# Slow the Flow, Save $H_20$

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## Abstract

An extensive radio and television water conservation campaign was initiated in 1999 when a dry year turned into a six year drought. Irrigation system audits of commercial properties were made free to the public by the Central Utah Water Conservancy District and its partners. Upon examination of water use records over a three year period, 106 large water use properties were able to reduce their seasonal water use per landscape acre by 14.9%. After receiving an irrigation system audit, properties were able to save 10.1% the year of the audit and 4.8% the year following the audit. One elementary school was audited before and after installation of a new weather-station based system. Landscape water was reduced from 1,254,528 to 712,206 gallons per acre. This 56% reduction in culinary water use brought the school down to within 14% of the evapotranspiration rate for that year.

## Introduction

Water conservation efforts in Utah came to a forefront in 1999 when a dry year turned into a six year drought. The drought situation along with a forecast of rapid population growth in the state was responded to by the Central Utah Water Conservancy District and its partnering agencies with the development of the *Slow the Flow, Save $H_20$* water conservation campaign.

Data from the Utah Division of Water Resources in 1999 indicated that about 50% of Utah's culinary, treated water was used outdoors, primarily in the landscape (*Utah Division of Water Resources, 2003*). Outdoor water waste was targeted by offering irrigation system audits or "water checks" free to the public under a grant provided to Utah State University Extension by the Central Utah Water Conservancy District and its partnering agencies. The water check program was initiated in 1999 as part of Utah's *Slow the Flow, Save $H_20$* water conservation program and has continued to grow through 2005 (*Jackson and Rosenkrantz, 2004*). The *Slow the Flow, Save $H_20$* water conservation program, including water checks was adopted and endorsed as the statewide water conservation program in 2003 by Utah's Governor, Mike Leavitt (*Jackson and Mohadjer, 2003*). Water audits that were performed for commercial, institutional, industrial, large private and public properties were coined "large water audits" for the purpose of differentiating the large water use properties from a residential water check program also serviced by Utah State University Extension. (*Jackson, 2000; Lopez and Jackson, 2004*).

As limited information is available about system performance of operational irrigation systems, data was collected for distribution uniformity (system efficiency), precipitation rate (system output), and operating head pressure for large water audits within this study. This information provided an indication of the types of irrigation systems being used in Utah, often despite their poor performance.

Data collected from large water audits was twofold in purpose. Not only was information gathered about existing sprinkler system performance; participant water use records were also evaluated to determine program effectiveness (*Jackson and Leigh, 2004*). Additionally, most water professionals recognized that the majority of water waste occurred in the landscape although the amount of water waste had not been documented (*Utah Division of Water Resources, 2003; Jackson and Leigh, 2004; Jackson, 2000*).

The overall objective of this study was to determine the practicality of reducing landscape water use through recommending irrigation scheduling for turf based on actual irrigation system precipitation rates and historical evapotranspiration data. Additionally, this study targeted water use through providing recommendations for proper irrigation system maintenance and repair in personalized written reports. An evaluation of water use records for 106 large water use properties determined that landscape water use could be reduced as participants followed the site specific recommendations provided to them through participation in the water check program (*Jackson and Leigh, 2004; Jackson and Leigh, 2004; Lopez and Jackson, 2004).*

## Materials and Methods

Water audits were performed by trained college interns employed by Utah State University Extension and were funded through grants provided by the partnering agencies of the Central Utah Water Conservancy District. Interns were generally from Utah State University, Brigham Young University, or Utah Valley State College in the course of studying horticulture, biology, natural resources or engineering.

Each large water audit consisted of a comprehensive evaluation of the participant's landscape and irrigation system, sprinkler catch cup and pressure tests, as well as a simple analysis of turf root depth and soil texture. These methods were similar to the guidelines established by the Irrigation Association for conducting an irrigation system water audit (*IA Manual, 2002*). Participants in the program received a personalized written report including recommendations for irrigation system improvements and a site specific irrigation schedule based on catch cup results.

A typical large water audit would begin with a walk through of the irrigation system. Common irrigation system problems were targeted and often included tilted, clogged, broken or sunken sprinkler heads, mismatched sprinkler heads, lack of head to head coverage, rotor zones without matched precipitation rate, and various other design or maintenance flaws. The various sprinkler system problems were noted and included in the written reports provided for the participants along with recommendations for improvements.

