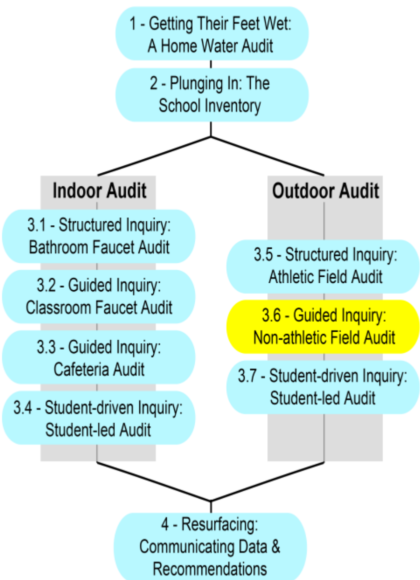
AZ1505 February 2010

3.6 The School Water Audit - Outdoor *Non-Athletic Fields Irrigation Audit, Guided Inquiry*



Summary:

Students will audit outdoor water use, namely irrigation other than the athletic fields. They will be assessing sprinkler, bubbler and drip irrigation systems and checking for leaks. They will collect and examine their data, convert units, draw conclusions, and draft recommendations for ways to use water more efficiently in these areas.

Objectives:

Students will:

- Develop a measurement procedure
- Measure amounts of water
- Convert data units
- Analyze data and draw conclusions
- Make recommendations for ways to use water more efficiently

Materials/Supplies:

Activity

Part 1

Per student group:

- 16 catch cans
- Stopwatch
- Graduated cylinders (10 & 100 ml)
- Outdoor tape measures
- 12 metal flagging stakes

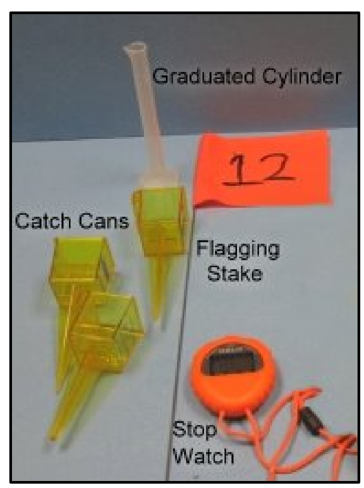
Per student:

- *Turf Irrigation Audit Datasheet* (Appendix 3.6.A)
- Clip board
- Pencil
- *Turf Irrigation Audit Worksheet* (Appendix 3.6.B)

Part 2

Per student group:

- 16 catch cans
- Stopwatch
- Graduated cylinders (10 & 100 ml)
- 12 metal flagging stakes



Audit Activity Equipment

Per student:

- *Procedure Writing for Non-turf Irrigation Audit* (Appendix 3.6.C)

- *Non-turf Irrigation Audit Data Sheet* (Appendix 3.6.D)
- *Non-turf Irrigation Audit Worksheet* (Appendix 3.6.E)
- *Plant Water Needs Table* (Appendix 3.6.F)
- Clipboard
- Pencil

Background for Teachers:

Evapotranspiration (ET) is a term describing the transport of water into the atmosphere from surfaces, including soil evaporation and from vegetation (transpiration). Evapotranspiration is one of the main consumers of solar energy at the Earth's surface and is one of the most significant components of the water cycle. Evapotranspiration is very high in arid to semi-arid Arizona.

Evapotranspiration is a major factor in determining watering requirements for plants in Arizona. See Appendix 3.6.F for estimated watering requirements for turf in many areas of Arizona. A rule of thumb for watering heat tolerant grass is to provide one to two inches of water per week.

The watering rate of an irrigation system is the depth of water applied (usually in inches), over a specified time (usually hours). Thus, it is the speed at which a sprinkler or an irrigation system applies water, resulting in a total volume of water. If a sprinkler system applies enough water to cover the irrigated area with one inch of water in one hour, the sprinkler system also has a watering rate of 1 in./hr.

