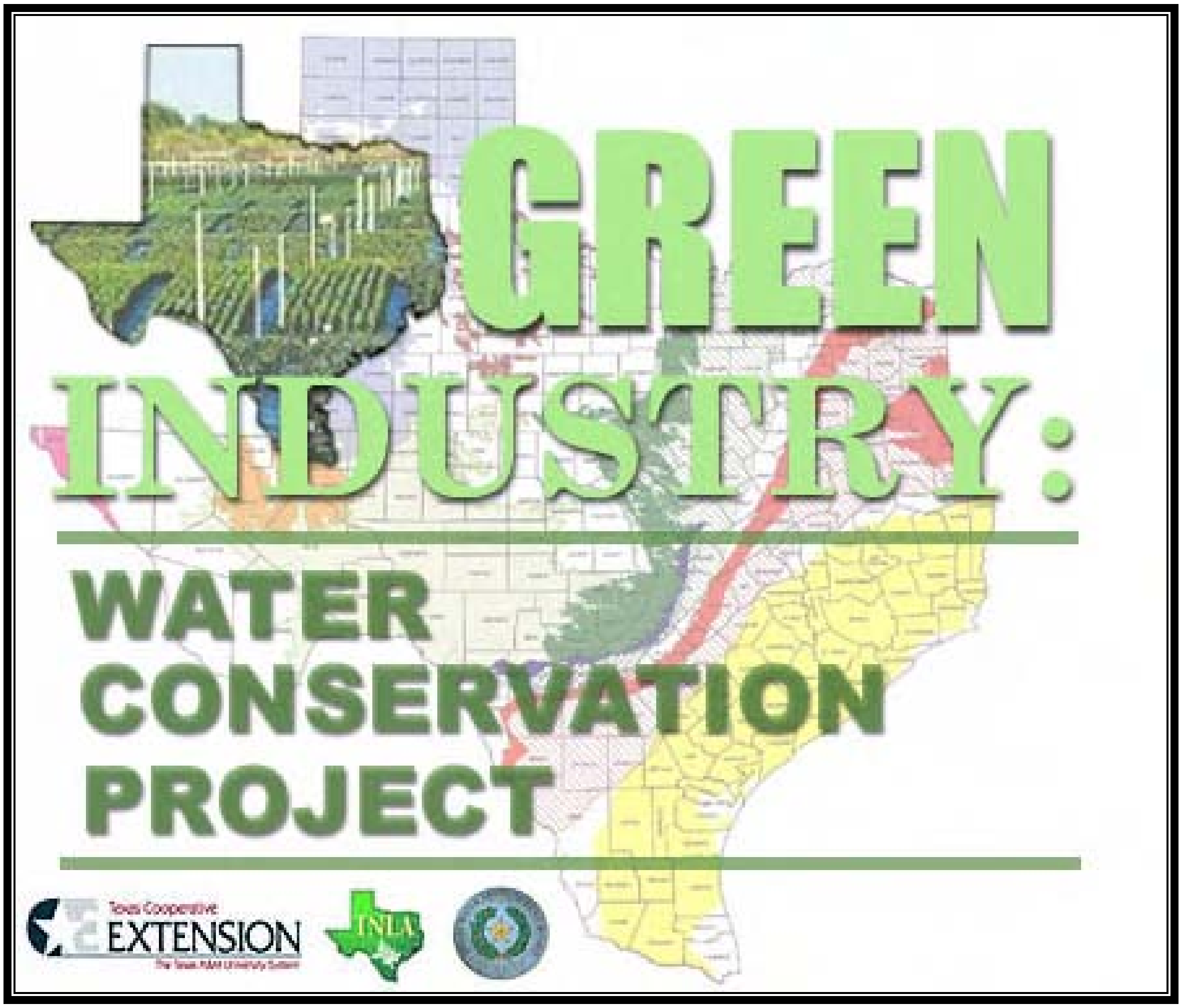
GREEN
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WATER
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GREEN INDUSTRY: WATER CONSERVATION PROJECT

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TEXAS GREEN INDUSTRY WATER USE SURVEY

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Executive Summary:

The production of container grown nursery crops is one of the largest segments of irrigated agriculture in Texas. Despite the scale of this industry, little is know about how water is used in crop production or the volume of water used statewide. In an effort to enhance the long term availability of high quality irrigation water, the Texas Water Development Board, in cooperation with Texas Cooperative Extension and the Texas Nursery and Landscape Association initiated the Texas GREEN Industry Water Use Project. The goal of the project was to work cooperatively with nursery/floral producers to disseminate information on conservation practices and to collect water-use and conservation data. Specific objectives included determining a general level of conservation used and an estimate of water use by general sources and counties, as well as conducting a series of statewide educational field days for commercial container nursery crop producers.

Survey results indicate that the average Class 3 nursery annually utilizes approximately 52 gallons of water/sq ft of production area. Class 4 nurseries average 56 gallons/sq ft/year. However, it should be noted that, generally speaking, production practices and associated water use/sq ft do not differ between Class 3 and 4 operations.

Based on a series of assumptions and calculations it is estimated that the statewide water use by Class 3 container nursery crop producers is approximately 3,147.37 acre feet per year. Class 4 producers utilize approximately 117,134.83 acre feet per year,

bringing the combined annual water use of Class 3 and 4 container nursery crop producers to approximately 120,282.20 acre feet.

A review of the current state of water conservation, as well as recommended practices for container nursery crop producers suggests that the best opportunities for water savings are in the area of irrigation management. Irrigation audits and improved control of the system were identified as areas of greatest potential savings. Broader use of drip irrigation could dramatically reduce the volume of water used in the production of 1-5 gallon container plant materials. However, additional research and development will be required to adapt drip technology to these production systems.

Although the number of participants in the project was limited the quality of data received was very good. Therefore estimates made on the basis of individual operations were considered relevant and accurate. The greatest opportunity for error occurred when attempting to extrapolate/project these values to statewide estimates. It should be noted that current licensing regulations make no distinction between operation type (i.e. greenhouse, container nursery, field grown, etc.), production stage (i.e. propagation, liner, etc.), nor do they require licensees to provide information on the number of acres or square feet under production. An improved method for determining the nature, size and distribution of container nurseries throughout the state would provide the opportunity for more accurate and precise projections.

Problem Statement:

The Nursery/Floral Industry represents the largest segment of irrigated crop producers in Texas with $1.2 billion in receipts, compared to $1.0 billion for cotton in 2001 (Texas Agricultural Statistics, 2001). Based on year 2000 data, annual economic activity associated with the nursery and landscaping industry in Texas results in about $3.2 billion worth of income for Texas workers and business owners. The industry directly and indirectly employs about 122,200 workers in the state and adds roughly $26 million per annum to state and local tax revenues. (Source: Based on TWDB analysis of 2000 economic data from MIG Inc., using IMPLAN PRO software). In a number of areas of the state, the impact of these operations is dramatic. For example, more than 200 nursery/floral growers are located in the 4 counties of Cherokee, Smith, Henderson and Van Zandt (TNLA). The combined economic impact of the industry in those 4 counties is estimated at more than $250 million (TNLA).

Despite the tremendous impact of the industry, there is no existing body of knowledge regarding how growers use water in their operations and the quantities used. The single nursery grower in the TWDB Water Use Survey, categorized by the Texas Department of Agriculture (TDA) as a Class 4 nursery (more than 20 acres of growing area), has a combined municipal and self-supplied groundwater use average of 2,600 acre-feet per year (TWDB Staff). The TDA lists 237 Class-4 nurseries and 75 Class-3 nursery operations (greater than 10 acres but less than 20). It is unknown whether 2,600 acre-feet of annual usage is representative of the average grower.

Few regional guides or conservation outreach efforts exist for nursery/floral growers. In addition, there is no information regarding how many currently use the Best Management Practices as laid out in the Water Conservation Best Management Practices Guide (TWDB Report 362). In order to benchmark existing conservation efforts and the potential for conservation savings, this body of knowledge is essential.

In the 2002 State Water Plan, irrigation water conservation strategies are planned for 60 counties, for a total of 669,447 acre-feet of savings in the year 2010 and 866,981 acre-feet of savings in 2050. Eleven counties in the state have 6 or more Class 4 nurseries; of these 11 counties, eight have irrigation water conservation strategies in the 2002 Plan to meet unmet needs. Conservation savings from nursery growers in these counties, and others, could be part of the broad conservation strategies to offset any unmet needs.

Scope of Work:

Goal:

Work cooperatively with nursery/floral producers in disseminating information on conservation practices and the collection of water-use and conservation data.

Objectives:

1) Establish a statewide network of nursery/floral producers that are either interested in a water efficiency audit of their operation and/or hosting a field day event showcasing their water conservation efforts.

2) Conduct an on-line survey of all large scale licensed nursery/floral producers in Texas (Class 3 and 4) to determine (A) a general level of conservation used and (B) an estimate of water use by general sources and counties.

3) Offer a free, on-line water efficiency audit for nursery/floral producers.

4) Conduct a special Water Conservation session at the TNLA Pre-EXPO Educational Seminar.

5) Host 3 regional field days (Harris, Smith and Bexar counties) using innovative nursery/floral producers to showcase their conservation practices (including practices listed in the TWDB BMP Guide).

Methodology:

Aggie-Horticulture - Texas Cooperative Extension- Horticulture is recognized as a state, regional and national information resource for the nursery/floral industry. Much of this information is provided via TCE-Horticulture’s information server on the World Wide Web (aggie-horticulture.tamu.edu). With an average of over 15 million hits/month (800,000 user sessions/month), Aggie Horticulture is the most widely used horticultural Website in Texas and the world. The water conservation project utilized the well-established presence of Aggie Horticulture as the principal means of accessing nursery/floral participants.

On-Line Nursery/Floral Water Use Survey - Texas nursery/floral producers have come to rely on Aggie Horticulture as their principal information resource for a variety of topics. This project utilized Aggie Horticulture to deliver an on-line survey for use in water planning efforts. Data was collected/entered in an electronic database which enabled a detailed analysis to determine a general level of conservation used and an estimate of water use by general sources and counties (see page A32).

On-Line Water Conservation Audit – The project also utilized Aggie Horticulture to provide on-line forms for conducting a water conservation audit of container nursery crop operations. The audit informed growers of their current water conservation status, as well as valuable planning information for the potential implementation of additional BMP's. In addition, educational information on a variety of water conservation BMP's was included (see page A18).

TNLA Pre-EXPO Educational Seminar – As a part of the project, TCE and TNLA conducted a special Water Conservation seminar at the TNLA EXPO Trade Show. This annual "flagship" event was attended by over 10,000 GREEN Industry participants. In addition, TCE, TNLA and the TWDB used the 3-day EXPO as the "kickoff" event to inform nursery/floral producers about the survey, audit forms, educational information and upcoming field day events associated with the project.

Field Days – Nursery/floral producers were identified in 3 key locations (Harris, Smith and Bexar counties). Utilizing TCE's network of County Horticulturists, the project conducted educational field days at each location to demonstrate innovative water conservation systems and strategies. These activities were jointly sponsored by TCE-Horticulture, TNLA and the TWDB, with special promotional assistance from TNLA.

Introduction:

To thoroughly understand and evaluate the potential savings from the implementation of any recommended Best Management Practice (BMP) it is important to have a basic comprehension of the many factors that effect water use/conservation in the production of container grown nursery crops.

Geographic Location:

The Texas nursery industry is widely distributed throughout the eastern half of the state. Concentrated areas of production include Smith, Van Zandt and Cherokee counties in east Texas. Harris, Fort Bend, Dallas, Tarrant, Bexar and Travis counties are also important areas of production within proximity to the states major metropolitan areas/markets. Annual precipitation in this geographic distribution ranges from approximately 48"/year (Harris) to 31"/year (Bexar). Average annual precipitation rates can significantly impact the volume of water required/used for the production of containerized nursery crops. The frequency of drought conditions in an area is also a key factor effecting water use. Other factors such as average annual temperature, humidity and wind can also influence water use.

Irrigation Systems:
Containers in the 1-5 gallon range are primarily irrigated using overhead, rotary impact sprinklers or similar delivery systems. The efficiency of an overhead system (e.g. water applied reaching the target zone) is largely dependent on container spacing, plant canopy, line pressure, droplet size, pattern distribution, wind velocity/direction etc. These high pressure/volume systems must run for extended periods of time to meet necessary water requirements for optimum plant growth. Generally speaking, overhead irrigation is the least efficient method of applying water to containerized nursery crops. However, practical, economic alternatives to overhead irrigation are not currently available for 1-5 gallon containers. The use of more efficient drip irrigation on these smaller sized units is impractical given the density of containers/square foot. The cost of operation, number of emitters and potential for system breakdown/clogging are among the most limiting factors.

The use of drip irrigation on 15 gallon and larger sized containers can approach 100% efficiency for a properly designed, installed, maintained and managed system.
Drip irrigation does require more maintenance and monitoring than overhead irrigation. Emitter clogging and system breakdown occur more frequently in drip irrigation systems than overhead systems. Drip irrigation also requires water pre-treatment (i.e. filtration and in some situations chemical) to minimize maintenance and clogging. By directing water to the growing medium, drip irrigation reduces the potential for diseases/insects associated with foliar wetting. If managed properly, low volume, drip irrigation provides the best means of maintaining optimum moisture distribution throughout the growing medium. Drip irrigation systems can also be used as a delivery mechanism for soluble fertilizers. Although this practice is not yet widely used in the container nursery industry, it represents an opportunity to enhance plant growth, reduce costs and protect the environment.

Drip irrigation has become the standard on 15 gallon containers and larger. Although emitters, pipe, valves and related materials/supplies are costly, the increasing use of drip irrigation on 15 gallon and larger sized containers suggests that producers can enhance both profitability and water savings through the use of these systems.

Growing Media:
A wide range of materials are used in the formulation of growing medium for containerized nursery crops. Bi-products like bark and other tree residues, composted municipal yard wastes, sewage sludge, dairy/poultry wastes, rice hulls, etc. have all been successfully used for the production of container grown nursery crops. Non bi-product materials like peat moss, sand, perlite, vermiculite, Styrofoam beads, etc. are also important components. The most commonly used growing medium for containerized nursery crops produced in Texas consists of a combination of pine bark, sand and peat moss. This growing medium provides the aeration and drainage

characteristics needed to compensate for excessive rainfall balanced with the water holding capacity required to limit irrigation frequency during the growing season.

Many producers make their own growing medium from the raw materials previously described. However there is an increasing trend towards purchasing ready-made growing medium from commercial firms. Regardless of the source, there is little known about the aeration/drainage and water holding characteristics of these products and the reproducibility of these physical parameters from one batch of medium to the next. Variations in aeration, drainage and water holding characteristics of a growing medium can significantly impact water use/conservation.

Water Quality:
The quality of surface and groundwater, for container grown nursery crops, is variable throughout the state. These quality factors include salinity, sodium absorption ratio, pH, alkalinity and mineral content. East Texas typically has high quality irrigation water. The state's other major production regions generally contend with high pH, alkalinity, salinity and the occasional mineral toxicity.

Managing poor quality irrigation water often means increasing the volume and frequency of water applied. By limiting large fluctuations in wetting and drying, growers can reduce the potential for salinity damage (burning of leaf tips and margins). Leaching containers can also reduce the build up of salts in the growing medium. Acid injection is sometimes required to neutralize alkalinity and lower pH to a desirable level for plant growth (i.e. 6.0 – 6.5). This water treatment process helps maintain optimum nutrient availability and reduces mineral deposits on the foliage, as well as in/on irrigation equipment. In most cases, producers with poor quality irrigation water ultimately require more water than producers with high quality irrigation water.

Plant Species:
Plants in their native habitat or in the urban landscape differ in their water requirements. One generally accepted paradigm is that native Texas plants typically require less water than non-natives. Also, arid or xeriophytic plants are more water conserving than other plant types in the landscape.

Many of these water conserving principals are diminished during the containerized production of these plants materials. The standardization and cultural practices required for efficient and profitable crop production largely impact the water use/conservation aspects of these plant species. Generally speaking, all crops (Texas natives and arid plants alike) are grown using a bark/sand/peat growing medium with supplemental irrigation. Furthermore, if a plant selection/introduction can not be produced using these standardized practices it typically does not succeed in the marketplace.

Recycled Irrigation Water:
Irrigation runoff is a major environmental issue for the container nursery industry. The potential for surface and groundwater contamination from fertilizers and pesticides has forced many producers to develop runoff capture systems primarily resulting from

overhead irrigation. Although there was initial concern about the quality (i.e. salinity, pH, chemical/fertilizer residuals and disease potential) of captured runoff, many growers now rely on this important source of irrigation water to supplement wells and surface resources.

Directing runoff from the production area to the capture pond/tank requires careful engineering to minimize potential problems. Sanitation is critically important in maintaining drainage ditches. Disease infested plant debris and weed seeds in these areas can be easily transported back to the capture pond/tank resulting in major cultural management issues. Water moving too rapidly through drainage ditches does not provide for larger sized particles to settle prior to reaching the pond/tank. This can cause rapid sedimentation and clogging of irrigation equipment. Pesticides and fertilizers entering drainage areas may also flow back in to the capture pond/tank. Excessive nitrogen in the recycle pond/tank often results in large accumulations of algae while residual pesticides (herbicides) may cause insipient plant problems. Improper design and installation in each of these areas can result in significant management challenges.

