WATER SOURCE USE AND EXPANSION ASSESSMENT

Greenhouse*A*Syst

The University of Georgia
Greenhouse*A*Syst
Publication Series
A Program Designed to Assess
and Manage Issues Involving
Our Natural Resources and
Environment

UGA extension

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The University of Georgia

The Greenhouse*A*Syst Publication Series

A Program Designed to Assess and Manage Issues Involving Our Natural Resources and Environment

Home*A*Syst is a national program cooperatively supported by the USDA Cooperative State Research, Education and Extension Service (CSREES), USDA Natural Resources Conservation Service (NRCS), and U.S. Environmental Protection Agency (EPA).

This publication follows the Farm*A*Syst/Home*A*Syst grower self-assessment model of dividing farming management into a series of issues, dividing each issue into categories, including educational materials, and following up the self-assessment with the development of action plans to address the key areas of concern. Universities that have *A*syst publication series include Oklahoma, Kansas, Texas and Wisconsin. New series have recently been successfully developed at major universities including Orchard*A*Syst and Food *A*Syst.

The Greenhouse*A*Syst publication Series has been developed to assist greenhouse owners with the task of assessing three management issues: Water management, Environmental Risk and Business Profitability. To date, six publications dealing with the water issues are being reviewed and six more are being developed.

The Greenhouse*A*Syst series of publications is a confidential self-assessment program you can use to evaluate your greenhouse business for risks associated with water management issues. Armed with facts and figures, you will then be able to re-evaluate your management strategies and determine ways to conserve water and minimize those risks. By following the guidelines, you will be able to establish a formal company-wide water conservation plan. Implementation of this plan will facilitate more efficient use of resources and impart significant savings in water use, fertilizer and pesticides.

This bulletin will also help you establish a water conservation document you may find useful if and when state or local water authorities develop policies or implement water restrictions. Most water authorities are favorably impressed with businesses that have developed water conservation plans.

Greenhouse*A*Syst risk assessment consists of a series of questions that will walk you through the considerations to be taken into account while evaluating your business. In order to gain the full benefit of the Greenhouse*A*Syst program, we recommend that you use all 12 publications in the series in the following order.

Risk Area	Greenhouse*A*Syst Publication	Suggested Order
Water Source and Expansion	In production	1
Delivery and Technology	In production	2
Water Management	In production	3
Water Quality	In production	4
Water Recycling/Pollution Prevention	In production	5
Water Regulations/Company Policy	In production	6
Fertility Management	In development	7
Operation Safety and Biosecurity	In development	8
Shipping, Transportation and Material Handling	In development	9
Greenhouse Energy Utilization	In development	10
Time and Labor Management	In development	11
Greenhouse Maintenance	In development	12

Water Source Use and Expansion Assessment

Publication #1 in the Series

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What Can This Bulletin Series Do for Me?

This bulletin will allow you to evaluate your greenhouse company's risks in terms of water use. When you have the facts and figures, you will then be able to re-evaluate your management strategies and determine ways to conserve water and minimize those risks. By following the guidelines, you will be able to establish a formal company-wide water conservation plan. Implementation of this plan will facilitate more efficient use of resources and impart significant savings in water use, fertilizer and pesticides. This bulletin will also help you establish a water conservation document you may find useful if and when state or local water authorities develop policies or implement water restrictions. Most water authorities are favorably impressed with businesses that have developed water conservation plans.

Pre-Assessment Considerations Using a Water Audit

What is the purpose of a water audit? A water audit will determine just how much water you use per year, per month and, perhaps, per crop. This data will allow the greenhouse owner to develop an overview of current and future water using real numbers so realistic strategies for water use and conservation can be defined at a later date. Knowing how you use water will not only aid in determining your potential to save water, it will also give you the facts you need when city officials and regulators question your company's water use history. Having facts and showing proof can go a long way in satisfying local administrators that your company is using water responsibly. A true water audit is usually performed by a professional irrigation consultant or by an official from a state regulatory agency. However, growers are certainly able to assess their own situations and use this information for management decisions involving technology upgrades and changes in cultural practices. This information will also allow growers to know that their water supplies are adequate and what amounts of reserve or emergency water resources they should have in place. If you know the amount of water you use, then when alternative water supply opportunities become available, you can determine how such a resource could fit into your operation. You also need to know water use to determine the cost of a water supply. Then alternative supplies can be evaluated economically.

Nursery and greenhouse managers also need to monitor water quality of their irrigation water and the runoff that leaves the greenhouse. Water qual-

ity legislation is continually becoming more restrictive on the amount of contaminants that can be returned to streams or other water sources. If your runoff goes to a wastewater treatment plant, then you already are paying for cleanup of your waste water through sewerage charges. These costs will continue to rise as the treatment plants fall under more stringent water quality requirements.

We are clearly in a period of great legislative changes involving water policy. Shrinking water resources in many states have prompted exploratory legislation to restrict commercial water use. Greenhouse and nursery businesses are unfortunately viewed as water wasters. Watering restrictions have been imposed in Georgia and 37 other states. This should be a wake-up call to commercial firms that water conservation issues will surface. It is only a matter of time. This assessment and the solutions suggested will allow the greenhouse grower to develop an overview of current and future water use so strategies for water use and conservation can be defined at a later date. Diminishing water resources in many states have prompted local ordinances and statewide legislation to restrict commercial water use. If a grower can show that water is being used efficiently, he or she would be less likely to have unreasonable water restrictions imposed on them.