Several catch cup tests were performed at the audit sites to determine sprinkler precipitation rate (PR) and distribution uniformity (DU). Catch cup tests were performed on zones or stations in the landscape that were deemed representative of the entire irrigation system. The number of tests performed varied by site and especially by the size of the landscape. For each zone or station being tested catch cups were placed at and in between each sprinkler head in a grid. The number of catch cups placed within a zone also varied by site and size of the area being tested with a minimum of 20 cups used per test. Catch cups used for this study were designed and manufactured by the U.S. Bureau of Reclamation and were calibrated to measure water depth in inches or centimeters.

Precipitation rate, or application rate of the sprinklers in inches per hour was determined by multiplying the average depth of catch cups used for one test by sixty, divided by the minutes that the test ran, [PR inches/hour = (average depth of catch cups in inches * 60) / X Minutes]. Distribution Uniformity, or evenness of water application represented as a percentage from 0-100% was determined by dividing the value of the average depth of the lowest 25% of catch cups used for one test by the average depth of the total number of catch cups used and multiplying that value by 100, [DU% = {(average depth of the lowest 25% catch cup values) / (average depth of the total number of catch cup values)}* 100]. Systems were considered "efficient" if they had a DU rating of 70% or above, as influenced by the standards set forth by the National Irrigation Association.

Operating sprinkler head pressure in pounds per square inch (PSI) was measured using pressure gauges attached to a pitot tube for rotor heads or adapters made to fit in place of the nozzle for fixed heads. Pressure was generally measured at stations where catch cup tests were performed and was compared to industry standards for proper operating sprinkler head pressure in the water audit reports.

Hollow steel core type soil probes were used to determine soil texture as well as turf root depth in inches for each site. A simple feel test was used to determine if the participant's soil was predominately sand, loam, or clay for irrigation scheduling purposes. Existing turf root depth was primarily measured to give an indication of pre-water audit irrigation habits. Although current irrigation schedules were noted during the site inspection stage for the large water audits, root depth gave additional insight to these habits as irrigation schedules are generally not constant.

Information gathered at each water audit was analyzed and combined to form customized, site-specific irrigation schedules. A standard irrigation schedule was developed based upon analysis of historical evapotranspiration (ET) rates along the Wasatch Front over a thirty-year period. Evapotranspiration, or water loss from soil evaporation combined with plant water use and transpiration is measured in inches. ET data combined from several weather stations in the area was used. Historically, ET for the Wasatch Front is around 25 inches of water for the total growing season, April through October. A standard of ½ inch of water applied for each irrigation throughout the growing season was set forth with the following intervals to apply 25 inches of water throughout the season. Intervals or irrigation frequency followed monthly ET rates as it was recommended that turf be watered every fourth day in May, every third day in June, July and August, every sixth day in September and every tenth day in October until system shutdown.

The standard irrigation schedule was adapted for the participants based upon the sprinkler precipitation rates and soil texture at the audit sites. Individual precipitation rates from catch cup tests were used to determine sprinkler system runtime to apply ½ inch of water.

Soil texture was also used for scheduling purposes to determine if a recommendation for cycling runtimes would be appropriate. Cycling runtimes was recommended as the practice of breaking up sprinkler runtimes to allow water to penetrate the soil without runoff. This recommendation was for sprinklers to be turned on and off multiple times with rest periods of about an hour between each cycle thus allowing the water to percolate deeper into the soil profile. Soil infiltration rates for clay, loam or sandy soil textures determined how long the sprinklers could run without runoff. The total number of minutes from each of the cycles would apply the recommended ½ inch of water.

Irrigation runtimes were not corrected with distribution uniformity values for water audits, unlike the methods of the National Irrigation Association (IA). Under IA methods, if an irrigation system was considered 70% efficient, runtimes throughout the season would be increased by 30% to compensate for uneven application of water. For the purposes of this study it was determined that the capillary properties of water could be exploited through lateral movement of water in the soil caused by soil texture horizons. This approach was used to compensate for uneven water application. A trail and error recommendation was used as participants were instructed to set their irrigation controllers to the suggested runtimes and then observe the landscapes. If dry spots occurred then additional watering time could be added only to those areas rather than for the entire landscape in an effort to conserve as much water as possible.