Micro-irrigation is a watering system that is applied at a low flow rate usually for drip emitters, between ½ to 3 gallons per hour (gph). Water in a micro-irrigation system is applied over a long period of time, at frequent intervals and via a low pressure delivery system. Drip irrigation is applied directly to soil surrounding the plant. The flow controllers for drip irrigation can be underground in the piping or at the surface attached to spaghetti tubing.

A rule of thumb for watering xeriscaped areas is to provide adequate water to plants in the area using a slow drip system that does not over water or spill into areas of rock or flagstone.

Preparation before the activity:

- Acquire a map of the school grounds and review the School Inventory (Unit 2) to identify ALL non-athletic field irrigated areas.
- Schedule the date(s) and time(s) of the audit with the school administration and grounds-keeper.
- Request information from the grounds-keeper (see blue side bar).
- Inspect the school's irrigation yourself to discover what students may find.

List of Questions for the Groundkeeper

1. What irrigation system(s) water the non-athletic field turf areas?
2. What is the sprinkler head spacing on the non-athletic field turf areas?
3. What irrigation systems water non-turf areas?
4. What types of irrigation there are at the school (e.g. bubbler, drip)?
5. Have irrigation systems been changed to keep up with growing plants?
6. What is the watering schedule for the turf and non-turf areas to be audited?
7. Are there seasonal differences in the watering schedule?
8. Is there a map of the school grounds?

Drip irrigation spaghetti tubing and emitter. Auditing drip irrigation by measuring drip rate.

- Review the T*urf Irrigation Audit Data Sheet and Worksheet (Appendices 3.6.A & 3.6.B).*
- Review the *Sample Non-turf Irrigation Audit Datasheet and Worksheet (Appendices 3.6.D & 3.6.E).*

Lesson Procedure:

Warm up:

Have the students write their answer to this question: What does it take to figure out how much water the school uses on a football field in a year?

Draw a 2-column chart on the board or overhead with the title *Athletic Field Irrigation Audit*. The column headings should be *what worked* and *what didn't work*. Discuss these topics and write the students' answers into the chart.

Example Athletic Field Irrigation Audit Chart

What worked	What didn't work

Activity:

Remember the focus question:

How can we reduce water use or use water more efficiently outdoors at School?

Introduce the next audit area: The Non-athletic Fields Irrigation Audit.

Refer to the decision-making process, the inventory map and brainstormed list of water uses generated via the school tour.

In the second outdoor audit, cooperative groups will design measurement procedures for non-uniform turf areas and design a data-gathering tool called a survey to determine overall use of non-athletic field irrigation. They will also design a measurement procedure for other irrigation fixtures like bubblers (usually used for trees) and drip irrigation (usually used for low water use plants or xeriphytes).

Discuss how outdoor areas are watered at your school. Refer back to the outdoor water use inventory. What kinds of things affect when, how, how long, and why the water is used in these areas?

For example, *is one turf area watered more than others? Why? What are the water requirements of the grass? Is the turf area important to a school function? What other plants are being watered? How are they watered? How much water is used to water these other areas?*

Pose potential inquiry questions:

Does the distribution uniformity on a non-athletic field turf area indicate a high functioning, efficient irrigation system?

Based on catch can data, how much water is used on the non-athletic field turf area in a year?

How much water is used for trees at your school? Are trees valuable and needed?

How much water is used on shrubs and plants? Is it drip irrigated? Are plants native to the landscape in your area?

Are there high water use areas that can be converted to low water use areas at your school?