Recycled irrigation water must be managed carefully to minimize potential plant health problems and to avoid maintenance issues with irrigation equipment. Most recycle systems are constructed to provide the option of directing recycled water to plants/zones with enhanced disease/salinity tolerance or to older (usually larger), less susceptible plant materials. Recycled water often requires filtering and chemical pre-treatment prior to reuse. This is particularly important if the water is to be re-applied through a drip irrigation system.

The use of recycled irrigation water “indirectly” increases the efficiency of overhead irrigation systems. However, water loss via evaporation, overflow, leaks, etc. still make drip irrigation the most efficient means of applying water to container crops.

Production Practices:

There are numerous variations in the practices used for the production of containerized plant materials. Some of these practices have a significant impact on water use/conservation. Generally speaking container production, particularly as related to water use/conservation, can be divided in to 2 broad categories.

A) 1- 5 Gallon Containers
B) 15 Gallon Containers and Larger (15 gallon +)

1-5 Gallon Containers:

Container spacing is a major factor effecting water use/conservation. Immediately after canning 1-5 gallon containers are typically placed pot-tight in the growing area. This practice enables growers to essentially double the number of containers/square foot prior to re-spacing once plants have developed an overlapping canopy. Pot tight spacing also reduces air flow around the containers and helps the growing medium retain a more constant level of moisture during the critical establishment phase of production. Fertilizer(s) can also be applied more cost and labor efficiently while plants are pot tight. At this stage of production virtually all pot tight crops are overhead irrigated. The efficiency of these systems at this stage of production typically ranges from 80% - 85%.

Once plants have developed an overlapping canopy growers typically move containers to an intermediary spacing or finished spacing. Plants grown pot tight beyond this stage are frequently misshapen (i.e. flat sides and elongated growth). Reduced air flow, resulting from this dense mass of foliage, can also increase the risk of insect/disease infestations and makes it difficult to penetrate the canopy with chemical fertilizers and pesticides. These conditions generally result in increased losses, poorer quality and lower value. It should be noted that a limited number of plants can be finished pot tight without significantly impacting quality. These crops are obviously produced at a lower cost with improved water use efficiency.

The decision to move plants to either an intermediary or finished spacing is based on the value of the product, plant species, plant size/canopy, container size, availability of labor and space, estimated crop time and other operational considerations. Providing additional space for plants to grow can greatly enhance plant quality/value. This practice also helps reduce potential insect/disease infestations and makes it easier to address those insect/disease infestations that occur. However, increasing the distance between containers decreases the efficiency of overhead irrigation. In these situations the volume of water reaching the target may be as little as 15% of the total volume applied.

The average density of 15 gallon + containers per square foot of production area is much less than the average number of 1-5 gallon containers per square foot. This lower density makes the use of drip irrigation feasible. Most 15 gallon + material are placed on finished spacing immediately after canning. This is due, in part, because of the labor required to move these larger/heavier units but primarily because spacing/configuration is frequently dictated by the placement of emitters in the drip irrigation system. The number of emitters per container typically ranges from 1 – 4 depending on container size, volume capacity/zone, etc. Low pressure, low volume drip systems make it possible to irrigate more area at one time than high pressure demanding overhead systems. Re-spacing 15 gallon + containers is possible by plugging emitters and re-configuring the drip system. However, this is a time and labor consuming process. A well designed, installed and maintained drip irrigation system is extremely efficient, with essentially 100% of applied water reaching the target zone.

15 gallon + plants require longer production time (i.e. 2 - 4 years) and associated inputs (i.e. pruning/training, fertilization, pest management, irrigation/management, etc.). The increased costs associated with these factors results in a higher value crop. Despite the higher cost/price, the demand for 15 gallon + plant material is rising among retailers and landscape contractors.

Water Management:
Management is the most critical factor effecting water use/conservation in the production of container grown nursery crops. Controlling when, where and how long water is applied to a plant is important for optimum growth, profitability and conservation. Most container nurseries try to irrigate early or late in the day when evaporation loses will be at their lowest. However, limited system capacity/volume may force growers to apply water at all times of the day. Ideally, growers establish a moisture allowed deficit (MAD) for the growing medium (approximately 50% of container capacity) and apply just enough irrigation water to replace that which is lost to the plant and evaporation (evapotranspiration). In reality, most nurseries establish an irrigation schedule, based on time, to approximate the same effect. Timers (controllers) are frequently used to automatically activate solenoids/valves throughout the nursery. Each solenoid/valve controls an individual growing area. Run time is based on the amount of time required to deliver sufficient water to reach the appropriate level of soil moisture. Where timers are not available this becomes a manual process.

At present there are no accurate monitoring devices for soil moisture. Although evapotranspiration (ET) models have been used successfully for agronomic mono-crops, these models have limited application for container grown nurseries. The diversity of species, container size, shape, leaf area, etc. makes it virtually impossible to use ET models for irrigation calculations.

Crops which lack uniformity require special attention. Excess water is often applied to smaller plants to ensure that larger plants receive sufficient amounts. The center of a production area generally receives more water than required in an attempt to deliver moisture to the edges of the area. Each of these situations requires management skills to optimize plant growth, profitability and conservation.

Growers working with several different water sources must also determine where these sources may or may not be used. High quality well water might be reserved for plants which are sensitive to elevated salts, pH or alkalinity. Recycled might only be used only on select plants with increased insect/disease tolerance. Unfiltered water sources might not be suitable for use through a drip irrigation system. These are just a few important water management considerations growers must make when producing container grown crops. It should be noted that even the most efficient irrigation systems can be wasteful if they are not managed appropriately.

Project Results & Summary:

Data collection for the Texas GREEN Industry Water Use Survey Project began on August 15, 2005 and terminated on April 3, 2006. The following provides detailed results and summary for each of the 5 project objectives.

Objective 1: Establish a statewide network of nursery/floral producers that are either interested in a water efficiency audit of their operation and/or hosting a field day event showcasing their water conservation efforts.

The Texas Nursery and Landscape Association, working collaboratively with Texas A&M University-Horticulture initiated a Strategic Partnership Plan in May, 2004. This effort established a 5 year plan for identifying and addressing issues affecting the Texas GREEN industry, including container nursery crop producers.

TNLA and TCE-Horticulture have acted on several items related to the Strategic Partnership Plan, including the formation of a select taskforce to identify priority issues and challenges for the GREEN industry. This taskforce selected 3 strategic issues to serve as a focus of cooperation between TNLA and TCE-Horticulture. These areas include:

1. Environmental Stewardship (Water Conservation)
2. Economic Profitability & Competitiveness
3. Quality of Life

The Partnership Taskforce and Strategic Initiatives developed greatly assisted in establishing a network of industry professionals with an interest in water use/conservation. This group was extremely valuable in providing input for the water use survey and analysis portion of the project.

Texas Cooperative Extension- Horticulture is recognized as an important information resource for the nursery/floral industry. Much of this information is provided via TCE-Horticulture's information server on the World Wide Web (aggie-horticulture.tamu.edu). Utilizing this innovative information technology resource a web site was created for the Texas Green Industry Water Use Project (http://aggie-horticulture.tamu.edu/greenhouse/TWDB/index.html). The site includes the following components: Project Information, Water Use Survey, Water Use Analysis, Events & Field Days, Publications, Web Links, and other useful features (see page A13). This site was used as the principal mechanism for communicating with container nursery producers with an interest in water use/conservation.

Working collaboratively with TNLA, several producers throughout the state were contacted regarding their interest in participating in the Texas Green Industry Water Use Audit/Survey. A feature article appeared in TNLA's GREEN magazine and grower members were contacted to solicit their participation (see page A4). Although the network of producers interested in conducting an audit was limited, these individuals represented an important cross section of the nursery industry. Three container operations volunteered to assist in showcasing their water conservation efforts.

Chamblee's Rose Nursery in Tyler, Texas is a 30 acre facility, specializing in the production of container grown roses. The capture and recycle irrigation system at this location is an excellent example of innovative water use/conservation technology. Currently Chamblee's supplements up to 50% of their total irrigation needs with recycled water. Careful monitoring of soil moisture and fertility in a growing medium with optimum aeration, drainage and water holding characteristics lends itself to optimum water use and conservation practices.

Hines Wholesale Nursery in Fulshear, Texas has long been recognized as the leader in water use/conservation technology. This 300+ acre facility specializes in the production of a wide range of container grown woody ornamental plants, as well as herbaceous annuals and perennials. Hines elaborate capture and recycle irrigation system is state of the art. Water pre-treatment options combined with a pumping and distribution/zoning system provide unique control over where, when and how much water will be distributed throughout the nursery. Hines also incorporates additional BMPs (including drip irrigation) into a total management program for optimum water savings.

Mortellaros Nursery in Shertz, Texas focuses on the production of container grown plant materials for landscape contractors. This 80 acre facility has been especially designed with water conservation in mind. The capture and recycle system is the center piece of this unique and innovative production nursery. Recycled water is zoned throughout the nursery to effectively supplement groundwater resources. The growing medium has been developed with optimum aeration, drainage and water holding characteristics to promote growth while conserving water. Much of the irrigation system is managed automatically using solid state irrigation controllers. The extensive use of drip irrigation on 15 + gallon containers is an excellent example of how growers can conserve water and maintain optimum soil moisture.

Object 2a: Conduct an on-line survey of all large scale licensed nursery/floral producers in Texas (Class 3 and 4) to determine a general level of conservation used.

The scope of Objectives 2a and 2b is limited to TDA Class 3 and 4 container nursery crop producers. The following is a brief description of how TDA defines each of these categories:

The Texas Department of Agriculture (TDA) is the principal regulatory agency for the Texas nursery industry. In this capacity TDA oversees a variety of programs including licensing and fees. Commercial nursery/floral licenses and fees are currently structured around 4 classes. Classes 2-4 represent those businesses which include a "growing area."

Class 1 - includes businesses who sell, lease or distribute, but do not grow nursery products and/or floral items. This classification includes businesses such as garden centers, stores, landscape contractors, floral shops, interior decorators and street vendors. Class 1 certificate holders may obtain up to ten event permits at no additional cost to sell, lease, or distribute nursery floral products and/floral items at trade shows, garden shows, or other horticultural exhibits.

Class 2 - includes permanently located businesses who sell, lease, or distribute nursery products and/or floral items and have a growing area of 435,600 square feet (ten acres) or less. Class 2 certificate holders may obtain up to ten event permits at no additional cost to sell, lease, or distribute nursery floral products and/floral items at trade shows, garden shows, or other horticultural exhibits.

Class 3 - includes permanently located businesses who sell, lease or distribute nursery products and/or floral items and have a growing area of 435,601-871,200 square feet (in excess of ten acres to less than twenty acres). Class 3 certificate holders may obtain up to ten event permits at no additional cost to sell, lease, or distribute nursery floral products and/floral items at trade shows, garden shows, or other horticultural exhibits.

Class 4 - includes permanently located businesses who sell, lease or distribute nursery products and/or floral items and have a growing area of 871,201 square feet or more (over twenty acres). Class 4 certificate holders may obtain up to ten event permits at not additional cost to sell, lease, or distribute nursery floral products and/floral items at trade shows, garden shows, or other horticultural exhibits.

The Texas nursery industry is extremely diverse, particularly compared to agronomic crops like cotton, corn and rice. No two nurseries are alike, making it very difficult to generalize production and water use/conservation practices. However, it is this diversity that has assisted the Texas nursery industry to sustain a steady rate of growth despite fluctuations in the economy and related trends.

General Level of Conservation Used By Container Nursery Crop Producers:
Several practices related to the irrigation of nursery crops have been identified as opportunities for potential water savings as part of the TWDB's Best Management Practices Guide prepared by the Texas Water Conservation Implementation Task Force. These practices consider system design, distribution and application of irrigation water to field, container, and greenhouse grown nursery plants.

Although similarities exist between field, container, and greenhouse grown crops, there are considerable differences in the water conservation practices that apply to each specific area. Many of these recommended practices are closely tied to production economics. Several of the practices which impact water use/conservation are also critically important in minimizing costs and increasing profitability. In the areas where environmental stewardship and production economics overlap, producers have implemented water conservation practices as a mater of sound business management.

A summary of survey results on the general level of conservation used by container nursery crop producers is presented in Table 1. A total of 15 producers out of an estimated 190 Class 3 and 4 container nurseries (7.8%), responded to this portion of the project.

Table 1. Summary of results from the Texas Water Use Survey – general level of conservation used by container nursery crop producers.

Best Management Practice:	%Yes	%No
Do you currently schedule irrigation according to crop needs (i.e. time of year, weather, methods of storage and type and stage of the plant)?	80	20
Do you currently schedule irrigation according to growing medium water depletion?	66	34
Do you currently plan to make irrigation system upgrades to improve application efficiency?	100	0
Do you currently use a computerized irrigation controller?	46.7	53.3
Do you currently use drip irrigation on 1 - 5 gallon containers?	0	100
Do you currently use drip irrigation on 15+ gallon containers?	73.3	26.7
Do you currently plug/close irrigation heads in non-producing areas of the nursery?	100	0
Do you currently position irrigation heads at an optimum height to maximize overhead irrigation efficiency?	93	7
Do you currently use a droplet size sufficiently large enough to maximize overhead irrigation efficiency?	86.6	13.4
Do you currently use an overhead boom system for irrigation?	0	100
Do you currently use sub-irrigation, ebb and flood or capillary mat irrigation technologies?	0	100
Do you currently have capture and recycle irrigation system?	53.3	46.7
Do you currently group plants with like requirements in the same location?	100	0
Do you currently know the characteristics of the application site, including soil type and depth to groundwater?	86.6	13.4
Do you currently space containers under fixed overhead irrigation to maximize irrigation efficiency and reduce waste?	86.6	13.4
Do you currently leach containers to deal with excessive salinity?	20	80
Have you currently performed a water efficiency audit to identify areas of improvement for water savings and optimization of water use?	7	93

The diverse nature of the Texas container nursery crop industry makes it very challenging to accurately define metrics for the specific purpose of estimating water use. Since each operation may consist of a unique combination of production systems, it is difficult to determine the industry-wide impact of water conserving practices. However, the survey results do provide valuable insight for prioritizing management practices that will yield the greatest potential water savings. To assist in describing these savings the following criteria have been used to describe estimated potential water savings resulting from the implementation of each of the practices described in the TWDB's Best Management Practices Guide. The accompanying percentages are broad estimates based on a non-quantitative evaluation of the survey data.

HIGH – This practice is not widely used by commercial nursery crop producers and has the greatest potential to significantly assist in conserving water. Best estimates would suggest the possibility of a 10% - 20% reduction in water use.

MEDIUM – This practice is already in use by commercial nursery crop producers but may be more broadly applied to assist in conserving water. Best estimates would suggest the possibility of a 5% - 10% reduction in water use.

LOW – This practice is widely used by commercial nursery crop producers OR is not feasible for use and has little potential for significant water conservation. Best estimates would suggest the possibility of a 0% - 5% reduction in water use.

The following summary describes each of the defined practices in the TWDB's Best Management Practices Guide for container grown nursery crops.

1) Irrigation System Design and Management:
a. Scheduling irrigation according to crop needs and growing-medium water depletion. Watering requirements will vary and should be adjusted based on time of year, weather, methods of storage and type and stage of the plant (e.g., dormancy). Plants need less water during cool, rainy weather than during hot, dry, windy weather.

The majority of growers responding to the survey (80%) indicated that they currently irrigate according to crop need, time of year, weather, and type and stage of the plant. Based on this response the estimated potential water savings resulting from the implementation of this practice is **LOW**.

Approximately 66% of the growers surveyed indicated that they did not currently schedule irrigation on the basis of a quantitative moisture allowed deficit based on the physical attributes of the medium. The lack of research and educational data/information in this area is extremely limiting. Since growers do not have adequate information/technology to implement this practice, the potential water savings is **LOW**.

b. Upgrading irrigation equipment to improve application efficiency. For example, a computerized irrigation scheduler using a drip system can reduce overwatering and excessive leaching compared to an overhead system.

All growers (100%) responding to the survey indicated that they planned to make irrigation system upgrades to improve application efficiency. Approximately 45% of the respondents were programming irrigation system controllers for optimal water use.

Automated controllers are widely used throughout the container nursery industry. If managed properly, this equipment has the potential to conserve water by accurately controlling when, where and how long water is applied to containerized crops. These systems are equally effective when used with overhead or low volume drip systems. However, if managed improperly, automated (computerized) irrigation systems can waste as much or more water than those monitored and operated manually. Based on grower response the estimated potential water savings resulting from the implementation of this practice is **LOW**.

None of the growers surveyed currently use drip irrigation on 1 – 5 gallon containers. The number of units/square foot, cost/time of monitoring the system and potential for breakdown/clogging are among the most limiting factors. Improved emitters and system design may eventually make drip irrigation feasible for use on 1 – 5 gallon containers. Development of a cost and operationally effective drip irrigation system (or other alternative to overhead irrigation) for 1 – 5 gallon containers represents the greatest opportunity for potential water savings in the container nursery industry. However, in the absence of this technology the estimated potential water savings resulting from the implementation of this practice is **LOW**.