In order to track the success of the program water use records were obtained from the water providers of the audit participants and analyzed. For each year of records obtained water consumption values were totaled by year and converted into gallons. In order to estimate water applied to the landscape for properties with indoor and outdoor water use from the same meter, usage from winter months was averaged, multiplied by 12 and subtracted from the total gallons used. Water use was converted into inches applied to the landscape and compared to the yearly ET value through the following formula [(landscaped acres/outdoor gallons applied to landscape)*(1/27154)]. An irrigated landscape size was needed for the conversion of gallons into inches, thus properties were measured for irrigated landscape in square feet using measuring wheels and global positioning units. Water use records were evaluated for total gallons, outdoor gallons, gallons per acre, inches applied to the landscape and percent of ET with an irrigated landscape calculation. A sample of 58% of the water records from audited properties were obtained and evaluated representing 106 properties. Water usage of these 106 properties was evaluated comparing water use the year before the water audit, the year of the audit, and the year after the audit. Unfulfilled water record requests, changing landscape sizes, broken water meters, denial of access to water records and primarily the use of secondary un-metered water made it impossible to track every property audited (*Jackson and Lopez, 2005*).

Irrigation system information was collected, compiled and evaluated for large water audit participants from 2001 through 2004 and is included in this summary. Participant water use was collected and compiled for participants from 2001 through 2004 although an evaluation of water use records for 2004 participants is not yet available. Thus, the following will include irrigation system data for 2001 through 2004 participants while water use data is limited to 2001 through 2003 participants.

## Results and Discussion

For the purposes of data summarization participants in the large water audit program were placed into categories. Number of audits completed within each category is listed in parenthesis: Apartments (19), Businesses (55), Churches (19), Golf Courses (6), Homeowners Associations (51), Public Facilities (48), Parks (67), and Schools (44), along with 2 properties deemed as “Other”. This total of 311 large water audits was conducted from 2001 through 2004. Data was collected and compiled for 302 of these properties as 9 of the properties were considered visual inspections or had other extenuating circumstances such as excessive wind during testing, un-testable mixed sprinkler head types or properties where the irrigation system was undergoing drastic changes or replacement (*Jackson and Lopez, 2005*). The vast majority of the large water audits were conducted in Salt Lake and Utah Counties.

System performance of operational irrigation systems was determined from 302 properties. Catch cup tests from these properties revealed that the average precipitation rate for rotor heads (large, rotating heads) within this study was 0.6 inches per hour with an average distribution uniformity value of 58%. The average precipitation rate for fixed heads (small, non rotating popup heads) within this study was 1.6 inches per hour with an average distribution uniformity value of 54%. This data for rotor head PR and DU values represents 605 total catch cup tests as data for fixed head PR and DU values represent 456 total catch cup tests from the 302 properties tested.

Catch cup data from the large water audits shows the types of irrigation systems being used in Utah. The data for distribution uniformity in particular shows that poor irrigation systems are generally the norm. It wasn’t uncommon to find newer irrigation systems that also fell below the standard of 70% distribution uniformity. Inexpensive water, lack of proper design and few installation regulations have promoted inefficient systems in Utah for many years. Average distribution uniformity values for each of the property categories audited are depicted in the following tables.

**Table 1 Distribution Uniformity – Fixed Head Average and Range**

| Fixed Head Distribution Uniformity % | | | | |
|---|---|---|---|---|
| Property Type | Average | High | Low | Standard Deviation |
| Apartments | 57 | 75 | 33 | 11 |
| Businesses | 57 | 83 | 29 | 12 |
| Churches | 59 | 77 | 27 | 12 |
| HOA'S | 55 | 86 | 3 | 14 |
| Public Facilities | 55 | 83 | 21 | 12 |
| Parks | 44 | 75 | 2 | 20 |
| Schools | 54 | 90 | 5 | 16 |
| **Database AVG** | **54** | **81** | **17** | **14** |

**Table 2 Distribution Uniformity – Rotor Head Average and Range**

| Rotor Head Distribution Uniformity % | | | | |
|---|---|---|---|---|
| Property Type | Average | High | Low | Standard Deviation |
| Apartments | 53 | 74 | 20 | 16 |
| Businesses | 56 | 84 | 20 | 13 |
| Churches | 61 | 80 | 26 | 14 |
| Golf Courses | 67 | 92 | 30 | 13 |
| HOA'S | 56 | 79 | 28 | 12 |
| Public Facilities | 60 | 80 | 30 | 12 |
| Parks | 54 | 85 | 6 | 16 |
| Schools | 57 | 82 | 16 | 14 |
| **Database AVG** | **58** | **82** | **22** | **13** |

Most sprinklers apply water faster than a heavy rainstorm, which weathermen classify as rainfall greater than 0.4 inches per hour. High precipitation rates cause runoff or puddling, create waste, and prevent the turf root system from receiving all the moisture and oxygen it requires. High precipitation rates and runoff can be a problem primarily with fixed heads. The following tables compare precipitation rate data averages by sprinkler head type for the various property categories (*Jackson and Lopez, 2005*).

