Irrigation Efficiency Audits

BMP Type			
Design			
Installation			
Maintenance/Operations			X
Green Industry Relevance			
ASLA		GCC	
ALCC	X	ISA	
CALCP	X	RMSGA	
CNGA		GCSAA	X

Description

Auditing existing irrigation systems to identify needed improvements is a key tool in reducing landscape water waste and improving irrigation efficiency. This process is sometimes called a "catch can test." This BMP is divided into two important components: the pre-audit to correct existing malfunctions in the irrigation system and the irrigation audit itself, which is used to assess distribution uniformity and precipitation rates for the irrigation system.

Basic Practice Guidelines

The majority of the guidelines presented in this BMP were developed by the Irrigation Association (IA 2007) and are intended to function as recommendations in the evaluation and performance of landscape irrigation systems. The IA recommends conducting irrigation audits approximately once every five years. These guidelines have been designed to aid landscape professionals in fieldwork procedures and in irrigation performance calculations and techniques. Recommendations and projections from the guidelines and their accuracy depend upon the quality of measurements and data provided by the individual user. The Irrigation Association makes no warranty, implied or expressed, as to the results obtained from these procedures. The Irrigation Association intends that these procedures by used as guidelines, not a set of regulations or standards.

STEP #1: PRE-AUDIT ASSESSMENT AND SYSTEM CORRECTION

1. Complete a pre-site inspection to document system components and conditions. As part of this step, obtain as-built drawings and water use history for the past three years, where available.

2. Determine whether irrigation system meets all local codes.

3. Repair operational defects so that the system is in working condition. Make sure all heads are in proper position.

4. Schedule the inspection after a mowing day to reduce interference from tall grass.

The Colorado WaterWise Council has developed a "pre-audit" form, which can be used as a checklist to document the landscape and irrigation system conditions. This form is provided in Appendix G and can be easily understood by a homeowner. In many cases, correction of the items identified in the pre-audit significantly improves irrigation system performance. Representative items covered in the pre- audit checklist include:

- Documentation of existing irrigation schedule and methods of adjustment over the irrigation season.

- Description of irrigation system zone (station) equipment.
- Description of water saving devices (e.g., rain shutoff, soil moisture sensor, weather-based controllers).
- Description of landscape features (e.g., slope, exposure, soil conditions, plant types and conditions in each zone).
- Condition of sprinkler nozzles (e.g., broken, tilted, spray direction) and drip systems (e.g., plugged, missing pressure regulator).

STEP #2: IRRIGATION EFFICIENCY AUDIT

The irrigation efficiency audit, which assesses distribution uniformity and precipitation rates, is completed by conducting a catch-can test and comparing the average distribution uniformity of the lower quarter of the catchment samples (DU_{LQ}) with the overall average of catchment samples (DU_{AVG}). A good distribution uniformity is indicated by the average values of the lower quarter being similar to the overall average.

Test Conditions (*as specified by the Irrigation Association*)

1. Maximum wind allowable during audit = 5 mph or less (ASAE S398.1). Wind speed must be monitored and recorded every 5 minutes during audit.
2. Audit must be conducted under normal operating conditions.
3. Pressure tests must be conducted at normal operating conditions at the sprinkler using the appropriate pressure testing device at the beginning, middle and end of operation of each audited zone.

Placement of Catchments

4. Catchments ("catch cans") for a test area should be aligned on a grid layout. All catchments must be uniform in size and type. See photo.
5. The catchments along the edge of the zones should be placed 12 to 24 inches in from the edge.
6. Catchment spacing
   a. For fixed spray sprinklers – near a head and half-way between the heads.

Placement of catch cans for irrigation efficiency audit. Photo Source: Kenneth Solomon

b. For rotor heads, less than 40 ft radius – near a head and every 1/3 of the distance between the heads.

c. Rotor heads, greater than 40 ft radius – near a head and every 1/4 of the distance between the heads.

7. Unusual areas

a. Large areas, rotor sprinklers – uniform grid, 10 to 15 ft spacing (i.e., infield for baseball field).

b. Small areas, spray sprinklers – uniform grid, 5 to 8 ft spacing (i.e., narrow turf area less than 6 ft wide).

Test Run Times

8. Test run times must be consistent among zones.

9. When the test area contains multiple zones, the zone run times must be adjusted to achieve a matched precipitation across the test area.

10. Rotor sprinklers must run for a minimum of five rotations during the test.

11. All catchment volumes must be read in milliliters (mL), and it is recommended that a minimum of 25 mL of water be collected.

Data Collection and Recording

12. The following data must be documented:

a. Catchment locations

b. Catchment volumes

c. Testing run times

d. Sprinkler locations

e. Sprinkler spacing

f. Pressure readings with locations

g. Make, model, nozzle of sprinklers

h. Soil types and root zone depths

i. Wind speed readings

j. Date and time of testing

STEP #3. CALCULATE DISTRIBUTION UNIFORMITY

13. The lower quarter distribution uniformity (DU_{LQ}) is calculated with the following method:

Step 1: Order the individual catch-can volumes in a list from smallest to largest. (Spreadsheets help to significantly reduce calculation time. Download the Turf Irrigation Management Program [TIM] from Northern Colorado Water Conservancy District [www.ncwcd.org] for an Excel spreadsheet that automates this process.)