Approximately 73% of the growers responding to the survey indicated that they used drip irrigation on 15 gallon + containers. Although emitters, pipe, valves, controllers and related materials/supplies are costly, the increasing use of drip irrigation on these larger sized containers suggests that producers can enhance both profitability and water savings through the use of these systems. The extensive use of drip irrigation on 15 gallon + containers and the extremely efficient nature of these systems suggest that the estimated potential water savings resulting from the implementation of this practice is **LOW**.

c. Plugging sprinkler heads that are not watering plants, keeping sprinkler heads as low as possible to the plants, and use of the largest appropriate water droplet size to reduce irrigation time.

All of the survey respondents (100%) valve or plug individual risers/heads to reduce the volume of water applied to non-producing areas of the nursery. Similarly the majority of responses (93%) indicated that heads were placed at an optimum height and droplet size was sufficiently large enough (86.6%) to maximize overhead irrigation efficiency.

Most irrigation systems are designed by licensed professionals that match pressure, pipe size, volume and other factors to produce an optimum droplet size and distribution pattern. Although improvements are always possible, the estimated potential water savings resulting from the implementation of this practice is **LOW**.

e. When using programmable irrigation booms, travel rate and flow rates should be adjusted to specific crop needs.

None of the growers surveyed indicated that they were using boom irrigation. Programmable irrigation booms are widely used for the production of floral crops. However booms are not currently used for container grown nursery crops. Research/development in this area may lead to future opportunities but at present the estimated potential water savings resulting from the implementation of this practice is **LOW**.

f. Use of sub-irrigation systems where appropriate, using ebb and flood or capillary mat irrigation technologies with water capture and reuse systems.

None of the growers responding to the survey indicated that they were currently using sub-irrigation for the production of container grown nursery crops. Sub-irrigation systems using ebb and flood or capillary mat irrigation are being used by an increasing number of floral crop producers. However, this technology is not currently feasible for the production of container grown nursery crops. Research/development in this area is being conducted on a limited basis but at present the estimated potential water savings resulting from the implementation of this practice is **LOW**.

Approximately 53% of the growers surveyed are currently recycling irrigation water. The use of recycled irrigation water is a rapidly growing trend among growers throughout the state. It is now estimated that 20% - 25% of the water used to irrigate 1 – 5 gallon containers is derived from a capture and reuse system. Increasing the number of growing operations with capture and recycle systems represents an excellent potential for future water savings. The estimated potential water savings resulting from the implementation of this practice is **HIGH**.

2) Plant Media and Management
a. Grouping plants together that have the same water requirements (i.e., use hydrozoning).

All of the survey respondents indicated that they were currently grouping plants with like requirements in the same location. However, hydrozoning is a concept not fully applicable to container nursery crop production. Most nurseries use a growing medium with a narrow range of physical parameters. As a result there is much less variation in plant water requirements than in a landscape setting. Also, crops in the nursery are typically grouped by species and container size to ensure uniformity in irrigation/soil moisture, as well as other cultural inputs. Successful container nurseries do not mix plant species or different container sizes in the same production area. This practice will have a very limited, if any impact on potential water savings for container nursery crop producers. Based on grower response the estimated potential water savings resulting from the implementation of this practice is **LOW**.

b. When ball-and-burlapped stock and containerized stock are received, they should be kept out of the wind and sun. Ideally, balls should be covered with moisture-retaining materials such as sawdust or wood chips if stock will be stored for a long time.

This practice addresses the post-harvest care and handling of field (balled-and-burlapped) and container grown plant materials. As a result, the estimated potential water savings resulting from the implementation of this practice is **LOW**.

c. Knowing characteristics of the application site, including soil type and depth to groundwater under the greenhouse or nursery.

Approximately 86% of the growers responding to the survey indicated that they had knowledge of the application site. Most container nursery producers have an excellent understanding of the characteristics of the site. Since the majority of water used for irrigation container crops is derived from groundwater sources, growers frequently deal with wells, well maintenance and related issues. A knowledge of soil type is also valuable for constructing container production areas (pads) and factors which may effect runoff capture and reuse. Although these are important considerations, the estimated potential water savings resulting from the implementation of this practice is **LOW**.

d. Spacing containers under fixed overhead irrigation to maximize plant irrigation and reduce waste between containers.

Approximately 86% of the growers responding to the survey indicated that they spaced containers under fixed overhead irrigation to maximize irrigation efficiency and reduce waste between containers. Growers typically use a 2-move system (pot tight to finished spacing) for the production of 1 – 5 gallon containers. This approach maximizes space use efficiency, enhances plant growth and optimizes profitability. Overhead irrigation efficiency is relatively high during the pot tight stage but falls off dramatically as spacing and plant canopy increase at the finished spacing. Many container nursery crop producers can better manage this practice by limiting the amount of time plants are not spaced for maximum water use efficiency (i.e. too long on finished spacing). The estimated potential water savings resulting from the implementation of this practice is **MEDIUM**.

e. Minimizing leaching from containers or pulse-irrigate containers. Many textbooks recommend leaching greenhouse and nursery crops to 10 percent excess. This rate can be reduced to close to zero by reducing fertilizer rates and closely monitoring the electrical conductivity or the root substrate.

80% of the growers responding to the survey indicated that they did not leach containers during irrigation. This cultural practice is no longer widely recommended as a means of dealing with water quality problems (salinity) on container grown nursery crops. In situations where recycled water is the primary irrigation source, leaching, as well as other water management tactics, may be a viable approach with limited impact on conservation. The use of controlled release fertilizers and careful monitoring of the growing medium are also valuable tools for managing salinity. Pulse irrigation provides another means of managing soil moisture/salinity. However, many larger container nurseries do not have the capacity to run short bursts of irrigation uniformly throughout the growing facility. In the absence of this capacity the estimated potential water savings resulting from the implementation of this practice is **LOW**.

C. Implementation
The implementation of this set of BMPs also calls for producers to perform a water efficiency audit of the nursery facility to identify areas of improvement for water savings and optimization of water use. The audit should review all aspects of operations including, types of plants and specific water requirements, growing medium characteristics, and the irrigation system.

93% of the growers surveyed indicated that they had not conducted an in-depth water use audit to assist in identifying potential opportunities for increased efficiencies. A water use audit can be an extremely valuable tool, enabling producers to identify both short and long term strategies for conserving water. These audits are generally low cost and can be conducted by in-house personnel/staff. Results from the audit can provide an extremely valuable roadmap which enable producers to prioritize water use/conservation efforts and capital investments required to meet targeted goals. Detailed water audits are the lowest cost approach to implementing significant water savings throughout the Texas nursery industry. The estimated potential water savings resulting from the implementation of this practice is **HIGH**.

Objective 2b: Conduct an on-line survey of all large scale licensed nursery/floral producers in Texas (Class 3 and 4) to determine an estimate of water use by general sources and counties.

Despite the tremendous economic impact of the Texas container nursery industry, there is limited information on how growers use water in their operations or on the amount of water used for the production of container grown crops. Without these data, state water planners have been forced to make broad assumptions concerning industry water use and potential savings from the implementation of conservation strategies.

The Texas nursery industry is predominantly based around the production of container grown plant materials. There are a limited number of in-ground field producers throughout the state but in general, Texas soils and climate do not lend themselves to this form of production. Since container grown plants are not dug (i.e. have an intact root system) they may be produced, sold and installed year round. The use of containerized plants has greatly helped limit the seasonality of the nursery/landscape business. However, the production of container grown plant materials presents a variety of challenges in the area of water use/conservation. This industry segment was the primary target of evaluation by the Texas Green Industry Water Use Survey.

To ensure the future availability of high quality irrigation water, Texas nursery professionals were asked to assist in establishing baseline data for long-term water use planning. Utilizing input from TWDB and TNLA, an extensive survey was prepared and served on line beginning on August 15, 2005. The focus of the survey was on water use/conservation practices among Texas Department of Agriculture Class 3 and 4 container nursery crop producers. The survey questionnaire was developed using an information database system and software (FileMaker Pro). The survey was then incorporated into the Texas Green Industry Water Use Web site. Two email announcements and two printed mailings were sent to TNLA Grower members requesting participation in the survey project (see page A5).

Results:
A summary of the results from the water use survey are presented in table 2. A total of 14 producers responded to this portion of the project. Two of these respondents held a Class 2 TDA Nursery/Floral License and were not included in the overall results. Two of the Class 3 respondents reported annual water use at levels far below those required for plant growth. Since these values were based on estimates and not determined on some quantitative basis (i.e. water meter) it was assumed that this information was reported in error. These data were subsequently handled as outliers and not included in overall water use calculations. Therefore, the data from 10 survey respondents, out of an estimated total of 190 Class 3 and 4 container nurseries (6.3%) served as the basis for water use calculations.

Table 2. Results from Texas Green Industry Water Use Survey – estimate of water use.

County	Class	% Groundwater	Acres	Est. Annual Use	Gal/Sq ft
Waller	4	50	47	103,000,000	50.31
Wood	4	30	19	45,000,000	54.37
Smith	4	50	21	49,000,000	53.56
Cherokee	2	100	4	6,500,000	37.3
Harris	2	100	3	5,200,000	39.79
Waller	4	25	220	540,000,000	56.34
Smith	4	100	34	32,400,000	21.87
Smith*	3	60	11	2,250,000	4.69*
Smith	4	85	53	104,000,000	45.04
Travis*	4	100	21	6,517,020	7.48*
Wharton	4	100	320	710,000,000	50.93
Smith	3	100	17	35,000,000	47.26
Harris	3	100	12	30,000,000	57.39
Brazos	4	100	50	105,000,000	48.2

*Outlier not used in calculations.

Based on these data it is estimated that the average Class 3 nursery annually utilizes 52.32 gallons of water/sq ft of production area. Class 4 nurseries average 56.24 gallons/sq ft/year. However, it should be noted that, generally speaking, production practices and associated water use/sq ft did not differ between Class 3 and 4 operations.

Assumptions, Calculations and Interpretation:
Both Class 3 and 4 container nurseries devote resources to propagation, liner production and finished crops. However, the commitment to each of these sectors varies widely by operation. In an attempt to maximize profitability, growers may purchase materials from custom propagators or outside liner suppliers. It should be noted that plant propagation and liner production are among the 2 most water use efficient phases of container crop production.

It should be noted that current licensing regulations make no distinction between operation type (i.e. greenhouse, container nursery, field grown, etc.), production stage (i.e. propagation, liner, etc.), nor do they require licensees to provide information on the number of acres or square feet under production. As a result there is little available data to for projection purposes. The Texas Department of Agriculture's 2006 data on Class 2 – 4 Nursery/Floral Crop licenses are as follows:

Class 2 (10 acres or less) – 2,029 producers
Class 3 (10 – 20 acres) – 89 producers
Class 4 (over 20 acres) – 235 producers
Total = 2,353   Total 3+4 = 324

Assuming that the majority (two-thirds) of Class 3 licenses are issued to floral crop producers with traditionally smaller operations, it is broadly estimated that approximately 30 Class 3 licenses are held by container nursery crop producers. Assuming that the average Class 3 producer is approximately 15 acres in size, it is estimated that the statewide water use by Class 3 container nursery crop producers is approximately 3,147.37 acre feet per year.

30 Class 3's x 653400 sq ft (15 acres) x 52.32 gal/sq ft =1,025,576,640 (3147.37 acre ft)

Assuming that the majority of Class 4 licenses (two-thirds) are issued to container nursery crop producers with traditionally larger operations, it is broadly estimated that there are approximately 160 Class 4 licensed container nursery crop producers in the state. It is further assumed that there are approximately 16,750 acres of container crop production in the state based on the following breakdown of numbers/acreage:

75 producers x 50 acres = 3,750 acres
50 producers x 100 acres = 5,000 acres
25 producers x 200 acres = 5,000 acres
10 producers x 300 acres = 3,000 acres
TOTAL = 160 producers = 16,750 acres

Based on these assumptions and calculations, it is estimated that the statewide water use by Class 4 container nursery crop producers is approximately 117,134.83 acre feet per year.

729,630,000 sq' (16,750 acres) x 52.32 gal/sq ft = 38,174,241,600 gal (117,134.83 acre ft)

Therefore the estimate of total acreage for TDA Class 3 and 4 container grown nursery crop producers is approximately 17,200 acres with a combined annual water use of 120,282.20 acre feet (3147.37 + 117,134.83 = 120,282.20 acre ft).

The 2003 United States Department of Agriculture's Specialty Crops Census (which includes containerized nursery crops) indicates that Texas has 295 individual firms representing 8,958.88 acres of production. The almost 2x difference between this estimate and the one based on TDA Class 3 and 4 licenses is difficult to explain/qualify. This discrepancy points out the challenges of making accurate/precise projections without the availability of critical industry-wide date.

Despite repeated attempts to solicit input from container nursery crop producers, very few took part in the survey. This may be attributed to a number of factors but the following prioritized list represents the principal considerations:

1) The extensive nature of the exercise and time required to complete the questionnaire.

2) Producers do not have much of the necessary data to complete the questionnaire.

3) A reluctance to share or reveal "sensitive" information, critical to the operation.

4) Limited access to an on-line, broad band internet connection.

5) A low priority or interest in the area of water use/conservation.

Although the number of participants was limited the quality of data received was very good. Therefore estimates made on the basis of individual operations were considered relevant and accurate. The greatest opportunity for error occurred when attempting to extrapolate/project these values to statewide estimates. An improved method for determining the nature, size and distribution of container nurseries throughout the state would provide the opportunity for more accurate and precise projections.

Objective 3: Offer a free, on-line water use analysis for nursery/floral producers.

The potential for water conservation and/or the contamination of surface and groundwater from irrigation runoff, are important issues impacting the Texas GREEN Industry. Implementing water conserving BMPs can significantly increase potential water savings. These practices can also decrease the risk of surface and groundwater contamination from irrigation runoff containing fertilizers and pesticides.

Understanding the factors that contribute to water conservation and contamination can greatly help producers manage these problems and ultimately preserve and protect the environment. An important step in this process is for producers to carefully evaluate the growing operation in an effort to identify potential areas where improvements may be made. This information can then be used to develop short and long term management tactics to conserve water, reduce irrigation runoff, and protect valuable natural resources.

To address these important issues an On-Line Water Use Analysis instrument was constructed using an information database system and software (FileMaker Pro). Over 50 questions concerning water use, conservation and related topics were identified. Each question on the analysis included pre-determined responses presented in a drop-down menu. These responses included water status/management options ranging from those that promote water conservation and limit the potential for contamination to those that were less conservation oriented and may lead to the contamination of surface and groundwater resources.

Participants were encouraged to select the answer to each question which most accurately described their operation. Based on this input respondents received an electronic report summarizing results. In addition the On-Line Analysis provided a conservation/ contamination estimate, ranking the potential for implementing best management practices, with potential action areas highlighted.

Participants were reminded that the validity of the analysis report depended entirely on answering every question accurately as it describes that aspect of the operation. Required fields were marked by a red asterisk *.

A very limited number of producers took part in the On-Line Water Use Analysis. This may be attributed to the same factors previously described for the Water Use Survey.

Despite the results, the Water Use Analysis is and will be an extremely valuable instrument for developing short and long term water use/conservation strategies for the container nursery industry. The Implementation phase of Texas Water Development Board's BMP for the nursery/floral industry states:

C. Implementation
Many operational procedures and controls to improve water use efficiency of the nursery operations should be implemented simply as a matter of good practice. Implementation of this BMP consists of the following actions:

1) Perform a water efficiency audit of the nursery facility to identify areas of improvement for water savings and optimization of water use. The audit should review all aspects of operations including types of plants and specific water requirements, growing medium characteristics, and the irrigation system.

The possibility of changing the format of the Water Analysis instrument to a hard copy version may broaden its use. However, it would be difficult to generate a report back to participants if the Analysis is not presented in some electronic format.

Objective 4: Conduct a special Water Conservation session at the TNLA Pre-EXPO Educational Seminar.

Texas Nursery & Landscape Association EXPO Kickoff Event:
On August 18 - 21, 2005 the Water Conservation Project was officially announced during the Texas Nursery and Landscape Association's EXPO industry event in Dallas, Texas. A project overview was presented to 35 nursery/landscape professionals in the Educational Lounge on Saturday - July 20th. During the 3 day EXPO approximately 150 participants reviewed the On-Line Water Use Survey, Water Use Analysis tool and publications relating to water conservation for nursery/floral producers. Dates and locations for three field days were also announced at the Kickoff Event.

Using TNLA's EXPO event to "kickoff" the Texas Water Use Survey Project yielded mixed results. Most Class 3 and 4 container producers were present but few had time to actually sit down and become familiar with the survey. The detailed nature of the questionnaire also required that participants have considerable information concerning water use prior to entering data. Most EXPO attendees were not prepared with the necessary information to complete the survey.

The presentation made at the EXPO educational session (Kluge & Wilkerson) did an excellent job of introducing the overall concepts of water planning, best management practices and the goals and objectives of survey the project. However, it was impossible to determine the overall impact on the project.

Objective 5: Host 3 regional field days (Harris, Smith and Bexar counties) using innovative nursery/floral producers to showcase their conservation practices (including practices listed in the TWDB BMP Guide).