At one recent drought policy meeting, local municipal water authorities, legislators, and nursery and greenhouse producers met in an attempt to find consensus between the demands of the local water authority to conserve water and the needs of the growers. One concerned legislator asked if anyone in the room knew how many gallons they used on their ornamental crops per year. Not one grower could even give a "guesstimate." The room fell silent. The legislator stared intently at the growers and then stated. "If you do not know, or don't care how much water you are using during one of our state's worst droughts, perhaps mandatory regulations are needed. You could hear a pin drop save for a few gasps. Notably, the local car washes were not restricted in any way. Legislators had heard their usage estimates, including water conservation plans, many months prior. A greenhouse or nursery water audit is clearly needed so growers and legislators know the facts and can establish individual conservation plans.

The audit, in combination with the risk assessment, will provide the business owner with a powerful tool to develop and publish a water use policy, and to explore new technology to aid in water conservation.

In order to do a proper assessment, you will need to know how much water you use and when. For most greenhouses and nurseries, this information is not available. The best method to determine water use is to install a flow meter or water meter to your water sources. This will allow you rapid assessment of hourly or daily use, and also allow some degree of extrapolation for yearly use. It will take some time to get an accurate accounting of annual water use. A proper assessment usually occurs over a 2-year period. However, you can take many steps immediately that will help you in this initial assessment. After you have reviewed these questions, read through the different options for assessment. Once you have developed these answers, proceed to the risk assessment form at the end of this section.

Section 1. Greenhouse*A*Syst Risk Assessment Of Water Source Use

The goal of this section is to help you formulate an accurate assessment of your current and potential water supply and usage.

Does your water supply vary during seasons?

This is an indication that the water supply may pose a problem in the future, especially if expansion is being considered or if periodic droughts are possible.

Do you have multiple sources of water or are you dependent upon one water source?

Single source dependence is very risky.

What is the daily capacity of extraction from your ground wells in gallons per day?

Souce # 1 ________ Source # 2 ________ Source #3 ________ Total ________ GPD

What is the daily extraction capacity from any stream or pond on your property?

Source #1 ________ GPD Source #2 ________ GPD Total ________ GPD.

What is the daily extraction capacity from any stored water source? ________ GPD

What is the daily extraction capacity of your municipal water supply? ________ GPD

What is the potential extraction capacity from rainwater capture? ________ GPD

Add your total water availability from all sources: Total __________GPD

Determining Water Use for A Greenhouse Operation

Do you know how much water you actually use, weekly, monthly or annually?

To get this information, you will need to consult your water bills or establish a monitoring system. Remember, water use varies over the seasons, so taking one month's sample and multiplying it by 12 is not an accurate method.

Deciding how much water your system should be able to apply at any given time depends on these factors:

1) area of production beds and benches.
2) plant material and their water requirements.
3) kind of irrigation system.
4) number of hours per day that your irrigation system works.

In the greenhouse, the temperature and humidity are held relatively constant day to day during the production schedule of a particular crop. For outdoor production beds, however, watering needs can change radically from day to day, so the actual amount of water use will be more variable for the outdoor production beds. Either way, for determining the amount of water you need to have available for complete watering, you need to look at a peak demand situation and make sure that your water supply can handle that peak demand.

The peak demand for watering varies from 250-1,500 gal./1000 ft^2 per watering. In a hot, dry time of year, watering may need to be carried out as many as three times a day for smaller container plants. Because of this reality, the peak demand needs to be recoverable in a 4-hour period, and the irrigation system needs to be able to apply water to the entire operation in 4 hours or less. The peak demand amount is used to determine pump capacity, pipe sizing, type of distribution system, number of independent watering zones and storage capacity. Table 1 gives values of estimated maximum daily water requirements for different greenhouse crops.

Table 1. Estimated Maximum Daily Water Requirements (adapted from Aldrich and Bartok, 1994).

Crop Example	Gallons of Water/Ft^2 per Day
Bench crops	0.4
Bedding plants	0.5
Pot plants	0.5
Chrysanthemums, Hydrangeas	1.5
Roses	0.7
Tomatoes	0.25
Outdoor production	0.25

For determining a peak demand, the crops in production in mid- to late summer would be the most likely crops to consider, unless you have a very high water-using crop at some other time of the year. Once the peak demand crop is determined, then select the maximum daily water requirement from Table 1. Multiply this value by the area in production for that plant material to establish the peak demand for that crop in gallons per day. You may have several crops at one time with different water requirements. In this case, calculate the gallons per day for each crop and add the water demand for all the crops together to get the total gallons per day to support the crop. With this total value, add 10 percent for leaching, giving the peak demand value. The design of water supply and irrigation system relies on this peak demand value for proper sizing.

The next thing to calculate is the flow rate required for the peak demand. To determine flow rate requirement, decide the amount of time to irrigate the whole operation. For example, if plants will need to be watered three times in a 12-hour day, then the irrigation of the operation must be completed in 4 hours. Flow rate requirement is the peak demand divided by the maximum length of time it takes to irrigate the whole operation once.

Example: Calculation of Water Requirement for an Operation

Given: Two, 25 ft x 110 ft greenhouses (assumed usable greenhouse space – 90%), one greenhouse has bedding plants, the other hydrangea. The bedding plants need to be watered three times a day in 10 hours or less.

Given that we have 90% space use efficiency due to benches, etc., we need to accommodate that fact first. Multiply 110′ by 25′ = 2,750 sq ft of production space. Now multiply that figure by 90%: 2,750 x 0.9 = 2,475 sq. ft. of usable growing space. Remember, your greenhouse may have 80% or even 70% use efficiency.

