in revenue associated with water use reductions. The potential exists to modify the water rate structures to address those persons making the changes. It was estimated that most irrigators would be in blocks 4 and 5 based on their schedule and irrigated area.

What if the block water rate structure described in Table 1 were "readjusted" to penalize those who use more water? For example, the water rate for blocks 4 and 5 could be increased ($/1,000 gal.) to encourage outside water users to use less water. Income to the water purveyor would not be reduced, since those wishing to use more water would pay an increased rate.

Positive incentives, such as reduced water rate structures by the implementation of water saving alternatives, could also be used to encourage reduced water use.

Spreadsheet Analyses
The majority of the analysis of water savings and collection of results were developed on simple spreadsheets. The ability to quickly modify zone operating times and nozzle sizes to calculate water savings was a benefit. In addition, the data collected from each site could be entered to allow easy calculation of overall water savings potential.

CONCLUSIONS

A new mobile landscape irrigation auditing program was developed and tested in a pilot study in Douglas, Georgia. At least 14 individual systems were audited (>7% of outside water meters). Fifty percent of the audit sites were municipal or commercial sites, the rest were residential. For the audited systems, at least 250,000 gallons per week were estimated to be used if all systems were operating on an "every other day" irrigation schedule. If all recommendations for water savings were implemented on these systems, nearly 50,000 gallons per week (about 20%) would be saved. All potential water savings were based on adjusting irrigation schedules to apply less water if they were currently exceeding recommended amounts (per week).

Some audited sites were applying less water than is recommended for turf and landscape plants (during the hot part of the summer). Irrigation efficiencies, and possibly health of turf and landscape plants could improve by applying more water.

In practically all irrigation audit situations, no seasonal adjustments were being made to reduce water applications during the fall, winter, and spring. The need for improved education on irrigation and operating system alternatives was obvious.

The audit program represents a real and potentially viable method of improving water use for small communities. The potential to use water more efficiently and save water under drought conditions is necessary to the future viability of the landscape and turf industries, and the quality of life and beauty we expect from our landscapes.

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