Water Conservation Field Days:
With the assistance of the Texas Nursery and Landscape Association (TNLA), all grower members were notified (twice) by email and information was posted on the TNLA web site, regarding each of the three Water Conservation Field Days held throughout the state at the following locations/dates:

Chamblees Nursery - Tyler, TX
September 8, 2005
(16 participants)

Mortellaro's Nursery - Schertz, TX
September 22, 2005
(14 participants)

Hines Wholesale Nursery - Fulshear, TX
October 6, 2005
(23 participants)

Approximately 50 growers took part in 3 field days conducted to provide participants with an opportunity to see the latest in water conservation practices and technology. A variety of hands-on demonstrations were also conducted to provide additional information on water conservation. No admission fee was charged to attend any of these events and lunch was provided to all participants. The same agenda/schedule and supplemental information were used for each field day (see page A8).

Each of the 3 locations provided excellent examples of state of the art water conservation practices and technology. The field day activities offered specific information on engineering, capacity specifications, operation and management of capture and recycle irrigation systems. Growers also provided detailed information on water treatment, fertilization and delivery options.

The hands-on demonstrations also provided in-depth information on substrate management. Participants significantly increased their knowledge in the area of determining the aeration, drainage and water holding characteristics of a growing medium, as well as water quality monitoring techniques. Perhaps the most valuable aspect of these field days was the opportunity for growers to informally share water use/conservation information and experiences.

Attendance was low at all 3 field day events but the overall response by participants was very positive. These events were highly promoted by TNLA through the Texas GREEN Magazine, Web site and several direct mail/emails to grower members. There were some externalities that may have impacted attendance (i.e. hurricanes Katrina and Rita). However, the general consensus is that most growers do not currently place a high enough priority or interest on water use/conservation to allocate the time and resources necessary to take part in this type of an educational activity. As the issue of water availability more directly impacts container nursery crop producers, field day activities such as these will be an important means of communicating water use/conservation practices and technology.

Summary & Conclusions:

The diverse nature of the Texas nursery/floral industry makes it extremely difficult to generalize any aspect of the production process. The lack of data on the type, nature and size of nursery/floral operations also creates a significant challenge in developing projections for any type of state or regional planning. Although the survey data from individual operations were relevant, the assumptions and calculations used to expand this information to state estimates leaves much room for discussion.

Current conservation efforts are largely tied to the production economics of the container nursery crop industry. The TWDB’s list of recommended practices touches on some important areas of concern but many are not totally relevant. Additional research and development in the area of irrigation technology will be required to address the most critical water conservation opportunities. A detailed water use audit and improved management strategies represent the greatest opportunity for water conservation/savings currently available to Texas container nursery crop producers. Although Texas container nursery crop producers recognize water availability as a critical issue, they have not fully committed to implementing practices for conservation. Many of the recommendations in TWDB's Best Management Practices Guide represent costly investments with little, if any, potential economic return. Since there are few regulations in this area, growers are voluntarily implementing water conserving practices when economically feasible. Until the cost of water significantly increases or availability decreases it is unrealistic to anticipate rapid adoption of most the TWDB's recommended practices.

However, improved water management, based on a detailed irrigation audit, not only represents the greatest opportunity for potential water savings, producers can implement this practice at little or no cost. Emphasizing the value of an irrigation audit and providing the necessary tools to assist with the audit process will be a key strategy for long term water conservation. Continued access to the On-Line Water Use Analysis Web site will greatly contribute to this ongoing effort. TWDB, TNLA and TCE collaborative educational programs, events and activities focusing on irrigation audits will also be important in improving knowledge and adoption of water conservation practices. The greatest challenge will continue to be grower participation. Without incentives or penalties growers are likely to maintain the current pace of implementing water conservation practices. However, the current drought status throughout much of the state does provide growers with additional motivation to evaluate various conservation strategies. Hopefully the information gathered as the result of the Texas GREEN Industry Water Use Survey Project will serve as a catalyst for a continued resolve to preserve and protect our state's valuable natural resources.

GREEN INDUSTRY: WATER CONSERVATION PROJECT

APPENDIX

Table of Contents:

Texas Department of Agriculture
Class 3 & 4 Nursery/Floral Licenses by County.

County	C-3	C-4
ANDERSON	-	2
ANGELINA	1	-
ATASCOSA	1	6
AUSTIN	2	1
BANDERA	2	-
BASTROP	-	3
BEE	1	-
BELL	2	-
BEXAR	2	6
BOSQUE	1	-
BOWIE	1	1
BRAZORIA	4	11
BRAZOS	1	3
BREWSTER	-	1
BURLESON	-	1
BURNET	1	-
CALDWELL	-	1
CAMERON	3	13
CHAMBERS	1	-
CHEROKEE	2	4
COLLIN	7	3
COMAL	1	-
COMANCHE	-	1
DALLAM	1	-
DALLAS	2	3
DELTA	-	1
DENTON	-	4
ECTOR	-	1
ELLIS	-	1
ERATH	-	2
FANNIN	-	2
FAYETTE	-	1
FORT BEND	1	8
FRIO	-	3
GILLESPIE	-	2
GRAYSON	1	2
GRIMES	1	2
GUADALUPE	2	-
HALE	-	1
HARRIS	8	11
HENDERSON	-	3
HIDALGO	5	13

County	C-3	C-4
HILL	1	-
HOOD	-	1
HUDSPETH	-	1
HUNT	-	1
JASPER	1	2
JEFFERSON	-	6
KAUFMAN	1	1
KERR	-	2
LAMAR	-	2
LAMB	-	1
LAVACA	1	1
LEE	2	-
LEON	1	2
LIBERTY	1	4
LIMESTONE	1	2
LUBBOCK	1	1
LUBBOCK	-	-
MATAGORDA	-	21
MCLENNAN	2	4
MIDLAND	1	-
MONTGOMERY	2	3
PARKER	3	-
POLK	-	2
PRESIDIO	-	1
RANDALL	-	2
ROCKWALL	-	1
RUSK	-	1
SMITH	5	15
SWISHER	-	1
TARRANT	1	-
TRAVIS	2	-
TYLER	1	-
VAN ZANDT	4	9
VICTORIA	-	-
WALKER	1	2
WALLER	1	3
WHARTON	1	20
WILLACY	-	1
WILLIAMSON	-	1
WILSON	1	1
WOOD	-	2
ZAVALA	1	-

4.5.2 NURSERY PRODUCTION SYSTEMS

A. Applicability
This BMP is applicable to irrigation of nursery crops and agricultural producers that grow nursery crops.

B. Description
This BMP considers the design of the irrigation system used for distribution and application of irrigation water to field, container, and greenhouse grown nursery plants. Improved efficiency of water use in the production of nursery crops includes the following practices:

1) Irrigation System Design and Management
    - a. Scheduling irrigation according to crop needs and growing-medium water depletion. Watering requirements will vary and should be adjusted based on time of year, weather, methods of storage and type and stage of the plant (e.g., dormancy). Plants need less water during cool, rainy weather than during hot, dry, windy weather.
    - b. Upgrading irrigation equipment to improve application efficiency. For example, a computerized irrigation scheduler using a drip system can reduce overwatering and excessive leaching compared to an overhead system.
    - c. Plugging sprinkler heads that are not watering plants, keeping sprinkler heads as low as possible to the plants, and use of the largest appropriate water droplet size to reduce irrigation time.
    - e. When using programmable irrigation booms, travel rate and flow rates should be adjusted to specific crop needs.
    - f. Use of sub-irrigation systems where appropriate, using ebb and flood or capillary mat irrigation technologies with water capture and reuse systems.
2) Plant Media and Management
    - a. Grouping plants together that have the same water requirements (i.e., use hydrozoning).
    - b. When ball-and-burlapped stock and containerized stock are received, they should be kept out of the wind and sun. Ideally, balls should be covered with moisture-retaining materials such as sawdust or wood chips if stock will be stored for a long time.
    - c. Knowing characteristics of the application site, including soil type and depth to groundwater under the greenhouse or nursery.
    - d. Spacing containers under fixed overhead irrigation to maximize plant irrigation and reduce waste between containers.
    - e. Minimizing leaching from containers or pulse-irrigate containers. Many textbooks recommend leaching greenhouse and nursery crops to 10 percent excess. This rate can be reduced to close to zero by reducing fertilizer rates and closely monitoring the electrical conductivity or the root substrate.

C. Implementation
Many operational procedures and controls to improve water use efficiency of the nursery operations should be implemented simply as a matter of good practice. Implementation of this BMP consists of the following actions:

1) Perform a water efficiency audit of the nursery facility to identify areas of improvement for water savings and optimization of water use. The audit should review all aspects of operations including types of plants and specific water requirements, growing medium characteristics, and the irrigation system.
2) Implement appropriate water efficiency practices, including:

- Design of the irrigation system such that water can be delivered to different zones at different application rates and for different durations.
- Upgrading or modernization of irrigation system.
- Organization of plants by water use.
- Programming of irrigation system controllers for optimal water use.

D. Schedule
The time required to implement one or more of the above practices depends on the size and extent of the nursery operation and which conservation practices are to be implemented. Implementation of some of the above practices can be done in less than a week (programming of irrigation controllers, replacement of sprinkler nozzles, scheduling irrigations, etc.) to several months (installation of a new irrigation system or water recovery and reuse system).

E. Scope
Nursery production systems vary in extent from small (less than 1 acre) operations to multi-acre farms and greenhouses. The applicability of each of the above practices must be customized for the specific requirements of each Nursery Production System. Some of the above practices may be not be cost effective for smaller operations. Larger operations may select to implement all of the above practices.

F. Documentation
The following information can be used to document implementation of this BMP:

- Description of irrigation techniques and water zones;
- Description of mulching practices and soil amendments used;
- Description of the irrigation and water recovery and reuse system; and
- Water use records for the periods both before and after implementation of water efficient prac tices.

G. Determination of Water Savings
Determination of the quantity of water saved by implementing this BMP must be determined specific to each nursery production system and is dependent on the amount of water used by the existing system and which conservation practices are currently implemented by the producer. Water use records prior to and after implementation of one or more of the above practices can be used to determine the amount of water saved.

H. Cost-Effectiveness Considerations
The cost-effectiveness of implementing one or more of the above practices must be analyzed for each nursery production system. The cost ranges from minimal (for reprogramming irrigation controllers, changing sprinkler heads, etc.) to significant (installation of water recovery and reuse system, upgrading or replacement of irrigation system, etc.). Some basic operational practices should be corrected without a cost-effectiveness analysis.

Nursery/Floral Producers Get Water Conservation Boost

Field days to demonstrate advanced water conservation methods

BY DR. DON WILKERSON

EDITOR'S NOTE: *Some time ago, TNLA became aware that statewide estimates of agricultural water use did not include uses by the nursery/landscape producers. Working with the Texas Water Development Board and the Texas Cooperative Extension, TNLA has facilitated a project that will not only help estimate nursery/landscape producer water use, but will also provide education for producers about advanced water conservation methods, and provide an online means for producers to conduct their own internal water use/conservation audits of their own facilities. The following article by Dr. Don Wilkerson describes the project, which will be introduced to the industry at the Nursery/Landscape Expo this August.*

In my role with Texas Cooperative Extension (TCE) I have the opportunity to interact with nursery/floral producers on a daily basis. Although these businesses can be extremely diverse in terms of operation and management, there is little debate over the key issues facing this segment of the Green Industry. In no particular order, they are marketing and water.

TCE and the Texas Nursery and Landscape Association (TNLA) are working collaboratively to address both of these important issues. However, in April 2005, our efforts in the area of water conservation for nursery/floral producers received a huge boost from the Texas Water Development Board (TWDB). A recently approved partnership project between TCE and TNLA, funded by the TWDB, will enable growers throughout the state to learn more about how they can improve water conservation. This project involves a number of components that will assist in the collection of water-use and conservation data and disseminating information on conservation practices.

AGGIE-HORTICULTURE TCE - Horticulture is recognized as a state, regional and national information resource for the nursery/floral industry. Much of this information is provided via Aggie Horticulture, TCE-Horticulture's information server on the World Wide Web (aggie-horticulture.tamu.edu). With an average of over 4 million hits/month (500,000 user sessions/month), Aggie Horticulture is the most widely used horticultural Website in Texas and the world. The new water conservation project will use the well-established presence of Aggie Horticulture as the principal means of delivering information related to the project.

ON-LINE NURSERY/FLORAL WATER USE SURVEY One of the components of the project is an on-line survey to assist in determining average water use by producers. Data will be collected/entered in to an electronic database, which will enable a detailed analysis to determine a general level of conservation used and an estimate of water use by general sources and counties. This information will be vital in water planning efforts to ensure the long-term availability of high quality irrigation water for the Texas nursery/floral industry.

ON-LINE WATER CONSERVATION AUDIT The project also uses Aggie Horticulture to provide on-line forms for conducting a water conservation audit of individual growing operations. The audit will assist in informing growers of their current water conservation status, as well as providing valuable planning information for the potential implementation of additional best management practices (BMP's). In addition, educational information on a variety of water conservation BMP's is included.

FIELD DAYS Educational field days will be conducted at three key locations to demonstrate the latest in innovative water conservation systems and strategies. These activities are jointly sponsored by TCE, TNLA, and the TWDB, with special promotional assistance from TNLA. The dates and locations of the field days are as follows:

Chamblee's Rose Nursery
Tyler, TX
10:00 am - 2:00 pm
September 8, 2005

Mortellaro's Nursery
Schertz, TX
10:00 am - 2:00 pm
September 22, 2005

Hines Wholesale Nursery
Brookshire, TX
10:00 am - 2:00 pm
October 6, 2005

Working together, TNLA, TCE, and TWDB are addressing the issue of water quality, conservation, and availability for the nursery/floral industry. However, it will require the support and cooperation of producers from throughout the state to make this a successful effort. We highly encourage your participation in this project. For additional information please come by the TCE booth or attend the informational session in the educational lounge during the Nursery/Landscape Expo in Dallas, August 19-21.

A4

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Introduction:
Texas Cooperative Extension, the Texas Nursery & Landscape Association and the Texas Water Development Board have initiated a collaborative project to estimate the annual volume of water used by nursery/floral crop producers statewide. This project also will investigate the use of Best Management Practices (BMPs) dealing with water conservation and quality.

Why is this important?
Water availability and quality are among the most critical issues facing the Texas GREEN Industry. Numerous regulatory plans and guidelines which will impact future water use in the production of nursery and floral crops are now in place. Despite the scale of the GREEN industry, there is little quantitative information regarding how/how much growers use water in their operations. In addition, there is limited information on how many Texas nursery/ floral crop producers currently use BMPs as described in the Texas Water Development Board's *Water Conservation Best Management Practices Guide (TWDB Report 362).*

The 2002 Texas State Water Plan, calls for irrigation water conservation strategies in 60 counties, for a total of 669,447 acre-feet of savings in the year 2010 and 866,981 acre-feet of savings in 2050. Eleven counties in the state have 6 or more Class 4 nurseries; of these 11 counties, eight have irrigation water conservation strategies in the 2002 Plan to meet unmet needs. Conservation savings from nursery/floral producers in these counties, and others, have been identified as a potential source of broad conservation strategies to offset unmet needs.

Without the necessary data, water use for the GREEN industry, as well as potential water savings, will be based on estimates, which may or may not accurately depict the status of these issues.

How can you participate?
On-Line Survey:
To ensure the future availability of high quality irrigation water, the Texas nursery/floral industry must work toward establishing baseline data for long-term water use planning. Your participation in this On-Line Water Use Survey will assist in this important effort. You can access the survey at:
http://aggie-horticulture.tamu.edu/greenhouse/twdb/survey.html

On-Line Analysis:
Understanding the factors that contribute to water conservation and contamination can greatly help producers manage these problems. An important step in this process is to evaluate carefully your growing operation to identify potential areas where improvements may be made. This information can then be used to develop short and long term management tactics to conserve water, reduce irrigation runoff, and protect our valuable natural resources.

The questions posed in the On-Line Analysis cover many of the basic factors to be considered when evaluating water management. Obviously, not all of these questions will pertain to every growing operation. Also there may be additional factors to consider which are not addressed in this format.

Participants are encouraged to answer each question in a way that most accurately describes their operations. Based on this input participants will receive an assessment summary report which provides a conservation/contamination estimate and recommends the implementation of appropriate BMPs. You can access the water analysis site at:
http://aggie-horticulture.tamu.edu/greenhouse/twdb/auditform.html

Texas Nursery & Landscape Association EXPO:
On August 18 - 21, 2005 the Water Conservation Project will officially kickoff during the Texas Nursery and Landscape Association's EXPO industry event. A project overview will be presented in the Educational Lounge on Friday - August 19th. There will also be an opportunity for participants to review the On-Line Water Use Survey, Water Use Assessment Tool and publications relating to water conservation for nursery/floral producers.

August 18 - 21, 2005
Dallas Convention Center
Dallas, Texas
For more information contact TNLA (512) 280-5182

Water Conservation Field Days:
Three field days will be conducted to provide participants with an opportunity to see the latest in water conservation practices and technology. There will be a variety of hands-on demonstrations to provide additional information on water conservation. Participants will also have the opportunity to review the On-Line Water Use Survey, Water Use Assessment Tool and publications relating to water conservation for nursery/floral producers.