1. In order to answer these questions, many smaller questions need to be addressed:
2. If we assume the same watering schedule over the entire year and negligible evapotranspiration (all assumptions that may not be able to be made once more data is collected), then we can figure out the data that is needed to answer a question:
   - How many times per day is the turf area watered? (X) the trees? (T) the native plants? (NP)
   - How long is each watering period? (t)
   - How many days per year, including summer? (D)
   - What is the total irrigation system flow rate in gallons per minute on the turf area? (FR_{TA})
   - What is the total irrigation system flow rate in gallons per minute on the trees? (FR_T)
   - What is the total irrigation system flow rate in gallons per minute on the native plant areas? (FR_{NP})
3. Demonstrate why this information is important:

a. The goal is to arrive at an accurate measure of gallons of water per year used in all area.

b. If the turf area is watered X times per day, and for t minutes each, then:
$X \times t = min/day$
that turf is watered.

c. If a turf is watered Xt minutes each day, and there are D school days in a year, then
$(X \times t) \times D = min/yr$
that the turf is watered.

d. If the turf is watered XtD minutes each year, and it's flow rate is FR_{TA} gallons per minute, then:
$[(X \times t) \times D] \times FR_{TA} = gal/yr$
which is the number of gallons used on the nonathletic field turf area in a year. This same equation building process can be replicated for the gallons per year used on school trees (FR_T), shrubs and native plants (FR_{NP}).

Part 1: Turf Areas

1. **Design of experiment:** The catch can experiment will be conducted on a turf area with sprinkler irrigation. Since the area is much smaller than an athletic field, rather than focusing on one sprinkler head at a time, the focus will now be on the entire area. How can we determine whether the water is

Observing the turf during the landscape observation.

Student flagging sprinkler head to indicate it has been audited.

distributed uniformly on the turf area?

2. **Pre-Assessment:** Have students do a quick write in their notebooks:
   a. What did the distribution uniformity experiment tell us about the football/soccer field?
   b. What would the distribution uniformity tell us about a smaller possibly non-uniform turf area?
   c. How should we lay out the distribution uniformity test in a non-uniform area?

Flag used to mark catch cans - see Appendix 3.5.C for example layout.

3. **Review** the data collected from the grounds-keeper.
   - Sprinkler spacing
   - Make, model, nozzle of sprinklers (if available)
   - Soil types and root zone depths (if available)

4. Review *Turf Irrigation Audit Data Sheet* (Appendix 3.6.A) where students will record:
   - Measure of water in each catch can matched with number on grid and datasheet
   - Observations/comments
   - Testing run time
   - Sprinkler locations (mark with metal flagging before setting out catch cans)
   - The Beaufort scale is an empirical measure for describing wind speed. Sprinkler audits should be conducted under normal operating conditions with no more than a maximum wind speed of 5 mph or less. On the Beaufort scale this equates to no more wind then a light breeze. Students can use their observations to estimate wind speed using The Beaufort Scale (Appendix 3.6.G).
   - Date and time of testing

5. **Laying out the Experiment:**

   a. Students will work in cooperative learning groups of 4 to 5. Each group will be assigned to one turf area. To differentiate learning non-uniform areas can be assigned to higher achieving students.
   b. Students lay out the catch cans according to their plan, taking into consideration that the total number used must be divisible by four.
   c. The intent is to assess the entire area, not single sprinkler heads, answering the question: *is the area being irrigated efficiently?*
   d. Students should mark the sprinkler head locations with metal flagging stakes. The sprinklers may need to be turned on to locate the sprinkler heads.
   e. Students should place a catch can about 3 feet from each sprinkler head and at

even intervals in between sprinklers using the tape measure and making sure that the total number of catch cans used is divisible by four.

f. When the catch cans are all in place students should draw the layout of their area indicating the locations of sprinkler heads and catch cans. Catch cans should be numbered on the layout drawing.

6. **Turning sprinklers on:** Once all groups have laid out their catch can grid they should clear the turf area and the assigned group timer should prepare to start the stopwatch. When the grounds-person turns the water on, the student timing starts the stopwatch. The watering time is 10 minutes.

7. **Discussion:** The discussion during sprinkler operation should review the terms scientific experiment, controlled variable and uncontrolled variable.