Step 2: Separate out the catchment values for the quarter of the cans containing the least amount of water. Calculate the average catchment volume of these cans (V_{LQ}).

Step 3: Calculate the average catchment volume for all the cans (including the low quarter) (V_{avg}).

Step 4: Calculate the lower quarter distribution uniformity (DU_{LQ}) as a percentage using the following formula:

$$DU_{LQ} = (V_{LQ} / V_{avg}) \times 100$$

Where:

V_{LQ}= Average Catch Volume in Lower Quarter (mL)
V_{avg} =Average Catch Volume in Zone (mL)
DU_{LQ} =Distribution Uniformity (in %)

Figure 1. Turf Irrigation Management Audit Spreadsheet
(download from www.ncwcd.org)

Northern Colorado Water Conservancy District
Irrigation Auditing Calculation Sheet

Date: Auditor:
Site: Controller:

Audit Column	A	B	C	D	E	F	G
Audit Area							
Precip. Rate:							
Total Volume:							
# of Catch Cans:							
Average Volume:							
LQ Ave Volume:							
DU $_{LQ}$:							
Sprinkler Area Data							
Run Time:							
Catch Can Area:							
Catch Can Readings							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
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16							
17							

14. Table 1 can be used to assign a qualitative rating to the lower quarter uniformity (DU_{LQ}) for overhead irrigation systems, rated as "excellent, very good, good, fair, or poor" based on the type of sprinkler head used in the zone. If the overall DU_{LQ} has a rating of "fair" or "poor," consider redesigning the system, replacing sprinkler heads that are not performing well, adjusting sprinkler head spacing, adjusting alignment and radius of throw, adjusting relative timing of overlapping zones, and correcting operating pressure problems.

Table 1. Irrigation Association Ratings of Lower Quarter Distribution Uniformity for Sprinkler Zones (Source: Irrigation Association 2001)

Type of Zone	**Excellent** (%)	**Very Good** (%)	**Good** (%)	**Fair** (%)	**Poor** (%)
Fixed Spray	75	65	55	50	40
Gear Driven Rotor	80	70	65	60	50
Impact Rotor	80	70	65	60	50

15. Table 1 can be used as a guideline for initial planning and design purposes in addition to use in system performance evaluation. While DU_{LQ} as measured with catch-cans is a good indication of sprinkler hardware performance, it does not always accurately reflect soil moisture uniformity within the root zone. This is because of the tendency of soil moisture to migrate horizontally, which is not reflected in catch-can measurements. Based on a study in turfgrass irrigation using test plots with different soil textures, an improved representation of soil moisture uniformity *for scheduling purposes* is the *lower-half* of the distribution uniformity (Irrigation Association 2005).

16. The catch can results can also be used to calculate the net precipitation rate for irrigation scheduling purposes. The net precipitation rate (PR_{net}) is based on the amount of water that actually reaches the landscape using the following formula:

$$PR_{net} = (3.66 \times V_{avg})/(t_R \times A_{CD})$$

Where:

PR_{net} = zone precipitation rate (inches/hr)
V_{avg} = average catch volume for zone (mL)
t_R = test run time (min)
A_{CD} = catch device throat area (in^2)
3.66 = constant for unit conversion

Regional or Industry Considerations/Adaptations

1. Some local governments may offer rebates for irrigation audits, particularly for large commercial properties or other high volume irrigation customers. Check with your water utility to see what programs or incentives are currently offered for large irrigators.

2. The Irrigation Association offers a software program to calculate the DU_{LQ} and precipitation rate, along with generic audit forms, downloadable from www.irrigation.org.

3. The Irrigation Association offers guidance on scheduling methodology and procedures are provided in the Golf Irrigation Auditor and Landscape Irrigation Auditor Manuals.

Key References

Colorado WaterWise Council. 2007. Pre-irrigation Audit Excel Spreadsheet. (See Appendix G.)

Irrigation Association Website: www.irrigation.org.

Irrigation Association. 2001. *Predicting and Estimating Landscape Water Use*. October.

Irrigation Association. 2001. Certified *Landscape Irrigation Auditor Manual*. August.

Irrigation Association. 2005. *Landscape Irrigation Scheduling and Water Management*. Prepared by the Water Management Committee.

Irrigation Association. 2007. Recommended Audit Guidelines. Modified April 2007.

Irrigation Training and Research Center website: (www.itrc.org), Cal-Poly State University, San Luis Obispo, California.

Keesen, L. 1995. *The Complete Irrigation Workbook*. Cleveland, OH: Franszak and Foster.

Northern Colorado Water Conservancy District (undated). Turfgrass Irrigation Management (TIM) Program, downloadable from www.nwcd.org/ims/scheduler.asp.