There is no admission fee to attend any of these events. Lunch will be provided, so we ask that you pre-register to assist in planning (only those that pre-register will be guaranteed a meal).

Field Day Events, Locations and Times

Chamblees Nursery - Tyler, TX
10:00 am - 2:00 pm
September 8, 2005

Mortellaro's Nursery - Schertz, TX
10:00 am - 2:00 pm
September 22, 2005

Hines Wholesale Nursery - Brookshire, TX
10:00 am - 2:00 pm
October 6, 2000

PRE-REGISTRATION INFORMATION

Name(s): ____

____

Name of Firm: ____

Address: ____

City/State/Zip: ____

Phone: ____

Email: ____

County: ____

Send To:
Texas Cooperative Extension - Department of Horticultural Sciences
Texas A&M University
College Station, TX 77843-2134
Email: d-wilkerson@tamu.edu
Phone: (979) 458-4433   FAX: (979) 845-3659

Water Conservation Field Days

Your are invited to participate in one of three upcoming field days focusing on the latest in water conservation practices and technology for commercial nursery/floral producers. There will be a variety of hands-on demonstrations to provide additional information on water conservation. Participants will also have an opportunity to learn more about the Texas GREEN Industry Conservation Project, including the On-Line Water Use Survey, Water Analysis Tool and publications relating to water conservation for nursery/floral producers.

Field Day Dates and Locations:

September 8, 2005
Chamblees Nursery - Tyler, TX
10:00 am - 2:00 pm

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Mortellaro's Nursery - Schertz, TX
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October 6, 2000
Hines Wholesale Nursery - Brookshire, TX
10:00 am - 2:00 pm

Pre-Registration Information:

There is no admission fee to attend any of these events. Lunch will be provided, so we ask that you preregister to assist in planning (only those that preregister will be guaranteed a meal).

Name(s): ______________________________

Address: ______________________________

City/Sate/ZIP: ______________________________

Phone/Email: ______________________________

County: ______________________________

Please Email/FAX Your Information To:

d-wilkerson@tamu.edu
Phone: (979) 458-4433 FAX: (979) 845-3649

OR Send To:

Conservation Field Day - Department of Horticultural Sciences
Texas A&M University
College Station, TX 77843-2134

For more info check out our web site...

http://aggie-horticulture.tamu.edu/greenhouse/twdb/index.html

Water Conservation Field Day - Agenda

10:00 am	Welcome and Introduction
10:30	Nursery Tour
11:30	Substrate Aeration, Drainage, & Water Holding Capacity Demonstration
12:00	Lunch *(Only those that have pre-registered are guaranteed a lunch).*
1:00 pm	Water Quality Discussion
2:00	Adjourn

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Calculating Aeration, Drainage & Water Holding Characteristics:

Maximizing the efficiency of an irrigation system can be extremely complicated. Many factors must be taken in to consideration in determining how best to manage the application of supplemental irrigation water. Environmental conditions, delivery and application system(s), plant type/size, container size/shape, water quality and much more all play an important role in the decision making process. The aeration, drainage and water holding capacity of the growing substrate are also key elements affecting irrigation management. However, growers rarely measure these factors to determine their impact on water use and plant growth.

The following procedure is a quick method for evaluating the aeration and water holding characteristics of any type of container growing substrate.

✓ Select the substrate and container size you plan on evaluating:

NOTE: Each substrate/substrate combination will have unique properties and must be evaluated separately. Container size and shape affect aeration and water holding characteristics. You should replicate this procedure a minimum of 3 times for each container/substrate combination.

✓ Place a piece of duct tape over the drain holes of the selected container(s).

✓ Fill the container(s) with the selected substrate.

NOTE: Initial substrate moisture content and compaction will impact water holding/ aeration characteristics. Be consistent.

✓ Fill a graduated cylinder (if you have access to one) with water and note the initial volume.

✓ Slowly pour the water in to the container until you see it reach the surface of the substrate.

NOTE: You must do this slowly, allowing displaced air to bubble from the surface. If you have to refill the cylinder keep track of the total volume of water used.

✓ Enter the volume of water poured in on line A of the work sheet.

✓ Place the saturated container over a bucket, remove the duct tape from the drain holes and carefully collect all of the water that drains out (this can be challenging with larger size containers).

NOTE: Do not squeeze the container or press on the substrate to force water out of the container.

✓ Enter the volume of water that drained from the container on line B of the work sheet.

Work Sheet/Calculations:

A. ________________________________ = Total porosity

B. ________________________________ = Air Space at saturation

C. Water retention = A-B ________________________________

D. (B * 100) / A = Percent air space at saturation ____________________________

E. (C * 100)/ A = Percent water retention ________________________________

Container media for nursery crops typically consist of 50% - 60% air space at saturation.

Monitoring the Quality of Irrigation Water

Irrigation water is a key factor in the production of nursery and greenhouse crops. Therefore it is important to monitor quality standards on a frequent basis to avoid potential problems.

Often growers are unfamiliar with the many determinations that are made on a routine water test. This also makes interpretation of the results somewhat difficult. The following is a brief summary of these quality factors, as well as guidelines which may be used to determine their effect on plant growth.

Electrical Conductivity (EC) is a measure of the total salt content of water based on the flow of electrical current through the sample. The higher the salt content, the greater the flow of electrical current. EC is measured in mho/cm, which is the opposite of ohms of electrical resistance. Since the conductivity of most water is very low, EC is generally reported in thousandths of a mho or millimhos/cc.

Carbonate + Bicarbonate (CO_3+ HCO_3) are actually salts of carbonic acid (the acid formed when carbon dioxide dissolves in water). When in combination with calcium and/or magne-sium ($CaCO_3$, $MgCO_3$) there is an alkalizing effect. This is generally mild because they are slightly soluble salts of moder-ately strong bases and weak acids. A stronger alkalizing effect may occur in the presence of sodium (Na_2CO_3) because this is a highly soluble salt of a strong base and weak acid. Carbonates and bicarbonates are reported in milliequivalents/ liter.

Calcium and Magnesium (Ca, Mg) are cations (positively charged ions) which are present in water. In most cases the sum of Ca and Mg are reported in milliequivalents/liter. Together Ca + Mg may be used to establish the relationship to total salinity and to estimate the sodium hazard.

Sodium (Na) is another cation occurring in most irrigation water. Along with Ca and Mg, Na is present in total amounts usually exceeding 0.1%. Sodium is often responsible for salinity problems when linked to chloride (Cl) and sulfide (SO_4) but seldom from Ca or Mg. Sodium is expressed in terms of the sodium absorption ratio (SAR) calculated as follows:

$$\sqrt{\frac{Na^{+}}{\frac{Ca^{++} + Mg^{++}}{2}}}$$

Continued on next page...

Chloride (Cl) is an anion (negatively charged ion) frequently occurring in irrigation water. Cl determinations are used to establish the relationship to total acidity as well as to indicate possible toxicities to sensitive crops.

Acidity/Alkalinity (pH) acids when mixed with water ionize into hydrogen ions (H^+) and associated anions. The stronger the acid the greater the amount of ionization. Weak acids (such as those in irrigation water) generally ionize to less than 1.0%. The H^+ ion activity of these acids is stated in terms of the logarithm of the reciprocal of H^+ ion activity or pH.

Interpreting Water Quality

The quality of irrigation water is dependent on total salt content, the nature of salts present in solution and the proportion of Na to Ca, Mg, bicarbonates and other cations. The following table presents guidelines on the interpretation of the water quality factors.

Table 1. Water quality standards for the production of greenhouse and nursery crops.

Quality	**Electrical Conductivity** (millimhos)	**Total Salts** (ppm)	**Sodium** (% of Total Salts)	**SAR**	**pH**
Excellent	0.25	175	20	3	6.5
Good	0.25 - 0.75	175 - 525	20 - 40	3 - 5	6.5 - 6.8
Permissible	0.75 - 2.0	525 - 1400	40 - 60	5 - 10	6.8 - 7.0
Doubtful	2.0 - 3.0	1400 - 2100	60 - 80	10 - 15	7.0 - 8.0
Unsuitable	>3.0	>2100	>80	>15	>8.0

For approximate conversion of EC to parts per million use the following calculations:

Millimhos

ppm = (EC x 10 -3) x 670

Micromhos

ppm = (EC x 10 -6) x 0.67

Texas A&M University Soil and Water Testing Laboratory
Room 345 Heep Center
College Station, Texas 77843.2474
Voice 979.845.4816 FAX 979.845.5958

Fertilizer Measurement and Vocabulary:
Several units are used to express the fertility level of nutrient solutions (fertilizer dissolved in water). This causes confusion among growers since the use of different units makes it difficult to understand different readings among growers.

Electrical conductivity (EC) is a measure of the ability of a solution to conduct electricity&emdash; the more concentrated the fertilizer solution, the more electricity it will conduct and the higher the reading will be. The general unit is mho (pronounced MO) with the plural being mhos (pronounced MOZE). You will notice that mho spelled backwards is ohm (pronounced OM), the unit of resistance in electrical jargon. Mhos, the reverse of ohms, is a measure of conductivity rather than resistance.

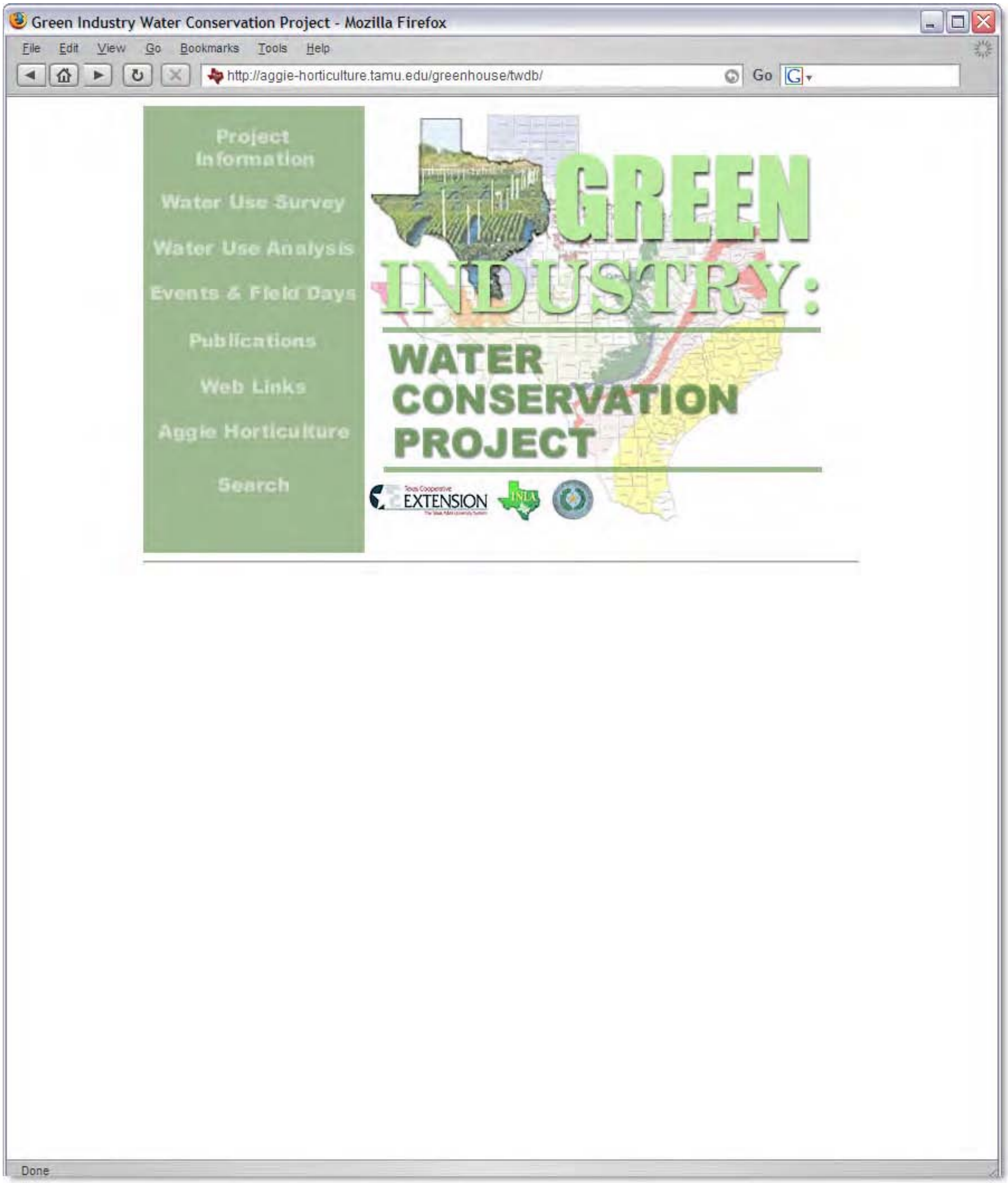
There are two units of mhos commonly used: micro-mhos (μmhos) (pronounced micro-MOZE) and millimhos (mmhos) (pronounced milli-MOZE). A micromho is one millionth of a mho and a millimho is one thousandth of a mho. Therefore, there are 1,000 micromhos in a millimho. Another way of looking at it is that a millimho is 1,000 times bigger than a micromho. Either scale can be used. Convert from micromhos to millimhos by sliding the decimal point 3 places to the left, and vice versa. Typical readings of millimhos are 0.30 to 2.50, while typical readings of micromhos are 300 to 2,500. Millimhos are more commonly used than micromhos on most meters today. Some portable EC meters measure in microsemens (μs). These are equivalent to micromhos (μmhos), and are more commonly used in European countries.

The best way to understand the nutrient status of a fertilizer solution and to communicate with other people is to know how many parts per million of each element you are applying. Parts per million (ppm) is the unit used to measure nitrogen concentration, or any other specific nutrient in solution. These units are usually within the range of 50 to 500 ppm for nitrogen. This is not directly related to or convertible to an exact measure of EC or total dissolved solids (TDS) in a nutrient solution. This is because both EC and total dissolved solids are measurements of everything dissolved in the solution, not just nitrogen.

Another way of measuring the amount of fertilizer in solution is by measuring dissolved solids. This is also referred to as total dissolved solids or TDS. The units commonly used for TDS are also parts per million (ppm). If you knew the ppm of each element dissolved in the solution, and added them up, along with the ppm of the water, you would get the ppm TDS. This is a measure of all salts in solution, not just nitrogen, so it is not the same as measuring ppm of nitrogen. Some of these salts may have been in the water supply before any fertilizer was added. For this reason, this form of measurement is not recommended. If a reading is 1,500 ppm TDS, how do you know if this is due to nitrogen or some other nutrient? You don't. You even may have water very high in sodium (salt) with no nitrogen. TDS is not a reliable measurement for this reason.

The readings of ppm dissolved solids are not directly convertible to millimhos or micromhos for a fertilizer; however, the conversions can be calculated for specific fertilizers. A rule of thumb (very crude conversion) is if your millimho reading is in the range 0.9 to 1.9, then mmhos x 680 = ppm total dissolved solids. If your millimho reading is in the range 2.0 to 2.8, then mmhos x 700 = ppm total dissolved solids. Remember - this is only a rule of thumb and does not give an exact conversion.

An important point: Any time dissolved solids or EC are measured in a solution, it is very important to know the dissolved solids or EC of the water source used to make the solution (it cannot be assumed to be 0). There may be sodium or some other dissolved element in your tap water that can lead to false readings when you measure your nutrient solution. Subtract the water source EC or dissolved solids measurement from that of the nutrient solution to find the true value caused by fertilizer. This is the number to compare to charts to decide if the correct amount of fertilizer is in solution.



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GREEN INDUSTRY: WATER CONSERVATION PROJECT

Project Information

Project Coordinators:
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College Station, TX 77843-2134
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Project Cooperators:
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Texas Nursery & Landscape Association
7730 South IH-35,
Austin, TX 78745-6698
mgood@txnla.org (512) 280-5182

Problem Statement:
The Nursery/Floral Industry represents the largest segment of irrigated crop producers in Texas with $1.2 billion in receipts, compared to $1.0 billion for cotton in 2001 (Texas Agricultural Statistics, 2001). Based on year 2000 data, annual economic activity associated with the nursery and landscaping industry in Texas results in about $3.2 billion worth of income for Texas workers and business owners. The industry directly and indirectly employs about 122,200 workers in the state and adds roughly $26 million per annum to state and local tax revenues. (Source: Based on TWDB analysis of 2000 economic data from MIG Inc., using IMPLAN PRO software). In a number of areas of the state, the impact of these operations is dramatic. For example, more than 200 nursery/floral growers are located in the 4 counties of Cherokee, Smith, Henderson and Van Zandt (TNLA). The combined economic impact of the industry in those 4 counties is estimated at more than $250 million (TNLA).

Despite the tremendous impact of the industry, there is no existing body of knowledge regarding how growers use water in their operations and the quantities used. The single nursery grower in the TWDB Water Use Survey, categorized by the Texas Department of Agriculture (TDA) as a Class 4 nursery (more than 20 acres of growing area), has a combined municipal and self-supplied groundwater use average of 2,600 acre-feet per year (TWDB Staff). The TDA lists 237 Class-4 nurseries and 75 Class-3 nursery operations (greater than 10 acres but less than 20). It is unknown whether 2,600 acre-feet of annual usage is representative of the average grower.