Determine the gallons per day for the operation.

Bedding plants – 0.5 x 2,475 = 1,237 gallons per day
Hydrangea – 1.5 X 2475 =3712 gallons per day
Total gallons per day = 1,237 + 3,712 = 4,949 gallons per day.

Now let's round 4,949 gallons to 5,000 gallons/day to make the next part easy. Rounding up is also a way to prevent underestimation.

Add leaching fraction of 0.1% (10%) to accommodate water that runs out of the pot.

0.1 x 5000 = 500 gallons per day
Total water required = 5,000 + 500 or 5,500 gallons per day

To water three times in 10 hours, the time to complete one watering must be

10 divided by 3 = 3.3 hours or 3 hours and 20 minutes

To get the flow rate needed

$$\frac{5{,}500\text{gal/day}}{3.3\text{ hrs/day}} = 1{,}667\text{ gal/hr}$$

Converting to gallons per minute

$$\frac{1667\text{ gal/hr}}{60\text{ min/hr}} = 28\text{ gpm}$$

The water system and supply needs to be designed for a 28 gpm flow to provide the peak demand for these two greenhouses.

Two Alternative Ways to Calculate Indoor Greenhouse Water Use

Method #1: Purchase and install a flow meter (the best and most accurate method).

Flow meters come in many sizes and cost from around $100 to $1,200 per unit, depending upon size, material construction and the amount of information reported. Flow meters are accurate, long-lived and essential for any growing operation that wishes to monitor water use. Flow meters are essential for rural operations where water comes from a well. Municipal water sources usually have a flow meter (water meter) installed as part of the water service agreement. However, owners may wish to know how much water is used in outdoor field operations and greenhouse bays or individual houses at any given time, separately. Smaller, in-line flow meters can accomplish this goal for a one-time investment of a few hundred dollars. However, flow meters do not record total use, and therefore simply show you current use at that moment.

It is probably best to assess weekly water usage via a water meter at the same time of day on a set day of the week. Reading the water meter on every Monday morning to record the water use of the previous week will not take much time, and will give you very accurate estimates of average daily use. A handy water audit form has been provided in Appendix A for you to copy and use as needed.

You can then total the data by month or growing season and determine averages, or project annual use or variations between seasons or years as years of data are collected.

Method #2. The Emitter Flow-Rate and Bucket Estimates (A quick way to get a general idea of maximal use).

Part A. Determine the number of sprinkler heads or drip emitters and their flow rates per zone, and add them together and compare to your potential demand rating. (Emitters should not emit more than their flow rate at the recommended pressures).

Part B. To test the output capacity of your well, find a 55-gallon drum. Record the time it takes to fill this drum with the water valve fully open. Then divide the 55 gallons by the number of minutes it took to fill the drum. You will get a fairly reasonable estimate of the number of gallons/minute your water source puts out.

The A & B figures averaged should be close enough to give you a good estimate for your daily water use. You may wish to perform this test during a high water use period to verify that high usage does not affect well flow rate.

A Method for Calculating Outdoor Production Water Use

Equation #1: Field Use — In Ground

For outdoor production, 1 acre of land irrigated with 1 inch of water equals the application of 27,154 gallons of water. Under hot, dry conditions, water requirements may be as much as 3 inches per day. This is due to wind and direct sun that greatly increase evaporative loss. Remember, depending on your arrangement of containers, the actual water applied off-target may change dramatically.

Equation #2: Field Use — Container

A commonly recommended volume of water to be used in irrigation for a 1-gallon container is 1 pint, or 0.125 gallon of water. You can multiply this value by the number of pots in production only if you use drip irrigation. Overhead irrigation covers the entire area and is handled as one would for field irrigation as stated above.

Let us assume a half-acre of outdoor perennial production, using overhead sprinklers on posts. On average, we will have something between the hottest and driest days. So let us estimate 1.5 inches per irrigation event every other day.

27,154 gallons x 1.5 = 40,731 gallons x 0.5 (every other day staggered by zone) = 20,365 gallons per day required. Multiply this by 2.5 to get the estimated weekly use, which is 50,912.5 gallons/week.

Equation #4: Total Operation Use

Add the indoor greenhouse weekly estimate and the outdoor nursery water requirement estimate together.

Is Water Storage the Answer?

Assuming that you have an unlimited water source (and you should not!), you must still consider your pump's delivery capacity. If your pump provides only 30 gallons per minute (GPM), you can easily see that it will not be capable of irrigating a large field of perennials and eight greenhouses at the same time. To make the system work, you would likely water one house or one zone at a time. At least one member of your crew would likely be watering all day. Your pump would run all day, every day.

If you had that one day's supply of water stored in a 30,000-gallon storage tank with a distribution pump capable of delivering several hundred gallons per minute, and you automated the water delivery system using efficient drip irrigation or ebb and flow benching, you could water your entire facility in a few hours. However, at 30 GPM, would you have enough water replaced in the storage tank each day to do so? If we assume the pump cycles on 45 minutes per hour, then 45 x 24 hours in a day = 1,080 minutes. At 30 gallons per minute, you would have 32,400 gallons of water pumped per day.

Do you store water for emergencies?

Typical emergencies:

Ice storm — 5 days without power
Drought — 2 week water use restriction
Main Water Pump Failure/Well collapse — 5 days no water

If the source is a sealed above- or below-ground tank, is the tank large enough to store sufficient water to supply your peak use needs (maximal flow rate) for one to three days?