**Table 3 Precipitation Rate – Fixed Head Average and Range**

| Fixed Head Precipitation Rate (inches per hour) | | | | |
|---|---|---|---|---|
| **Property Type** | **Average** | **High** | **Low** | **Standard Deviation** |
| Apartments | 1.6 | 3.1 | 0.6 | 0.5 |
| Businesses | 1.6 | 3.3 | 0.4 | 0.6 |
| Churches | 1.8 | 3.4 | 0.9 | 0.5 |
| HOA'S | 1.6 | 4.0 | 0.3 | 0.6 |
| Public Facilities | 1.6 | 2.9 | 0.6 | 0.4 |
| Parks | 1.4 | 2.6 | 0.3 | 0.6 |
| Schools | 1.7 | 4.7 | 0.4 | 0.7 |
| **Database AVG** | **1.6** | **3.4** | **0.5** | **0.6** |

**Table 4 Precipitation Rate – Rotor Head Average and Range**

| Rotor Head Precipitation Rate (inches per hour) | | | | |
|---|---|---|---|---|
| **Property Type** | **Average** | **High** | **Low** | **Standard Deviation** |
| Apartments | 0.5 | 1.1 | 0.3 | 0.2 |
| Businesses | 0.6 | 1.1 | 0.2 | 0.2 |
| Churches | 0.7 | 2.5 | 0.3 | 0.4 |
| Golf Courses | 0.6 | 1.1 | 0.4 | 0.2 |
| HOA'S | 0.7 | 1.9 | 0.2 | 0.3 |
| Public Facilities | 0.6 | 2.5 | 0.2 | 0.4 |
| Parks | 0.5 | 1.6 | 0.1 | 0.2 |
| Schools | 0.5 | 1.7 | 0.1 | 0.3 |
| **Database AVG** | **0.6** | **1.7** | **0.2** | **0.3** |

Pressure directly affects sprinkler head performance and was commonly found to be operating at higher or lower values than manufacturer recommendations. The proper pressure for fixed heads is between 15 and 30 pounds per square inch (psi) while rotor heads operate best at pressures greater than 50 psi (*Rainbird Product Catalog, 2005*). High pressure causes misting and increased evaporation, lowers the distribution uniformity, and creates undue stress and wear on the sprinkler system. Low pressure can be detrimental to an even sprinkler coverage pattern. The following tables depict operational sprinkler head pressures for the 302 properties tested by property type.

**Table 5 Water Pressure – Fixed Head Averages and Range**

| Fixed Pressure (PSI) | | | | |
|---|---|---|---|---|
| **Property Type** | **Average** | **High** | **Low** | **Standard Deviation** |
| Apartments | 43 | 75 | 19 | 15 |
| Businesses | 51 | 112 | 18 | 24 |
| Churches | 70 | 104 | 30 | 24 |
| HOA'S | 54 | 110 | 18 | 22 |
| Public Facilities | 53 | 108 | 20 | 21 |
| Parks | 59 | 100 | 15 | 20 |
| Schools | 56 | 100 | 24 | 21 |
| **Database AVG** | **55** | **101** | **21** | **21** |

**Table 6 Water Pressure – Rotor Head Averages and Range**

| Rotor Pressure (PSI) | | | | |
|---|---|---|---|---|
| **Property Type** | **Average** | **High** | **Low** | **Standard Deviation** |
| Apartments | 51 | 78 | 14 | 18 |
| Businesses | 58 | 117 | 22 | 22 |
| Churches | 55 | 85 | 24 | 19 |
| Golf Courses | 71 | 100 | 45 | 13 |
| HOA'S | 59 | 104 | 20 | 19 |
| Public Facilities | 55 | 80 | 20 | 16 |
| Parks | 68 | 100 | 20 | 17 |
| Schools | 55 | 90 | 28 | 15 |
| **Database AVG** | **59** | **94** | **24** | **17** |

It is worth mentioning that the average large water audit participant had a turf root depth of only 4.8 inches. With a uniform soil and proper irrigation, a bluegrass lawn should have a root system up to 12 inches deep. A short root system would make it necessary to water more frequently during the summer to keep the lawn from going dormant (*Jackson and Lopez, 2005*). Average turf root depth depicted by property type is included in the following table.