Few regional guides or conservation outreach efforts exist for nursery/floral growers. In addition, there is information regarding how many currently use the Best Management Practices as laid out in the Water Conservation Best Management Practices Guide (TWDB Report 362). In order to benchmark existing conservation efforts and the potential for conservation savings, this body of knowledge is essential.

Due to the lack of water use data and conservation practices information, it is difficult to estimate the potential savings from conservation. However, if the average water use for Class 4 nurseries is assumed to be one half of the surveyed nursery (1,300 acre-feet) and one quarter of the amount for class 3 nurseries (650 acre-feet), then potential for savings through the adoption of conservation techniques is estimated to be about 35,685 acre-feet per year based on a 10% savings (237 times 1,300 acre-feet and 75 times 650 acre-feet equals 356,850 acre-feet).

In the 2002 State Water Plan, irrigation water conservation strategies are planned for 60 counties, for a total of 669,447 acre-feet of savings in the year 2010 and 866,981 acre-feet of savings in 2050. Eleven counties in the state have 6 or more Class 4 nurseries; of these 11 counties, eight have irrigation water conservation strategies in the 2002 Plan to meet unmet needs. Conservation savings from nursery growers in these counties, and others, could be part of the broad conservation strategies to offset any unmet needs.

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GREEN INDUSTRY: WATER CONSERVATION PROJECT

Field Days & Events:

Texas Nursery & Landscape Association EXPO:
On August 18 - 21, 2005 the Water Conservation Project will officially kickoff during the Texas Nursery and Landscape Association's EXPO industry event. A project overview will be presented in the Educational Lounge on Saturday - July 20th. There will also be an opportunity for participants to review the On-Line Water Use Survey, Water Use Analysis tool and publications relating to water conservation for nursery/floral producers.

August 18 - 21, 2005
Dallas Convention Center
Dallas, Texas

For more information contact TNLA (512) 280-5182

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There is no admission fee to attend any of these events. Lunch will be provided, so we ask that you pre-register to assist in planning (only those that pre-register will be guaranteed a meal).

Be sure to checkout the highlights (featured on right) from these educational events and activities...

Events & Activities:


TNLA EXPO Kickoff


East Texas Field Day


San Antonio Field Day


Houston Field Day

To Pre-Register Please Contact:
Texas Cooperative Extension - Department of Horticultural Sciences
Texas A&M University
College Station, TX 77843-2134
d-wilkerson@tamu.edu
(979) 458-4433

Field Day Events, Locations and Times
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10:00 am - 2:00 pm
October 6, 2000

FIELD DAY AGENDA AND PROGRAM INFORMATION

Texas Cooperative EXTENSION
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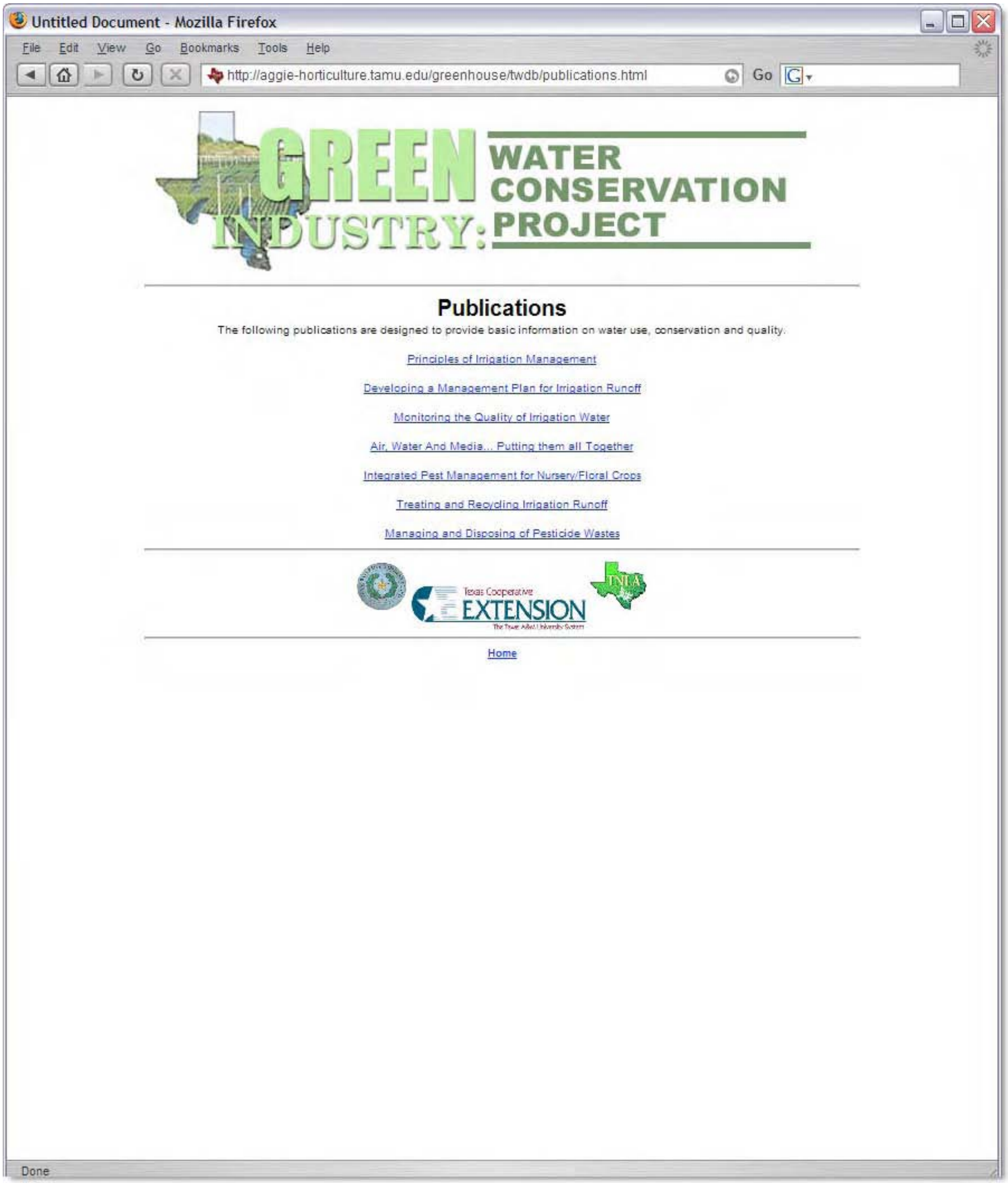

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GREEN INDUSTRY: WATER CONSERVATION PROJECT

Publications

The following publications are designed to provide basic information on water use, conservation and quality.

Principles of Irrigation Management

Developing a Management Plan for Irrigation Runoff

Monitoring the Quality of Irrigation Water

Air, Water And Media... Putting them all Together

Integrated Pest Management for Nursery/Floral Crops

Treating and Recycling Irrigation Runoff

Managing and Disposing of Pesticide Wastes

Texas Cooperative EXTENSION

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GREEN INDUSTRY: WATER CONSERVATION PROJECT

Web Links

The following Web links provide additional information concerning water and water conservation for the GREEN industry.

Center for Irrigation Technology An institute at California State University at Fresno that has educational resources for irrigation efficiency and best management practices.

SaveWater - Australia An Australian .com Web site funded by a number of industries including the Nursery Industry Association of Victoria.

Irrigation System Selection for Container Nurseries
An extension leaflet from the University of Florida that compares the water use efficiency of several commonly used nursery irrigation systems, including overhead sprinklers, microirrigation, and subirrigation.

Efficiencies of Irrigation Systems Used in Florida Nurseries
An extensions leaflet from the University of Florida that describes the efficiencies of water use as well as factors that affect this efficiency. The inefficiencys of each type of irrigation system is described.

Soil Plant Water Relationships
An extensions leaflet from the University of Florida that describes the abilities of different types of soils to absorb an hold water.

Reed Beds Clean-up Nursery Run-off
Article from the Nursery Papers funded by the Nursery Industry Levy in Australia. It explains one method for treating Nursery water run-off using reeds.

Water Wells for Florida's Irrigation
This is an extensions leaflet from the University of Florida that describes the construction, testing and development of Wells.

Arizonia Department of Water Resources
The Arizonia Department of water resource is involved in a number of water conservation projects. For example, rain water collection, recycling water, ground water management and well maintanence.

Efficient Water Use In Landscapes and Nurseries
The University of New Hampshire Extensions publication that lays out some methods for conserving water in Nurseries and in landscapes.

Texas Water Development Board
The Texas Water Development Board is responsible for the water management of Texas. There are several publications about water conservation and water use.

Irrigating on a schedule and water management
University of Florida extensions leaflet that describes using irrigating schedules to conserve water usage. Watering with specific plant requirments in mind and using soil and evapotranspiration estimations to get the most use out of the water.

Capturing and Recycling Irrigation Runoff
Oklahoma State University website dealing with nursery runoff and the different methods of recycling the water depending on the nursery size and price estimation to implement these systems.

Nursery Water Management
University of Florida's extension website with publications database. Contains several publications about Nursery Water Management and Irrigation practices in the state of Florida.

Water Management
Article describing water management history, planning, irrigation methods and design factors.

OSU Water Management Articles
Oklahoma State University Division of Agriculture Sciences and Natural Resources Department. This website contains several articles describing best management practices for water, water quality handbooks, irrigation water measurement, and irrigation systems.

EPA Irrigation management efficiency and a feasibility of water recyling
South Australian Environmental Protection Agency (EPA) case study of one nursery implementing irrigation management efficiency and water recyling. Includes prices of implementation, how they analysed the nurseries needs, and how they implemented the needed changes.

Water Use Tricks
Article that tells some tips on how to conserve water in the greenhouse environment. For example, measuring water use to determine any waste.

American Water Works Association
The American Water Works Association offers education, training and conferences about water and how to mange and save it. The Association mainly caters to water professionals.

Australian Government; Department of the Environment an dHeritage Australian Greenhouse Office
Australian Government website dealing with greenhouse issues like water efficiency.

Water Resource Management Branch
Water Resource Management Branch
Government of British Columbia Ministry of agriculture and Lands Resource Management. This website contains publications and conceptual plans about wate management, irrigation, drainage, and farm water supply.

Recycling Nursery Runoff
Oklahoma Cooperative Extensions services article detailing advantages and disadvantages of implementing a water recycling program and how to manage it.

Nursery and farm case studies of water conservation
United Kingdom government article of several farms and how they implemented water conservation techniques and the outcome of these practices.

New Techniques for Monitoring Drip Irrigation Water Use Effieciency, Drainage, and Leachate in Container Nurseries
The Society for engineering in agriculture, food, and biological systems article writen for a presentation at the 2004 ASAE/CSAE Annual International Meeting in Otawa, Ontario, Canada. This article describes a Pot-in-Pot method for growing trees to reduce water loss through drainage, and evaporation.

The Society for engineering in agricultural, food and biological systems
This website is the home page for the society with access to their technical papers database. To gain full access to the technical papers you must be a member.

Recycling Irrigation Water in Nurseries/Greenhouses: Innovative Approaches to Disease Control
South Australian Research and Development government website. This article describes several water recycling methods to achieve disease free water.

South Australian Research and Development Governmental Publications Website
South Australian Research and Development government website. This website contains a publications database with several agricultural topics.

Texas Cooperative EXTENSION
The Texas A&M University System

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Green Industry Water Conservation Project - Mozilla Firefox

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http://aggie-horticulture.tamu.edu/greenhouse/twdb/auditform.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

On-Line Analysis for Water Conservation and Surface & Groundwater Contamination

Introduction:
The potential for water conservation and/or the contamination of surface and groundwater contamination from irrigation runoff, are important issues impacting the Texas GREEN Industry. Implementing water conserving best management practices can significantly increase potential water savings. These practices can also decrease the risk of surface and groundwater contamination from irrigation runoff containing fertilizers and pesticides.

Understanding the factors that contribute to water conservation and contamination can greatly help producers manage these problems. An important step in this process is to carefully evaluate your growing operation in an effort to identify potential areas where improvements may be made. This information can then be used to develop short and long term management tactics to conserve water, reduce irrigation runoff, and protect our valuable natural resources.

Conducting an On-Line Analysis:
The questions posed in the On-Line Analysis cover many of the basic factors to be considered when evaluating water management. Obviously, not all of these questions will pertain to every growing operation. Also there may be additional factors to consider which are not addressed in this format.

Participants are encouraged to select the answer to each question which most accurately describes your operation. Based on this input you will receive an electronic report which summarizes results. In addition the On-Line Assessment will provide a conservation/ contamination estimate, ranking the potential for implementing best management practices, with potential action areas highlighted.

Click Here to Conduct an On-Line Assessment...

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TNLA

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Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox

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http://floriculture.tamu.edu:7998/riskassessment/index.html Go

GREEN INDUSTRY: WATER CONSERVATION PROJECT

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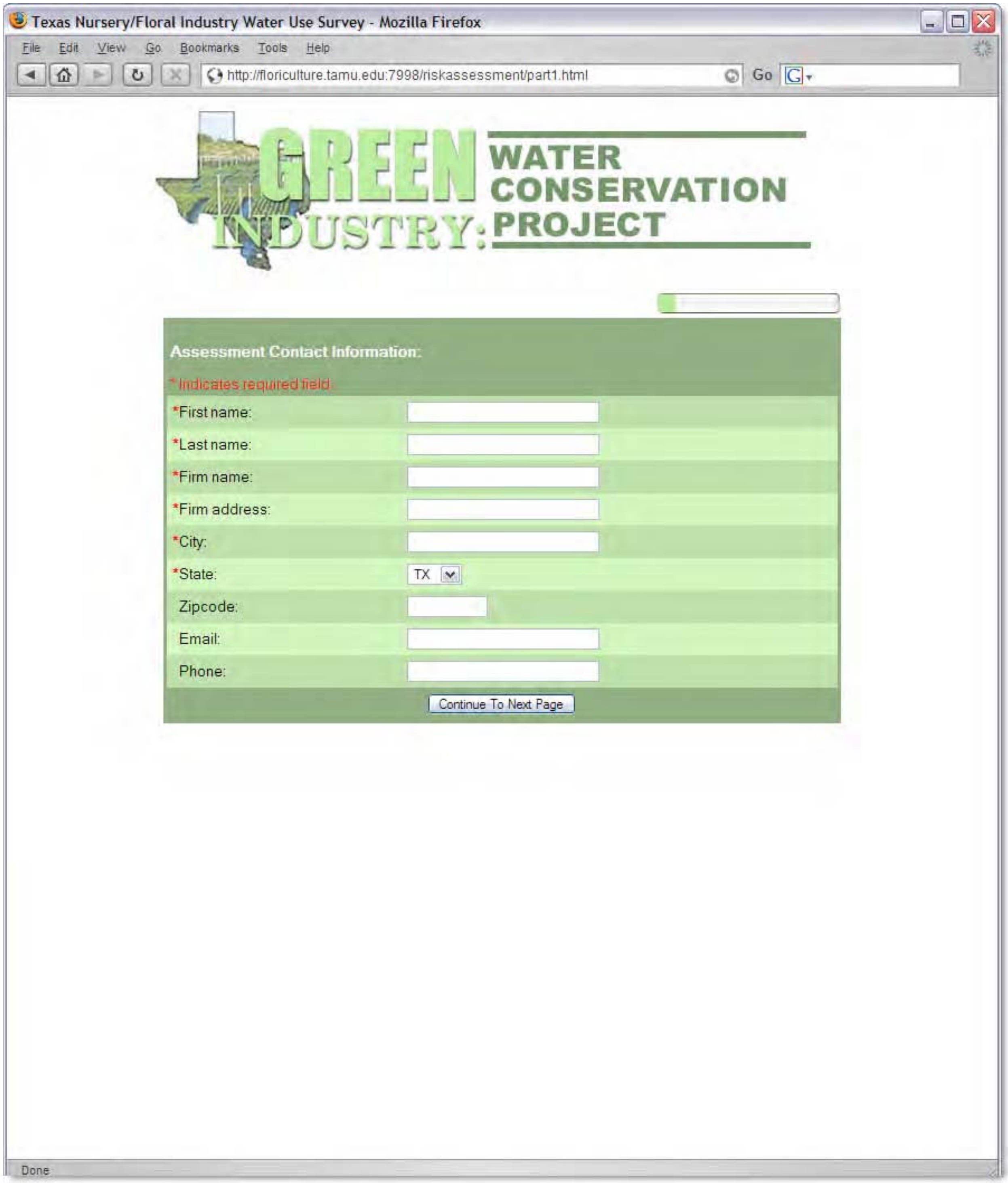
The validity of the assessment report depends entirely on your answering every question accurately as it describes that aspect of your operation. Required fields are marked by a red asterisk *.

The progress bar at the top right of the survey monitors the percentage of the assessment you have completed.