Do you know how much water is costing you on a per 1000 gallon basis?

There is a true cost even if you have your own well in a rural setting or pump water from a local stream. The 1,000-gallon basis for cost estimating purposes is fairly universal.

Do you have an electric generator dedicated to, or supporting the water delivery system?

If you have ever had a power outage, you know how devastating it can be, especially in late summer when young poinsettia and pansy crops are being grown.

Do you have multiple water sources for use as irrigation water if filtered?

Municipalities might be very happy to see that you could go off-line for a month if need be.

Are there any impediments to using this water source?

Examples: Electrically operated pumps (w or w/o backup power)
Municipal ordinances, water restrictions
Dry season well capacity
Water quality
Water rights issues

Do you know the potential amount of rainwater you could collect from a 1-inch rain?

Given 2,500 sq ft of greenhouse roof, a 1-inch rain generates 1,558 gallons of fresh water. If your region averages 30 inches of rainfall per year, and you could store that water, you would have 4,6740 gallons of water available (1,558 x 30). How much roof area do you have? How much annual rain falls in your region?

The following is a table designed to help you estimate the yield of a single rainfall on a per-square-foot of roof surface area. To obtain a yearly estimate, simply calculate the square footage of your greenhouse roof and multiply by your average yearly rainfall to get an estimate of water harvest potential per year.

Table 2. Yield of a Single Rainfall on a Per-Square-Foot of Roof Surface Area.

Rainfall (Inches)	Gallons (Sq. Ft.)
1	0.62
2	1.25
3	1.87
4	2.49
5	3.12
6	3.74

Example: A business has five greenhouses with a combined roof surface area of 30,000 sq. ft. The owner lives in Athens, Ga., where depending upon the year, it rains between 35 and 60 inches per year. If we assume the average is 48 inches, a figure cited by University of Georgia scientists, then we can estimate the rainfall yield of the roof.

First divide the annual value by one of the rainfall values in the table. This allows for easy calculations later.

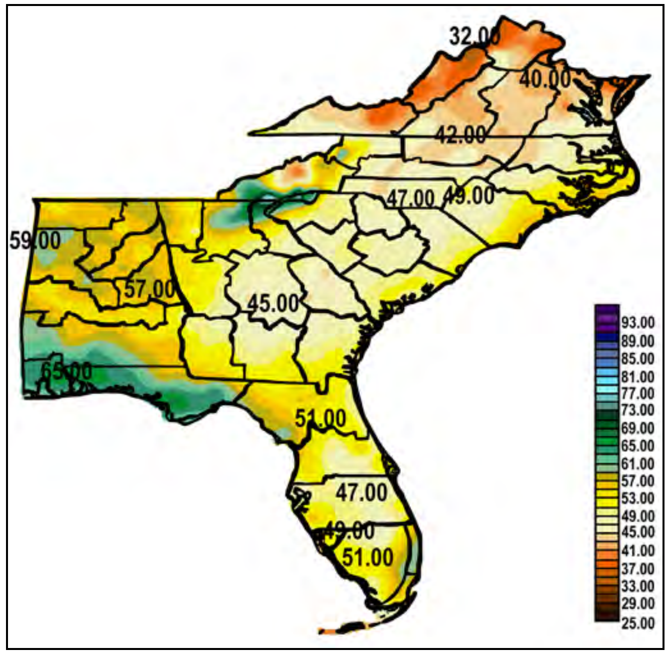
Forty eight inches divided by 6 inches equals 8. Now multiply 8 times the rainfall value for the 6″ rainfall (Table 2); 8 x 3.74 = 29.92 gallons. Now multiply this per square foot yield by the number of square feet of the roof, 30,000 x 29.92 equals 897,662 gallons of water per year.

You can also do this procedure on a monthly basis by checking with the national weather service to get your local monthly rainfall averages, and then multiplying out those figures. You may be surprised how much water is still available in your local dry season.

Table 3. Average Monthly Rainfall for Athens, Georgia.

ATHENS, GA.	
Month	**Inches**
January	1.60
February	2.49
March	1.68
April	3.11
May	4.19
June	3.06
July	1.89
August	2.24
September	3.60
October	3.38
November	2.20
December	2.06

Example: How much rain would a business owner be able to harvest in July? You have two choices. Round up 1.89 to 2.0 and simply multiply 30,000 by the yield value in Table 2 for 2 inches: 30,000 x 1.3 inches = 39,000 gallons. Alternatively, if you want a less optimistic estimate, multiply the value for 1 inch (0.6 from Table 2) by 1.89. This yields 1.13 inches. Now multiply by 30,000: 1.13 x 30,000 = 34,020 gallons for July.



Calculating Storage Capacity And Need

If you have a few days reserve of water in an underground or above ground tank, you will likely experience short term municipal or on-site water loss with little or few problems. This can be critical during peak crop production times. First, obtain monthly water use from recent water bills, or the data from your own flow meter. Then estimate the amount of water you use per day, on a per month basis. Select the highest water use per month value. For our purposes, let us assume you own a small greenhouse that uses about 8,000 gallons per day (peak) in the month of June.

Calculate Holding Tank Capacity

Equation #1: Full Capacity Storage

(Number of gallons of water needed per day x 3 days) = required cubic feet of storage capacity for three-day supply of water

Average Day Use:

If we want to have just enough storage for 1 day, we decide we need an 8,000-gallon tank. If we divide this by 7.48 (a conversion value), we get the tank capacity: (8,000 gallons/7.48 = 1069.5 cubic foot tank). Now multiply that figure by 3 days' usage (or more): 1,069.5 x 3 = 3,208.5

gallons. You would likely consider in-stalling a 3000 cu. ft. tank or larger.