**Table 7 Root Depth – Averages and Range**

| Root Depth (inches) | | | | |
|---|---|---|---|---|
| **Property Type** | **Average** | **High** | **Low** | **Standard Deviation** |
| Apartments | 4.7 | 11 | 2 | 1.7 |
| Businesses | 4.4 | 9 | 1 | 1.6 |
| Churches | 5.2 | 9 | 2 | 1.5 |
| Golf Courses | 3.4 | 4.5 | 2.6 | 0.7 |
| HOA'S | 4.8 | 11 | 1 | 1.7 |
| Public Facilities | 4.6 | 9 | 2 | 1.4 |
| Parks | 5.7 | 13 | 2 | 2.4 |
| Schools | 5.2 | 12 | 2 | 2 |
| **Database AVG** | **4.8** | **9.8** | **1.8** | **1.6** |

The 311 irrigation water audits covered in this report do not constitute a randomized sample of apartments, small businesses, churches, golf courses, homeowners associations, public facilities, parks and schools along the Wasatch Front. Each property requested assistance in evaluating their system and determining the correct watering schedule. For statistical evaluation, there is no randomized control group for comparison. Therefore, each property has been compared to its own water use record by year. The water used over the growing season was evaluated the year before the water audit compared to the water used during the audit year followed by the water used the year after the water audit where records were available. Three-year water records for 106 properties were evaluated in several ways as shown in the **Table 8**.

**Total Gallons Used per Property:** The first row in **Table 8** shows the evaluation using the total number of gallons used per property for each of the three years. This number includes both indoor and outdoor water use and varies by the size of the irrigated landscape which ranged from 0.2 of an acre for a small business up to 388 acres for a golf course. By this method, the 106 properties in the water record database saved an average of 11.8% the year of the audit and followed by another reduction of 8.2% the year following the audit. By this method of calculation, the large golf courses and parks had more influence on the average than the smaller businesses and apartment complexes.

**Total Gallons Used per Acre:** The second method of evaluation reduces the variation caused by property size through calculating the total gallons used per season per one acre of landscape. Results from line two of **Table 8** indicate a reduction in water use by 4.2% the year of the audit and by 8.5% the year following the audit and shows a somewhat smaller savings than total gallons alone.

**Outdoor Gallons Used per Acre:** As irrigation system audits concentrated on outdoor water conservation line three of the table is based only on outdoor water used during the growing season. With this method, the amount of water used outdoors required calculation. This was not always an easy task since some water purveyors did not read the water meters on a monthly basis. Often times, the water consumption values provided by the water districts for the winter months were estimated with corrections made in later months. This method of calculation (outdoor water use per season per acre) indicates a savings of 10.1% the year of the audit and 4.8% the year following the audit resulting in 14.9% reduction in water use over a two year period (*Jackson and Lopez, 2005*).

**Inches of Water Used per Acre:** The fourth set of calculations converted gallons of water used into inches for use in comparison to evapotranspiration values. The results of calculation through this method were very close to the outdoor gallons of water used.

**Percent Reduction in Evapotranspiration (ET):** Outdoor water use can be evaluated through comparing usage to the turfgrass water requirement (net $ET_{turf}$). This comparison is valuable because it accounts for variability in weather patterns which may influence irrigation schedules. For this study a comparison was made to the evapotranspiration value for each year of water use. Since evapotranspiration values change each week, month and year, this set of calculations has the most room for error due to the number of calculations and conversions required. By this method, the average property in the database saved 10.7% the year of the audit and only 1.9% the following year indicating a total savings of 12.6% over the two year period.