Continue To Next Page

Done


Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox
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http://floriculture.tamu.edu:7998/riskassessment/part1.html
Go
GREEN INDUSTRY: WATER CONSERVATION PROJECT
Assessment Contact Information:
* indicates required field
*First name:
*Last name:
*Firm name:
*Firm address:
*City:
*State:
TX
Zipcode:
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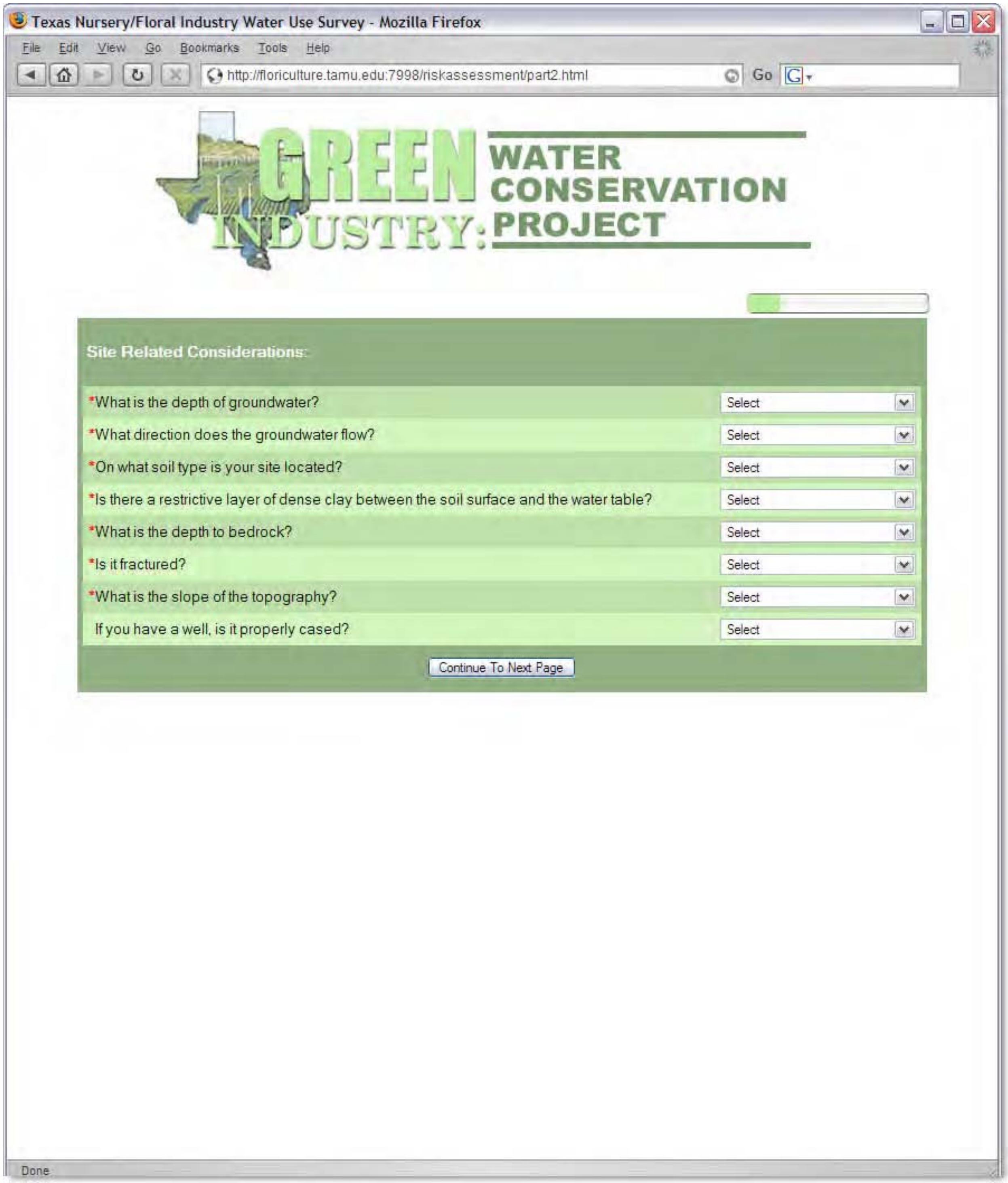
Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox
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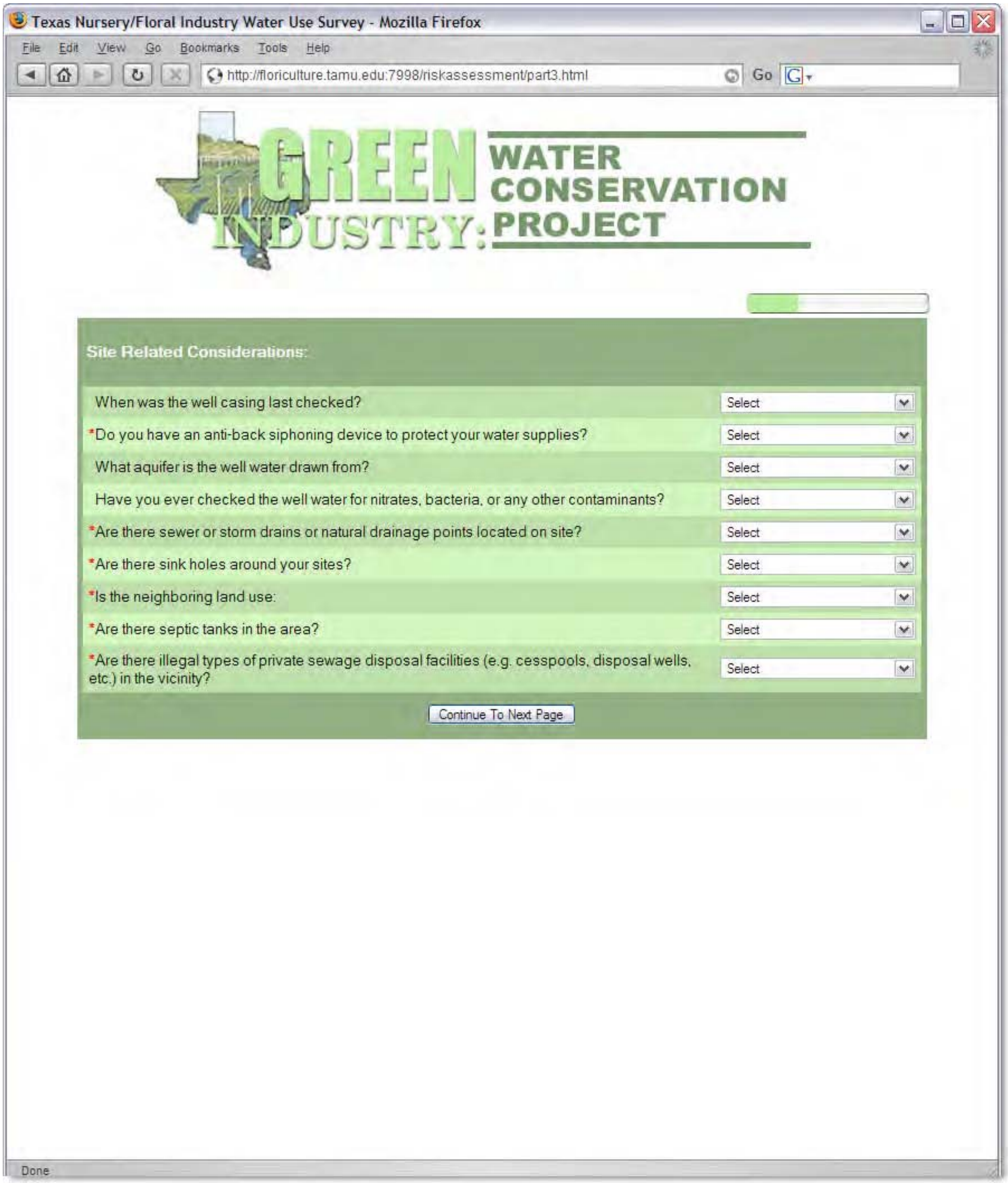
http://floriculture.tamu.edu:7998/riskassessment/part2.html
Go
GREEN INDUSTRY: WATER CONSERVATION PROJECT
Site Related Considerations:
*What is the depth of groundwater?
Select
*What direction does the groundwater flow?
Select
*On what soil type is your site located?
Select
*Is there a restrictive layer of dense clay between the soil surface and the water table?
Select
*What is the depth to bedrock?
Select
*Is it fractured?
Select
*What is the slope of the topography?
Select
If you have a well, is it properly cased?
Select
Continue To Next Page
Done



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http://floriculture.tamu.edu:7998/riskassessment/part3.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Site Related Considerations:

When was the well casing last checked?	Select
*Do you have an anti-back siphoning device to protect your water supplies?	Select
What aquifer is the well water drawn from?	Select
Have you ever checked the well water for nitrates, bacteria, or any other contaminants?	Select
*Are there sewer or storm drains or natural drainage points located on site?	Select
*Are there sink holes around your sites?	Select
*Is the neighboring land use:	Select
*Are there septic tanks in the area?	Select
*Are there illegal types of private sewage disposal facilities (e.g. cesspools, disposal wells, etc.) in the vicinity?	Select

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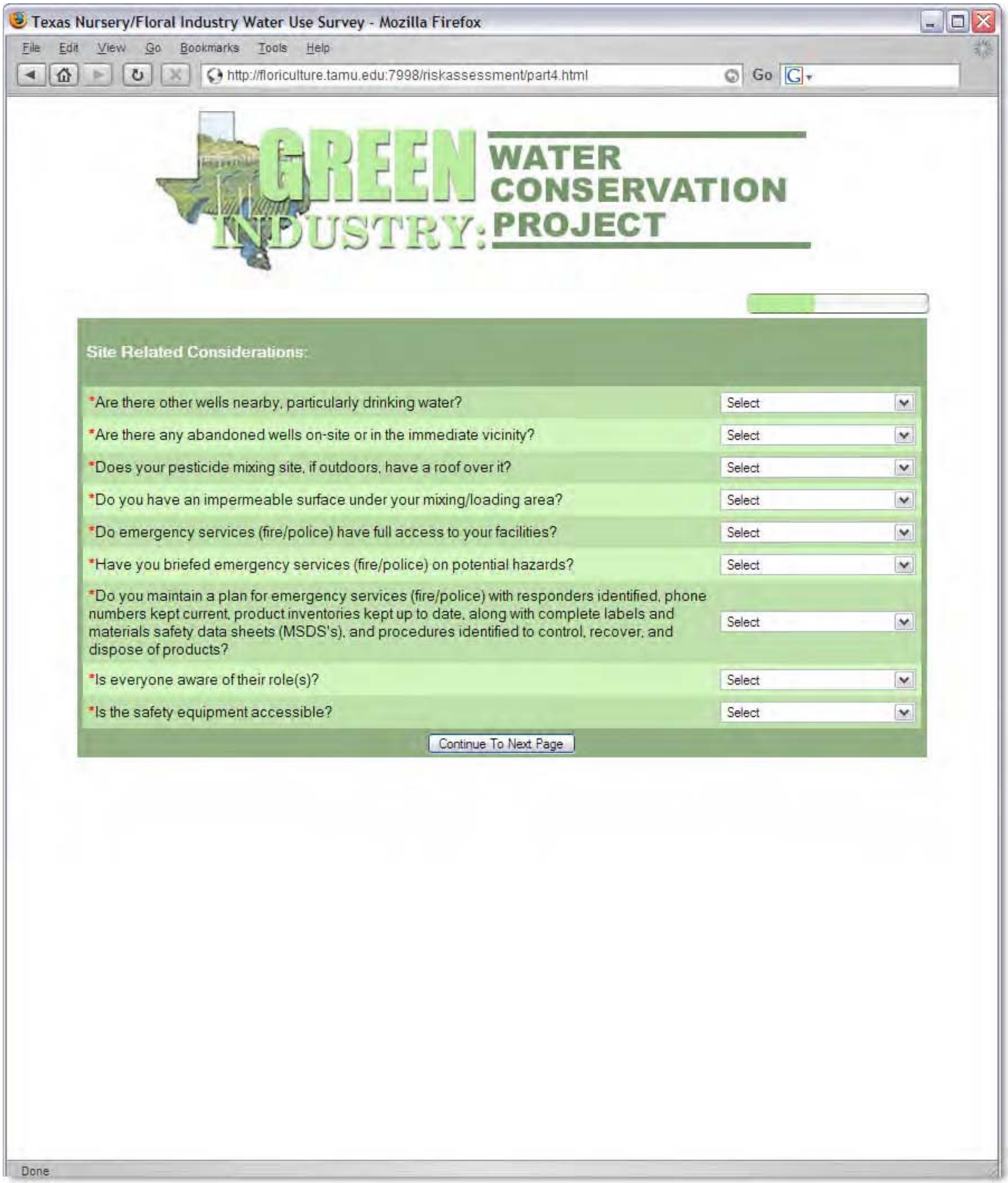

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http://floriculture.tamu.edu:7998/riskassessment/part4.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Site Related Considerations:

*Are there other wells nearby, particularly drinking water?	Select
*Are there any abandoned wells on-site or in the immediate vicinity?	Select
*Does your pesticide mixing site, if outdoors, have a roof over it?	Select
*Do you have an impermeable surface under your mixing/loading area?	Select
*Do emergency services (fire/police) have full access to your facilities?	Select
*Have you briefed emergency services (fire/police) on potential hazards?	Select
*Do you maintain a plan for emergency services (fire/police) with responders identified, phone numbers kept current, product inventories kept up to date, along with complete labels and materials safety data sheets (MSDS's), and procedures identified to control, recover, and dispose of products?	Select
*Is everyone aware of their role(s)?	Select
*Is the safety equipment accessible?	Select