Some Additional Considerations

Depending upon the cost of the storage structure, and the types of crops grown, some rural growers are storing up to 2 weeks of water using large cisterns. This is prudent as rural electric lines tend to be down longer during occurrences of hurricanes, ice storms and tornadoes. How much you choose to set aside in reserve must be based upon your needs and the cost of the installation.

In addition to the storage tank, we also recommend a generator to back up the water pump if extensive power outages occur.

Now that you have completed a basic assessment of water availability, you need to quantify that risk by doing a thorough risk assessment. This will give you an overall view of how reliable your water supply is.

Using the Risk Assessment Tables

- The Greenhouse*A*Syst risk assessment portion of this document presents a series of management practices and equipment specifications concerning your watering and irrigation practices.
- Each evaluation topic affects the risks of water waste or water pollution for the practices and equipment of your operation.
- The results of your assessment will indicate practices or equipment that are the most problematic and where changes are most needed.
- Greenhouse*A*Syst is a voluntary program and your assessment is for your eyes only to help you make well-informed decisions.
- The assessment should be completed in an established period of time set by the business owner. If needed, a professional from the CES can provide assistance in completing the assessment or an action plan in response to your assessment.

Greenhouse*A*Syst Assessment of Water Supply

Instructions for Completing the Risk Assessment

For each subject given in the leftmost column, read through each column and then select the description that best describes your operation. Do not rate practices that do not apply to your operation. Record the risk rating value in column 6 (the rightmost column), and then calculate the overall risk rating for this section. We will use these ratings to assess the overall water related risk of your operation at the end of the document.

	Low Risk 4	**Low-Moderate Risk 3**	**Moderate-High Risk 2**	**High Risk 1**	**Rank Your Site**
Water Supply Sources	More than one water supply option, i.e. city water and a pond or well for supply.	One water supply option fully functional with second source in need of equipment repair or setup to be functional.	One consistent water supply only, with no backup water supply plan.	Your primary water supply changes seasonally in its amount of water available.	
WATER SUPPLY FROM PUBLIC WATER SYSTEM					
Preparation for Water Cost Changes	Are aware of the current utility plans for water rate increases in the next 5 years and have developed budgets or other water sources accordingly.	Are aware of the current water supply situation for the public utility, but have no knowledge of rate structures and how they might change in the future.	Are aware of current public utility limitations on water supply but have no backup water resource to handle future water restrictions.	Have no estimates of current water costs and are unaware of the public utilities' future plans for rates.	
RECYCLED WATER SUPPLY					
Volume of recycled Water	Amount of water applied that gets recycled has been measured for most different operating scenarios and is known.	Amount of water that gets recycled has been measured for the highest water use seasons and operating scenarios and is known.	Amount of storage for recycled water is the measure of how much water gets recycled, but change in storage over time is not monitored.	Amount of water that is recycled during different seasons is unknown.	
Cost and Benefits of Recycled Water	The initial capital costs and operating costs for use of recycled water have been determined, and the amount of fresh water saved and cost savings of the saved fresh water due to recycling has been determined.	The initial capital costs and operating costs for use of recycled water have been determined, but the difference in cost of fresh water and recycled water use has not been determined.	The initial capital costs for setting up a recycling system are known, but operating costs of recycled water use have not been determined.	Cost of recycled water use has not been evaluated.	

Ranking Totals	÷	**Total Areas Ranked**	=	**Water Source Risk Rating**
______________	÷	__________________	=	________________________

Section 2. Greenhouse*A*Syst Risk Assessment of Planning for Expansion

The purpose of this section is to review how expansion may affect your water supply and management.

Most businesses grow and, as the business grows, the amount of water needed also increases. This may require drilling an additional well or changing the water use efficiency of the entire operation to avoid drilling a new well. By considering not only your future water needs, but how much your current supply would be adequate in the future if conservation measures were taken now, is a very important task. The following questions will outline the basic considerations.

Is your current water supply sufficient for your potential expansion needs for the next 10 years?

Your best estimate of growth, based upon your past growth, may be sufficient to use in this planning exercise. If you have a long-term plan to use a certain amount of space or acreage, extrapolate your current use to that entire space. Use your current water use per square foot figure and multiply it by the square feet of space you plan to use in 10 years, or at maximum capacity of your land.

What are the impediments to expanding your water supply?

List the restrictions or impediments to expanding your water supply. These would include the financing for a new well, the lack of municipal water supply, drilling restrictions in your county, water quality issues, and local ordinances or zoning issues.

Could conservation and new technology negate the need for a new well or expanded usage?

By looking at the maximum, realistic gallons per day you could conserve, you may find that your current water supply could last up to 10 years longer than expected without conservation.

Are you considering changing crops grown to include more drought tolerant plants?

Water use is very crop dependent, and switching to an inventory of plants that require less water will dramatically affect your water usage.

Would changing over to a water efficient application method pay for the new well or additional water source costs in the next 5 years?

Cost savings from conservation of water use comes not only from the water saved, but the reduced use of fertilizer and pesticides. When added together, these savings may allow a new well and irrigation system to be purchased in 5 to 10 years.