Scientific Experiment - In scientific inquiry, an experiment is a method of investigating causal (cause and effect) relationships among variables. A variable is a value that may vary.

Controlled variable - A controlled variable is something in an experiment that doesn't change. In this experiment we've controlled the size (diameter) of the catch cans and the run time.

Uncontrolled variable – An uncontrolled variable may be what you are trying to measure. But real-world experiments often have other variables that cannot be controlled like the wind on the day of the experiment. Students should learn to make notes about all of the uncontrolled variables or uncertainties in their experimental design.

8. **Record the data** on the *Turf Irrigation Audit Data Sheet* (Appendix 3.6.A).

a. One student should be the map reader in charge of announcing the catch can number as written on the layout drawing so that the data is recorded at the correct catch can number on the data sheet.

b. Students will need a 10 milliliter graduated cylinder to measure the water in each of the catch cans.

c. One student should hold their clipboard upside down (paper down) trying to hold it as parallel to the ground as possible.

d. Another student should place the graduated cylinder on the clipboard and read the amount. The bottom of the meniscus marks the correct amount of water.

e. Students should alternate jobs allowing each student to acquire experience reading the graduated cylinders. All students

Student pouring catch can water into 10 ml graduated cylinder.

Student reading the water level in a graduated cylinder using a clipboard to create a level surface.

should record data on the data sheet.

9. Back in the classroom, work through the calculations. Calculate your distribution uniformity using the *Turf Irrigation Audit Worksheet* (Appendix 3.6.B).

Distribution Uniformity:

a. Calculate the average catch of all of the cans in the data set.

b. Find the 4 lowest values in your group's data set. What is the average of these 4 values?

c. Students use the following formula to calculate the distribution uniformity of the irrigation system on the turf area (the answer is a percent).

$$DU = \left(\frac{\text{Average Catch of Lowest 4 Values (ml)}}{\text{Average Catch Overall (ml)}} \right) \times 100$$

d. The higher the DU is the better the performance of the system. If all samples are equal, the DU is 100%. There is no universal value of DU for satisfactory system performance, but generally a value >80% is considered acceptable.

10. Continue to use the *Turf Irrigation Audit Worksheet* (Appendix 3.6.B). Calculate the amount of water applied to the turf area in one year:

a. What is the watering rate (WR) for the turf area irrigation system? *The answer will be in inches/hour.*

$$WR = \left(\frac{3.66 \times \text{Average Catch (ml)}}{\text{run time (min)} \times 1.9\ \text{in}^2} \right)$$

b. Using the data from the grounds-keeper about the watering schedule for the turf area, students calculate the amount of water used on the turf area each year if the sprinkler system runs __ minutes per day, __ days per week, __ weeks per year (fill in the blanks with data from your grounds-keeper).

c. Calculate the area of the turf area. The area of a rectangle is: length x width. The area of a triangle is ½ base x height. Students may need to divide their area in to sections to calculate the total area. Based on the turf area, how many inches are used to water it each year?

d. Irrigation specialists estimate turf landscaping needs in different areas of the state (Appendix 3.6.F). Use the data estimate closest to your location in inches of water per square foot per year. Compare this number to the answer the students calculated in inches per year. Is the turf area being under or over watered?

e. Students can calculate how many gallons per square foot per year is used with *the conversion factor of 0.623 to convert inches of water to gallons of water.*

f. Ask the cooperative learning groups to discuss whether it is important to school operations and students at the school that this area remains turf.

Part 2: Non-Turf Irrigation Audit

1. **Design of experiment:** In cooperative learning groups, students will write their own procedures for auditing other non-turf irrigation fixtures (drip and bubbler).
2. **Pre-Assessment:** Have students do a quick write in their notebooks:
   - How can we determine whether the irrigation is efficient on non-turf areas?
   - Estimate the amount water used in one week on a drip irrigated area.
3. **Review** the operation of bubbler and drip irrigation emitters. Describe a drip irrigation system to students and show them the components that make up the system. Remember that flow controllers can be underground or at the end of the spaghetti tubing for drip irrigation.