**Table 8 Water Saved by Different Calculation Methods**

| 2001-2003 Water Savings Summary | | | |
|---|---|---|---|
| Percent Water Saved by Different Calculation Methods | | | |
| Calculation Method | Percent Water Saved Audit Year | Percent Water Saved Year After Audit | Percent Saved Over 2 Years |
| Total Gallons Used per Property (indoor + outdoor) | 11.8% | 8.2% | 20.0% |
| Total Gallons Used per acre (indoor + outdoor) | 4.2% | 8.5% | 12.7% |
| Outdoor Gallons Used per acre | 10.1% | 4.8% | 14.9% |
| Inches of Water Used per acre | 10.3% | 4.8% | 15.1% |
| Percent Reduction in Evapotranspiration (ET) | 10.7% | 1.9% | 12.6% |
| Database of 106 complete water use records with information before audit, year of the audit and the year following the audit | | | |

Water usage by property type was also evaluated for this study. It is interesting to note the variability of savings when the large water audits are categorized by property type. The following table shows the various responses to the water audit recommendations per property type. The assumption could be made that most businesses have little or no desire to reduce landscape water use. This assumption has been backed by the problem that water bills for chain businesses in particular are often paid at a corporate office in a different state. Water pricing in Utah has yet to send a big enough message to the water users that water conservation is important.

**Table 9 Water Saved by Category**

| 2001-2003 Water Savings Summary | | | | |
|---|---|---|---|---|
| by Category | | | | |
| Category | Number of Audits | Percent Water Saved Audit Year | Percent Water Saved Year After Audit | Percent Saved Over 2 Years |
| Apartments | 12 | 6.9% | 3.8% | 10.8% |
| Businesses | 19 | 1.5% | -4.1% | -2.6% |
| Churches | 6 | 29.4% | -5.2% | 24.2% |
| Golf Courses | 5 | 10.1% | 4.3% | 14.4% |
| Homeowners Associations | 22 | 12.1% | 10.7% | 22.8% |
| Public Facilities | 13 | 9.1% | 19.4% | 28.5% |
| Parks | 16 | 20.4% | 1.6% | 22.0% |
| Schools | 13 | 13.5% | 7.0% | 20.5% |
| Calculations based on outdoor gallons used per acre per season | | | | |

Although information is limited about water savings based on irrigation system improvements one elementary school in West Jordan, Utah has provided a great example. A new Rain Bird Maxicom central control irrigation system was installed at the school in West Jordan City along with a new automated irrigation system. The system had its own weather station with sensors for air temperature, solar radiation, relative humidity, wind speed, wind direction and rainfall. The information was calculated for Evapotranspiration for turf on a daily basis and supplied to the computer running the irrigation system. Each irrigation zone was then programmed for the correct minutes to water each week. A total of 54% of the 10.8 acre site was measured as irrigated landscape. During 1998, 1999 and 2000, the school used an average of 7,305,110 gallons of irrigation water during the growing season. This equated to a value of

28.8 gallons of culinary water per square foot per season. The school was being watered at 201% of the actual turf water requirement. After the Maxicom automated system was installed, the water use records indicated that the facility irrigated at 114% of the current year's water requirement. When an entire sprinkler system was replaced with an automated system based on a weather station, the total water used was brought down to about the same level as the standard (*Lopez and Jackson, 2004*).

### Water Savings by an Elementary School

| West Jordan City Elementary School |
|---|
| **Total gallons per landscape area** |
| 7,305,110 gal/ 5.83 acres |
| 28.8 gal/ft$^2$/season |
| **Comparison to turf water requirement (ET)** |
| ET = 14.3 gal/ft$^2$/season |
| **201% of ET** |
| Prior to automation with weather station |
| **With automated system** |
| **16.35 gal/ft$^2$/season** |
| **114% of ET** |

### Conclusion

The results of this study are unique as they reflect tangible, real-life situations where beneficial changes were made to watering habits and where data was collected for existing, functioning irrigation systems. Although the nature of this study made it impossible to control all aspects of the data collection process, adaptability as well as consistency and quality from all contributors to this project proved effective. The large water audit program has been a well received public relations campaign in enabling mangers of large landscapes to successfully cut back on water waste by an average of 15%. Modified irrigation water audits are now being conduced in several other states with similar results (*Mecham, 2004; Graham and Lander, 2005*). Through providing recommendations for irrigation scheduling based on ET and actual irrigation system precipitation rates as well as recommendations for proper irrigation system maintenance, the overall objective of this study was met with notable results. In addition to water savings data, information compiled for operational sprinkler system performance will increase in value as water conservation efforts in Utah continue throughout the future.

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