Expansion Considerations

STEP 1. Begin by establishing the total number of square feet of production area you currently have. Next, use your best estimated or actually measure Annual Current Water Usage (ACWU) from the first section in this publication as your optimal water use value. Divide the ACWU by the square footage of operation to obtain the number of gallons used per square foot per year. You can divide this figure by 52 or 365 to get weekly or daily use requirements respectively. However, if you do not have actual values and you estimate water use, remember that you actually use larger amounts of water in spring and summer. Perhaps when estimating, a better method is to use the values estimated for the months of May, June and August and September to get a conservative maximal use value to estimate expansion needs. In other words, growers usually underestimate water use unless they have actual flow meter data. Be careful.

STEP 2. Estimate the square footage of expanded production area you think you will need. Use the annual, monthly average, weekly or daily water use per square foot value you have determined and multiply this by the amount of expansion footage. This will provide you a maximum estimated increase in water needs based upon the expansion planned.

Keep in mind that changes in plant inventory and adjustments in greenhouse water delivery technology will great affect this value. If a new house or production area is to have high efficiency water delivery, such as micro mist systems or drip irrigation, you may wish to multiply the final volume of water by the efficiency percentage.

As an example, consider if you found data that clearly shows that you use 600,000 gallons inside of your 50,000 sq ft. production area, over the period of one year. This tells you that you are currently using 12 gallons per square foot per year (600,000/50,000 = 12). In this example we are assuming your pump can handle the peak periods. If you plan to expand production area using today's technology by 25,000 square feet, you would multiply that figure by 12. This would yield a yearly additional need of 300,000 gallons.

Now let us assume you build the new production area with a high efficiency water delivery system, one designed to save 30 percent of water use. Subtract that efficiency percentage from 100 percent. Thus, 100% - 30% = 70%. This means you would only need 70 percent as much water, and the real figures would be 300,000 gallons x 0.70 = 210,000 gallons.

STEP 3. Sum your values. Your total operation needs after completion of the expansion would be 600,000 plus 210,000 or 810,000 gallons per year. If you have estimated your maximal output properly from existing wells, you can tell immediately if your current water supply can handle the expansion.

Estimating Needed Increase In Well and Pump Capacity

Let us return to the current operation. We are assuming your existing well is likely capable of meeting your current demand of 600,000 gallons per year. If we divide this by 365 days, we get 1,644 gallons per day. If we again divide by 8 hours per day of actual use, we need to be able to deliver 205 gallons per hour. You could base new pump purchases on this, but you might be disappointed.

Consider, this daily figure does not truly reflect what you need in peak need periods. Once again, it is better to have actual use data for May, June, September and October to determine maximal needs. For our example, let's assume our real data from the average of the four high use months is 3,400 gallons/day. This means we need 425 gallons per hour. If we divide this by 60 minutes, our pump and well system should be able to deliver 7.0 gallons per minute to meet demand. Just to make a point, if we multiply this out, (7.0 x 60 x 8 x 365), we get 1,226,400 gallons. Buying the larger pump insures you can meet your needs. Just remember, we don't use near the 425 gallons per hour rate most of the year. We just want to have a well and a pump that can handle the peak capacity. If the well cannot provide 7.0 gallons/minute, drilling another well may need to be considered, or a greater emphasis placed on water use efficiency!

Now let us calculate the needed GPM capacity requirement for the new, expanded operation:

810,000 divided by 365. This comes to 2,219 gallons per day. Now remember that we only water 8 hours per day, so we divide by 8. Thus 2,219 gallons/8 hours = 277 gallons per hour. Now we divide this by 60 minutes. For this greenhouse, on average you would need 4.6 or more gallons per minute to accommodate the average watering needs. Obviously our existing water supply is inadequate for the planned expansion. When capacity is inadequate, you need to consider further water conservation efforts or the possibility of drilling a new well for additional water. Water storage may also mean an appropriate option.

Remember, this is maximal use assuming constant water use in that 8-hour period. No greenhouse or nursery ever uses this much water in one given day. However this allows you to have a system guideline that prevents underestimating peak use in hot weather.

Greenhouse*A*Syst Assessment of Future Water Use

Instructions for Completing the Risk Assessment

For each subject given in the leftmost column, read through each column and then select the description that best describes your operation. Do not rate practices that do not apply to your operation. Record the risk rating value in column 6 (the rightmost column), and then calculate the overall risk rating for this section at the end of each section. We will use these ratings to assess the overall water related risk of your operation at the end of the document.

	Low-Risk 4	**Low-Moderate Risk 3**	**Moderate-High Risk 2**	**High Risk 1**	**Rank Your Site**
Planning for Growth	Have a plan in place for production increases for the next 10 years, and have water needed for this growth available.	Have a plan for production increases for the next 5 years, and have water needed for this growth available.	Have a plan for the next year's production and have assessed water supply to assure sufficient water is available for the next year.	Have no plans for increasing or improving production of plants for the future.	

Ranking Totals	÷	**Total Areas Ranked**	=	**Future Use Risk Rating**
____________	÷	________________	=	___________________

Summarizing, Evaluating Your Greenhouse*A*Syst Assessment Results and Identifying Action Steps

The purpose of this section is to assist you in summarizing your overall risk to your business from water related issues.

Once you have filled out the seven sections of risk assessment, you may summarize the results in the table provided below. This will allow you to easily see what areas your company needs to reduce risk in, and where effort needs to be made for improvement. An overall risk value for the company is the last step in the process.

STEP 1.
Identify Areas Determined to be at Risk

Fill in this summary of your Greenhouse* A*Syst Assessment for Your Operation.