   Review the *Procedure Writing for Non-turf Irrigation Audit* (Appendix 3.6.C). Students will develop their own procedures in their cooperative learning groups.

   Notes: Students could mark the irrigation emitter once measured with metal flagging to show that data was collected. The irrigation may need to be turned on to locate the emitters.
4. **Discussion:** The discussion during procedure writing should review the basics of good scientific procedure. Introduce to or review with the students the concepts of independent and dependent variables.
   a. Can students describe how they will change the independent variable?
   b. Can students explain how they will measure the dependent variable?
   c. Students should list their controlled and uncontrolled variables.
   d. Add to the *Non-turf Irrigation Audit Data Sheet* (Appendix 3.6.D) accordingly.
5. **Assemble materials and record the data** on the *Non-turf Irrigation Audit Data Sheet* (Appendix 3.6.D). Students should alternate jobs allowing each student to acquire experience measuring the data. All students should record data on the data sheet.

Student investigating and flagging broken drip tubing.

Pros and Cons of Using Turf on Non-athletic Field Areas

Pro	Con
-Holds in soil -Good for playing on	-Uses a lot of water -Is only one color

Student auditing drip emitter.

6. Back in the classroom, work through the calculations to determine the amount of water used each year on non-turf irrigation using the *Non-turf Irrigation Audit Worksheet* as a basis (Appendix 3.6.E).
7. Compare the amount used on non-turf areas with the amount used on turf areas (that are not athletic fields).
8. Record and discuss recommendations for improving the school's outdoor irrigation for turf areas? Non-turf areas? Are all the turf areas needed?

Wrap-up

Discuss the findings of the nonathletic field turf irrigation water audit and the non-turf irrigation water audit. For a similar sized area which uses more water? Discuss with students the pros and cons of using turf on nonathletic field areas.

Discuss with students how much water could be saved by converting turf areas to non-turf vegetation.

Assessment via Note-booking/journaling:

Write a compare and contrast paragraph regarding the benefits of turf versus non-turf vegetated areas.

Have each student share these observations with a partner.

Appendix 3.6.A

Turf Irrigation Audit Data Sheet

Name: ___________________________________ Group #: _____ Period: _____ Date: ___________

Inquiry Questions:	*How much water is used on your designated turf area? Do we water it efficiently?*		
Materials:	10 ml graduated cylinder, clipboards, pencils, catch cans, stop watch, outdoor tape measure, metal flagging stake		
Sprinkler Location:		**Run time:**	

Catch Can #	**Water in can? How many ml in can after 10 minutes?**	**Comments/Problems?**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
Average		Wind Speed Description: ______________ Speed in miles per hour: ______________

Appendix 3.6.B
Turf Irrigation Audit Worksheet

Name: ________________________________ Group #: _____ Period: _____ Date: ___________

1. Find the average of all 16 catch cans.

2. Find the 4 lowest values in your group's data set. What is the average of these 4 values?

3. What is the distribution uniformity of the irrigation system on the football field? *Your answer will be a percent.*

$$DU = \left(\frac{\text{Average Catch of Lowest 4 Values (ml)}}{\text{Average Catch Overall (ml)}} \right) \times 100$$

4. What is the area of the turf area you measured (write the formula; don't forget unit)?
   Length = Width =

5. What is the watering rate (WR) in inches per hour for the turf area? *Your answer will be in inches/hour.*

$$WR = \left(\frac{3.66 \times \text{Average Catch (ml)}}{\text{run time (min)} \times 1.9\ \text{in}^2} \right)$$

6. How much water is used to water the turf area each year if the sprinkler system runs 3 hours per week, YY weeks per year. *These numbers will come from the grounds-keeper and may not be the same during all seasons.*

7. Irrigation specialists estimate turf landscaping needs in different areas of the state. Use the Table in Appendix 3.6.F to get the estimate in inches of water per square foot per year. Compare this number to the number you calculated (question 6). Is the turf area being under or over watered?

8. How many gallons per square foot per year is being used on the turf area? *Use the conversion factor 0.623 to convert inches of water to gallons of water.*

Appendix 3.6.C
Procedure Writing for Auditing Non-turf Irrigation

1. Inquiry question is clearly stated.
2. Objectives are listed.
3. Students have content knowledge about the subject they are studying.
4. Logistical data is listed on datasheet including location.
5. Materials used are listed.
6. The measurement procedure is clear, concise and numbered in chronological order
7. The data collection units are clearly written on the data sheet.
8. Assumptions made are noted on the data sheet.
9. A process for unit conversion has been identified.

Appendix 3.6.D
Non-turf Irrigation Audit Data Sheet

<table>
<tr><th></th><th>How many ml after 5 minutes?</th><th colspan="2">What is the drip rate in gallons per hour (gph)? (See Appendix 3.1.E for help with conversion factors.)</th><th>Comments (What should the emitter output be? Is the emitter properly functioning?)</th></tr>
<tr><td>Open tubing</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>Emitter 1</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>Emitter 2</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>Difference</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td colspan="5">What is the area of the common area watered with drip irrigation? (Measure length x width)</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">What other problems do you notice with the irrigation system?</td></tr>
<tr><td>Problem</td><td colspan="4">Description of Problem</td></tr>
<tr><td>1</td><td colspan="4"></td></tr>
<tr><td>2</td><td colspan="4"></td></tr>
<tr><td>3</td><td colspan="4"></td></tr>
<tr><td>4</td><td colspan="4"></td></tr>
<tr><td>5</td><td colspan="4"></td></tr>
</table>

Appendix 3.6.E
Non-turf Irrigation Audit Worksheet

1)	Xeriscape landscaping needs ______ inches of water per square foot per year. How many gallons is this? *Use the conversion factor 0.623 to convert inches of water to gallons of water.*
2)	How many gallons of water is needed each year to water the drip irrigation area you measured and recorded on the data sheet?
3)	What is the difference in gallons per square foot between turf and drip irrigation?
4)	What are your recommendations for the common area? *(Consider the pros and cons of xeriscape and turf.)*

Appendix 3.6.F
Plant Water Needs Table

Annual Water Requirements for Different Landscape Types

For use with Appendix 3.6.B and 3.6.E Worksheets

(all values in inches/square foot/year)

		Xeriscape Vegetation		Non-native & Ornamental		
City	Evapo-transpiration	Low Water Use	Medium Water Use	High Water Use	Citrus	Turf
Bullhead City	75.91	9.87	19.74	34.16	49.34	60.73
Casa Grande	73.78	9.59	19.18	33.20	47.96	59.02
Douglas	70.74	9.20	18.39	31.83	45.98	56.59
Flagstaff	47.13	6.13	12.25	21.21	30.63	37.70
Gila Bend	73.81	9.60	19.19	33.21	47.98	59.05
Holbrook	55.69	7.24	14.48	25.06	36.20	44.55
Kingman	69.74	9.07	18.13	31.38	45.33	55.79
Marana *	80.63	10.48	20.96	36.28	52.41	64.50
Maricopa *	79.77	10.37	20.74	35.90	51.85	63.82
Nogales	68.19	8.86	17.73	30.69	44.32	51.28
Page	64.10	8.33	16.67	28.85	41.67	69.25
Parker *	86.56	11.25	22.51	38.95	56.26	44.62
Payson	55.77	7.25	14.50	25.10	36.25	61.30
Phoenix *	76.62	9.96	19.92	34.48	49.80	36.47
Pinetop	45.59	5.93	11.85	20.52	29.63	48.79
Prescott	60.99	7.93	15.86	27.45	39.64	61.84
Safford *	77.30	10.05	20.10	34.79	50.25	51.98
Sierra Vista	64.97	8.45	16.89	29.24	42.23	36.06
Springerville	45.07	5.86	11.72	20.28	29.30	44.46
Tuba City	55.58	7.23	14.45	25.01	36.13	61.94
Tucson *	77.43	10.07	20.13	34.84	50.33	52.74
Willcox	65.93	8.57	17.14	29.67	42.85	37.57
Williams	46.96	6.10	12.21	21.13	30.52	37.57