Risk Area	Greenhouse*A* Syst Publication	Overall Risk Rating
Water Source	Bulletin 1274	
Delivery and Technology	Bulletin 1275	
Water Management	Bulletin 1276	
Water Quality	Bulletin 1277	
Water Recycling/ Pollution Prevention	Bulletin 1278	
Legislative Awareness/ Company Policy	Bulletin 1279	
Total Overall Risk Level for Water (Average of 6)		

* Bulletins are all Georgia Cooperative Extension bulletins; visit http://pubs.caes.uga.edu/caespubs/pubs.html

Low risk practices (4s) are ideal and should be your goal. Low to moderate risk practices (3s) provide reasonable results and protection. Moderate to high risk practices (2s) provide inadequate protection in many circumstances. High risk practices (1's) are inadequate and pose a high risk for causing environmental, health, economic or regulatory problems.

High risk practices, rankings of "1," require immediate attention. Some may only require little effort to correct, while others could be major time commitments or costly to modify. These may require planning or prioritizing before you take action. All activities identified as "high risk" with a ranking of "1" should be listed in your action plan developed from this assessment. Rankings of "2" should be examined in greater details to determine the exact level of risk and attention given accordingly.

STEP 2.
Determine Your Overall Risk Ranking

This value provides a general idea of how your water use practices might be affecting your efficiency of water use and your understanding of proper watering practices and maintaining good water quality in your operations as well as impacts to surface and groundwater.

Water Use Risk Ranking	Level of Risk
3.6 to 4.0	Low Risk
2.6 to 3.5	Low to Moderate Risk
1.6 to 2.5	Moderate Risk
1.0 to 1.5	High Risk

This ranking gives you an idea of how your water use practices might be affecting your business success and conservation of water. This ranking should serve only as a very general guide and not as a precise diagnosis, since it represents the average of many individual rankings.

STEP 3.
Transfer Information on Risk to a Formal Plan for Improving Your Water Management and Use Practices.

From the results of this assessment, and after studying the provided guidelines and facts section, outline a plan of changes you want to incorporate into your operations with a timetable on when you will achieve these changes. A plan can always be amended and changed due to new information but, if you do not make a plan with the new knowledge about your own practices that you have gained, then odds of follow-through with real changes is unlikely. The plan outline can be as brief or as detailed as you want to make it. Be sure and note where you need to gather more information or consult with someone in your plan so you will take action only after careful consideration of complex issues.

STEP 4.
Develop A Formal Action Plan.

Simply put, assign specific staff to accomplish specific tasks in a known period of time. If more information is needed to make appropriate decisions, delegate specific fact-finding tasks to personnel best suited to accomplishing the task. Set goals and time lines based upon realistic expenditures of time and resources. Have each individual task written up for the entire team to assess and put into the larger context of the company. A formal action plan form is provided in the Appendix.

STEP 5.
Develop A Company Water Use and Monitoring Policy.

The final step in this process is to sit down with your management team and decide upon how to address your plans. The best method is to establish company water conservation/use policy. By doing so, every new and existing employee will be able to learn and follow your expectations for water management. By developing a policy document, you are also showing legislators and regulators that your company is serious about water management. Such documents will greatly improve how your business is viewed in the community.

STEP 6.
Implement the Policy.

Your policy document stands as a symbol of your commitment to resource preservation. Consistent implementation will yield greater profits and better relations with your community.

References

Bartok, J.W., and R.A. Aldridge. 1994. *Greenhouse Engineering.* NRAES –33, Cooperative Extension Service, Cornell University, Ithaca, New York. 1-209.

Dole, J.M., J.C. Coile, and S.L. von Broembsen. 1994. Growth of poinsettias, nutrient leaching, and water use efficiency respond to irrigation methods. *HortScience* 29:858-864.

Frink, C.R. and G.J. Bugbee. 1987. Response of potted plants and vegetable seedlings to chlorinated water. *HortScience* 22:581-583.

Holcomb, E.J., S. Gamez, D. Beattie, and G.C. Elliot. 1992. Efficiency of fertigation programs for Baltic Ivy and Asiatic Lily. *HortTechnology* 2:43-46.

Contacts and Information Sources

Organization/Individual	Responsibilities	Address	Phone Number
Georgia Department of Agriculture, Pesticide Division	Questions regarding anti-siphon requirements for irrigation systems.	Agriculture Building 19 Martin Luther King Jr. Dr. Atlanta, GA 30334	404-656-4958 www.agr.state.ga.us
Geologic Survey Branch Environmental Protection Division	Regulations concerning water well drinking standards.	Georgia DNR 19 Martin Luther King Jr. Dr. Suite 400 Atlanta, GA 30334	404-656-4807 www.state.ga.us/dnr/environ — Geologic Survey Branch
Department of Biological and Agricultural Engineering, University of Georgia	Questions related to well-head protection or ground water on a farm.	Extension Unit Landrum Box 8112, GSU Statesboro, GA 30460	912-681-5653 www.bae.uga.edu
Drinking Water Program Environmental Protection Division	Questions regarding public drinking water.	Georgia DNR 205 Butler St SE Floyd Towers East, Ste. 1152 Atlanta, GA 30334	404-651-5157 www.state.ga.us/dnr/environ — Water Resources Branch
Safe-Drinking Water Hotline U.S. Environmental Protection Agency	General drinking water questions. 8:30 a.m. - 5:00 p.m. EST	401 M Street SW (Mail Code 4604) Washington, DC 20460	1-800-426-4791 www.epa.gov/safewater
U.S. Environmental Protection Agency	General drinking water questions.	U.S. EPA Region IV 61 Forsyth St SW Atlanta, GA 30303	404-562-9424 www.epa.gov/region4
Water Protection Branch Environmental Protection Division	General water quality questions.	Georgia DNR 4229 International Parkway Suite 101 Atlanta, GA 30354	404-675-6240 404-675-1664 www.state.ga.us/dnr/environ — Water Protection Branch
Pollution Prevention Assistance Division	Pollution prevention references	Georgia DNR 7 Martin Luther King Jr. Dr. Suite 450 Atlanta, GA 30334	404-651-5120 1-800-685-2443 www.p2ad.org
Robert A. Aldrich and John W. Bartok Jr.	Greenhouse engineering. NRAES-33	National Resources Agricultural and Engineering Service. 1994	
Karen L. Panter Steven E. Newman Reagon M. Waskom	Pollution Prevention for Colorado commercial greenhouses. SCM-206.	Colorado State University Cooperative Extension	
Sharon L. Von Broembsen Mike Schnelle	Best Management Practices (BMPs) for nurseries to protect water quality. E-951, *Water Quality Handbook for Nurseries.*	Department of Entomology and Plant Pathology Oklahoma State University Cooperative Extension Service	http://zoospore.okstate.edu/nursery/recycling/shy.html