Yitayew, M. 1990. Reference Evapotranspiration Estimates for Arizona. Technical Bulletin 266. Arizona Agricultural Experiment Station. College of Agriculture, The University of Arizona, Tucson, AZ 85721.

* Indicates updated data from AZMET stations (averaged for years 1987-2001).
<http://ag.arizona.edu/AZMET/normals.htm>

Appendix 3.6.G
Beaufort Scale - Estimating Wind Speed

Beaufort number	Description	Wind speed				Land conditions
		km/h	mph	knots	m/s	
0	Calm	< 1	< 1	< 1	< 0.3	Calm. Smoke rises vertically.
1	Light air	1.1 – 5.5	1 – 3	1 – 2	0.3 – 1.5	Wind motion visible in smoke.
2	Light breeze	5.6 – 11	4 – 7	3 – 6	1.6 – 3.4	Wind felt on exposed skin. Leaves rustle.
3	Gentle breeze	12 – 19	8 – 12	7 – 10	3.4 – 5.4	Leaves and smaller twigs in constant motion.
4	Moderate breeze	20 – 28	13 – 17	11 – 15	5.5 – 7.9	Dust and loose paper raised. Small branches begin to move.
5	Fresh breeze	29 – 38	18 – 24	16 – 20	8.0 – 10.7	Branches of a moderate size move. Small trees begin to sway.
6	Strong breeze	39 – 49	25 – 30	21 – 26	10.8 – 13.8	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	High wind, Moderate gale, Near gale	50 – 61	31 – 38	27 – 33	13.9 – 17.1	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt, especially by people on upper floors.
8	Gale, Fresh gale	62 – 74	39 – 46	34 – 40	17.2 – 20.7	Some twigs broken from trees. Cars veer on road. Progress on

						foot is seriously impeded.
9	Strong gale	75 – 88	47 – 54	41 – 47	20.8 – 24.4	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. Damage to circus tents and canopies.
10	Storm, Whole gale	89 – 102	55 – 63	48 – 55	24.5 – 28.4	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	Violent storm	103 – 117	64 – 72	56 – 63	28.5 – 32.6	Widespread damage to vegetation. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	Hurricane	≥ 118	≥ 73	≥ 64	≥ 32.7	Very widespread damage to vegetation. Some windows may break; mobile homes and poorly constructed sheds and barns are damaged. Debris may be hurled about.

Chart reference: http://en.wikipedia.org/wiki/Beaufort_scale

ARIZONA COOPERATIVE EXTENSION
THE UNIVERSITY OF ARIZONA • COLLEGE OF AGRICULTURE AND LIFE SCIENCES

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE AND LIFE SCIENCES
TUCSON, ARIZONA 85721

KERRY SCHWARTZ
Director, Arizona Project WET
Associate Specialist, Dept. of Agriculture Education, Water Resources Research Center

MARY ANN STOLL
Program Coordinator, Water Sustainability Program, Maricopa County

CANDICE RUPPRECHT
Senior Program Coordinator, School of Natural Resources and the Environment, Water Resources Research Center

NANCY CROCKER
Senior Program Coordinator, Water Sustainability Program, Maricopa County

CONTACT:
KERRY SCHWARTZ
kschwart@ag.arizona.edu

This information has been reviewed by University faculty.
cals.arizona.edu/pubs/water/az1505.pdf

Other titles from Arizona Cooperative Extension can be found at:
cals.arizona.edu/pubs