Reagon M. Waskom	Best Management Practices for irrigation practices. XCM 173. August, 1994.	Colorado State University Cooperative Extension
Don Wilkerson	Irrigating Greenhouse Crops. From *Texas Greenhouse Management Handbook*.	Texas Agricultural Extension Service
Don Wilkerson	Treating and recycling irrigation runoff. From *Texas Greenhouse Management Handbook*.	Texas Agricultural Extension Service

Environmental Protection Agency (EPA)
National Service Center for Environmental Publications
U.S. EPA/NSCEP
PO Box 42419; Cincinnati, OH 45242-0419
Phone: 1-800-490-9198 or 1-513-490-8190
M-F 7:30 a.m.-5:30 p.m. EST (www.epa.gov/ncepihom)

Drinking from Household Wells, EPA 570/9-90-013
LEAD In Your Drinking Water, EPA 810-F-93-001
Protecting Our Ground Water, EPA 813-F-95-002
Citizens Guide to Pesticides, EPA

University of Georgia, Cooperative Extension Service
Ag Business Office; Room 203, Conner Hall, UGA
Athens, GA 30602
Phone: 706-542-8999 (http://pubs.caes.uga.edu/caespubs/pubs.html)

Northeast Regional Agricultural Engineering Service, Cooperative Extension
Cornell University
152 Riley-Robb, Ithaca, NY 14853-5701
Phone: 607-255-7654 (www.osp.cornell.edu/vpr/outreach/programs/ageng.html)

Home Water Treatment, NRAES-48. Includes water-treatment basics, physical and chemical treatments, USEPA Primary Drinking Water Standards and health advisories, and pesticide products that contain USEPA drinking-water contaminants. (120 pp.)

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Appendix A

Water Use Balance Sheet

Month	From Municipal	From Ground Wells	From Storage (Pond/Tanks)	Total Used	Efficiency*
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
YEAR TOTAL					
Example	8,000	9,500	12,500	30,000	58% – Excellent

* Efficiency is calculated by adding the water used from municipal and in-ground sources, and dividing by the total water used. Efficiency ratings are: 10% - Poor; 11-25% - Acceptable; 25-50% - Good; over 58% - Excellent. How does your monthly water efficiency rate?

Appendix B

Scouting for Leaks

No greenhouse irrigation system is watertight. After a few years fitting and underground water pipes may be damaged and/ or lose their proper fit and leak. This slow and often unnoticed water loss can be costly over many years and may contribute to improper greenhouse environments, loss of water pressure and even unintentional contamination of irrigation water.

If you suspect you have a leak, you can measure the volume:

1. Write down the meter reading and the time of day, to the closest minute.
2. Do not use any water during the test. Usually it is best to do this when you will be away from the operation for an hour or more. Make sure devices such as evaporative coolers and ice makers are turned off.
3. Read the meter again when you return and note the time of day.
4. Subtract the second reading from the first. Multiply the remainder by 7.48*. This is the number of gallons that passed through most commercial meters during the test period.
   * check with the meter manufacturer for the specific flow rate.
5. Divide the amount of water by the number of minutes in the test. For example, if 17 gallons leaked out during a 180-minutes period, you have a leak of 0.094 gallons per minute.
6. Multiply the gallons per minute by 1,440 to calculate gallons per day. Multiply gallons per minute by 43,920 to calculate gallons per month. In this example, just 0.094 gallons per minute equates to over 4,128 gallons each month.

What to do if you are losing water:

Check taps, toilets and connections to spigots, lines and headers for leaks, which may be hidden. As an example for rural dwellers who have their own wells and do not pay fees, here is a typical city water charge: the fee consists of a “base charge,” determined by the size of your water meter, plus a “commodity charge” for water. The water rate is $0.8844 per unit (748 gallons). A slow leak in a nursery can be hundreds of gallons per day or one to two dollars/day. Multiply that by months and years and it can add up.

Action Plan Form

Use this action plan form to organize your ideas and to map out the activities necessary to complete your goals. Be sure to make the time frame realistic. Changes in basic resources take time. Please consult the list of references provided if you need additional information to develop this plan.

Area of Concern	Risk Rating	Planned Action	Time Frame	Estimated Cost

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