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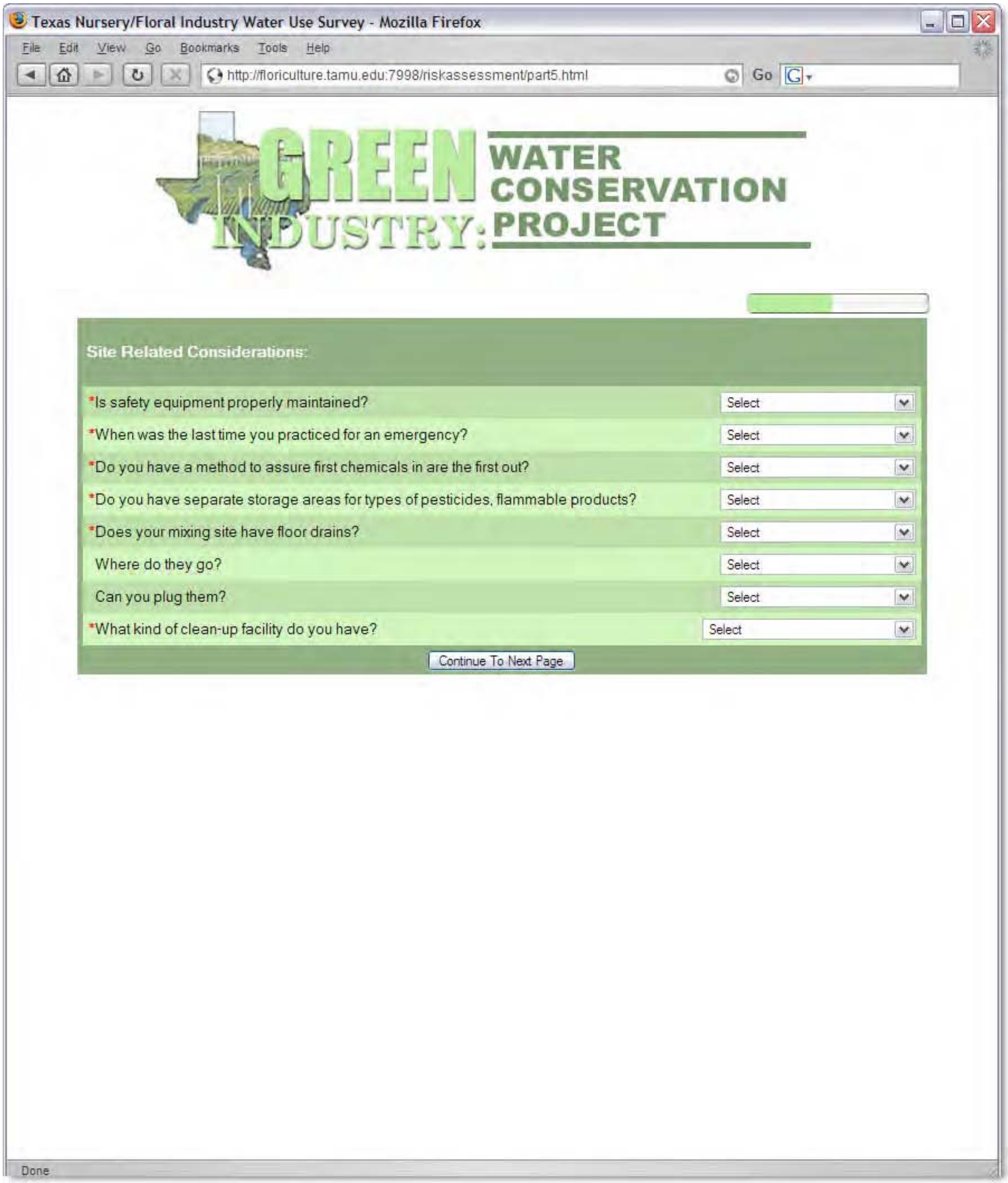
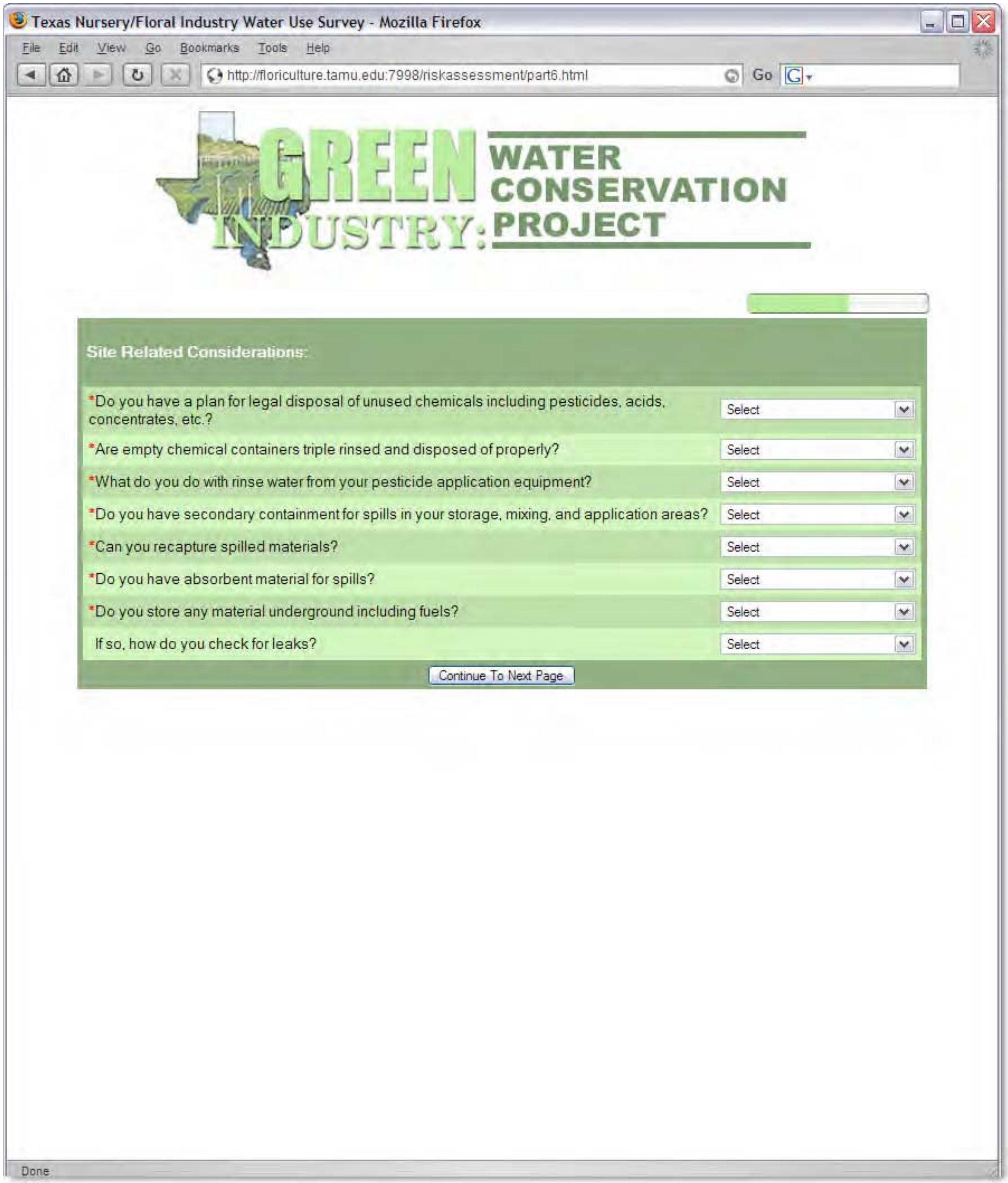

Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://floriculture.tamu.edu:7998/riskassessment/part5.html
Go
GREEN INDUSTRY: WATER CONSERVATION PROJECT
Site Related Considerations:
*Is safety equipment properly maintained? Select
*When was the last time you practiced for an emergency? Select
*Do you have a method to assure first chemicals in are the first out? Select
*Do you have separate storage areas for types of pesticides, flammable products? Select
*Does your mixing site have floor drains? Select
Where do they go? Select
Can you plug them? Select
*What kind of clean-up facility do you have? Select
Continue To Next Page
Done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http://floriculture.tamu.edu:7998/riskassessment/part6.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Site Related Considerations:

*Do you have a plan for legal disposal of unused chemicals including pesticides, acids, concentrates, etc.?	Select
*Are empty chemical containers triple rinsed and disposed of properly?	Select
*What do you do with rinse water from your pesticide application equipment?	Select
*Do you have secondary containment for spills in your storage, mixing, and application areas?	Select
*Can you recapture spilled materials?	Select
*Do you have absorbent material for spills?	Select
*Do you store any material underground including fuels?	Select
If so, how do you check for leaks?	Select

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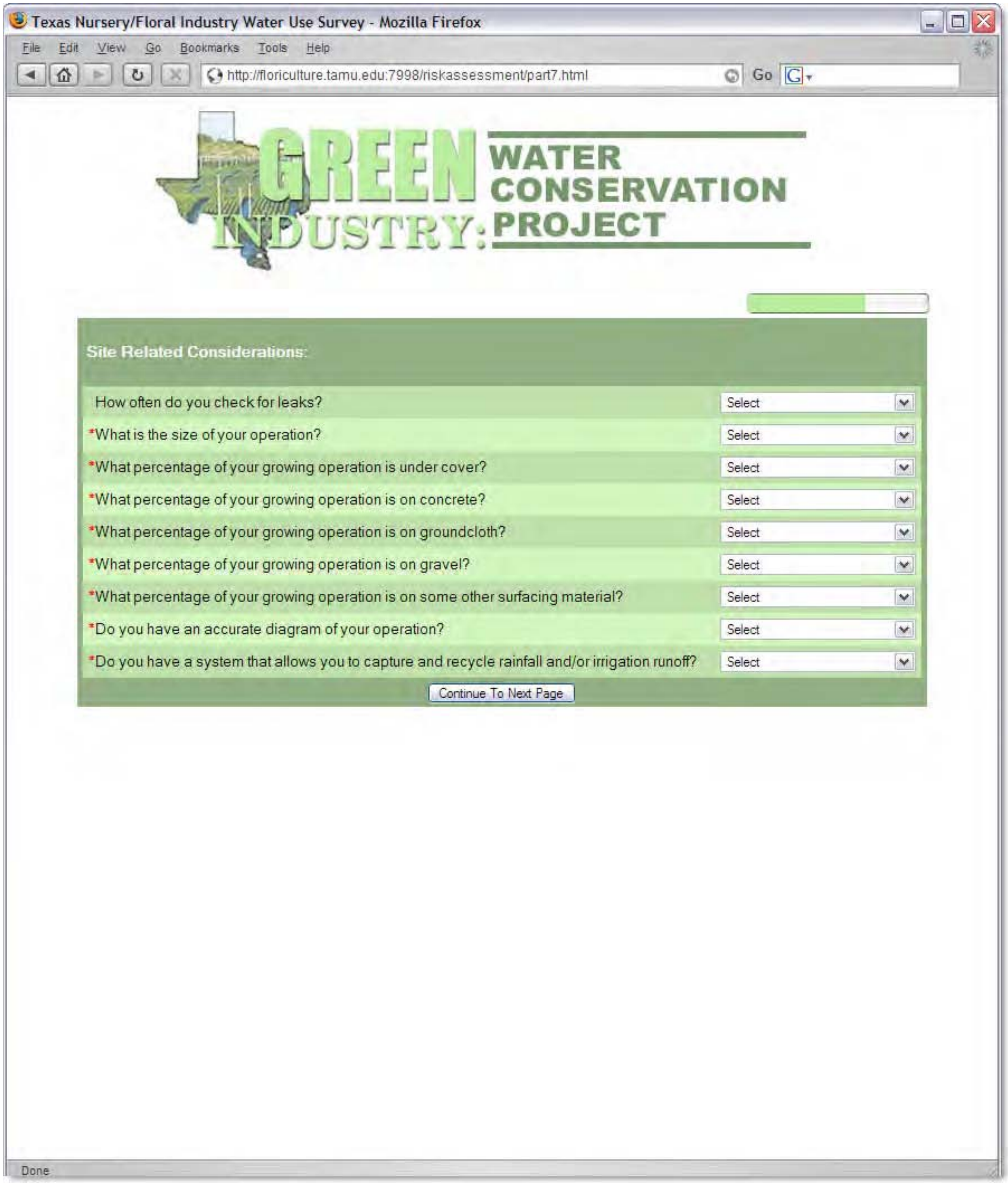
Done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http://floriculture.tamu.edu:7998/riskassessment/part7.html Go

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Site Related Considerations:

How often do you check for leaks?	Select
*What is the size of your operation?	Select
*What percentage of your growing operation is under cover?	Select
*What percentage of your growing operation is on concrete?	Select
*What percentage of your growing operation is on groundcloth?	Select
*What percentage of your growing operation is on gravel?	Select
*What percentage of your growing operation is on some other surfacing material?	Select
*Do you have an accurate diagram of your operation?	Select
*Do you have a system that allows you to capture and recycle rainfall and/or irrigation runoff?	Select

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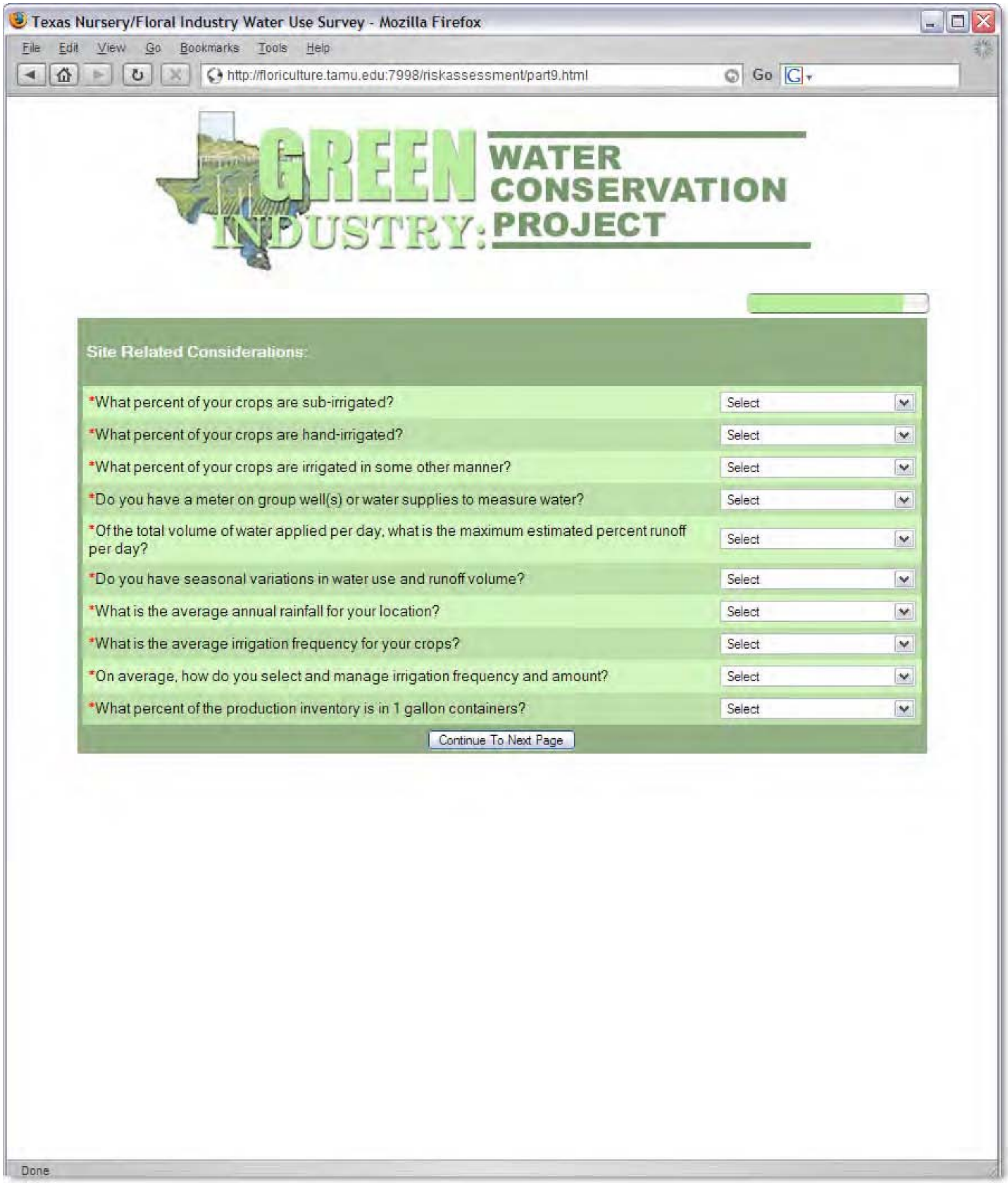
Done


Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox
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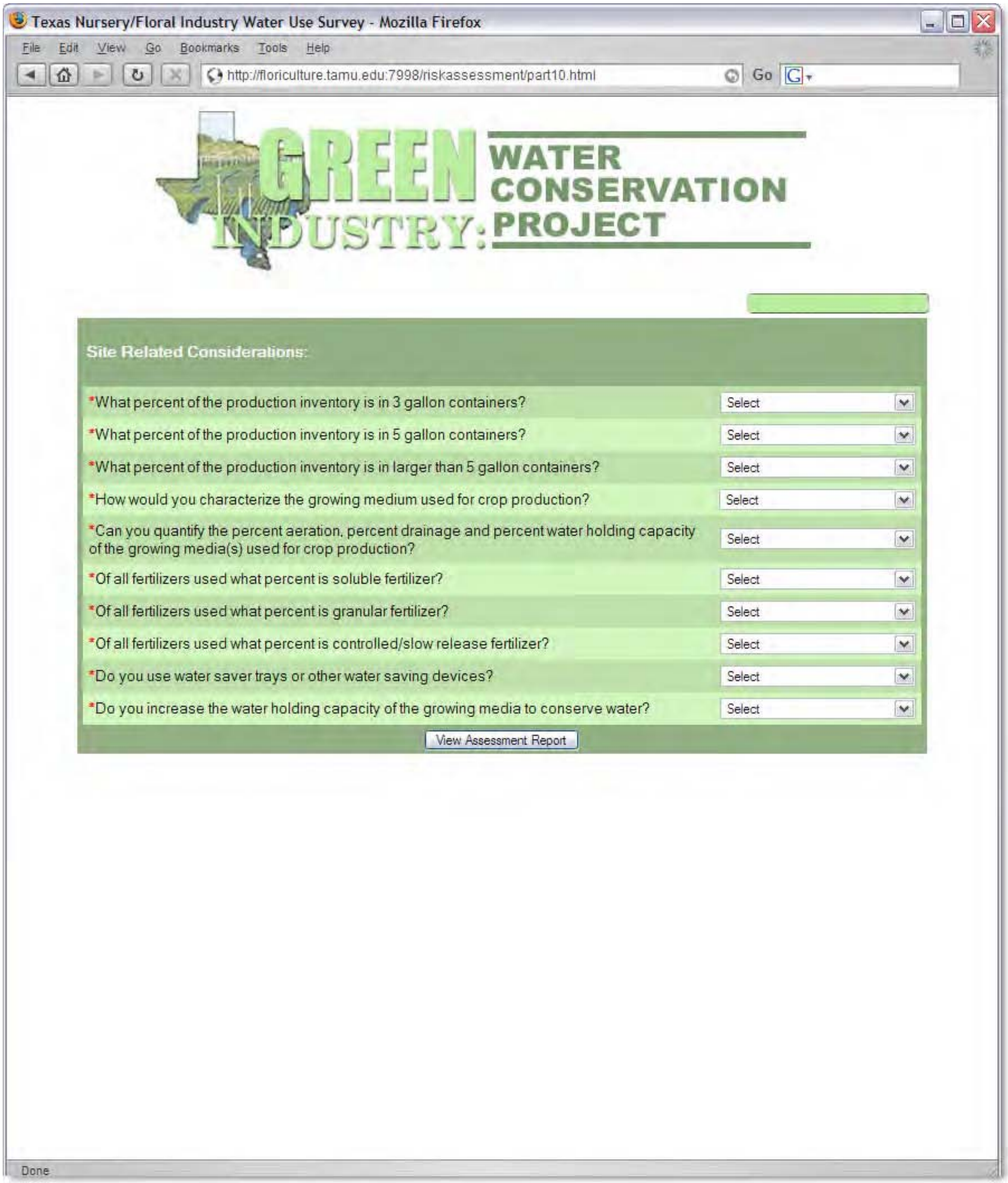
http://floriculture.tamu.edu:7998/riskassessment/part9.html
Go
GREEN INDUSTRY: WATER CONSERVATION PROJECT
Site Related Considerations:
*What percent of your crops are sub-irrigated? Select
*What percent of your crops are hand-irrigated? Select
*What percent of your crops are irrigated in some other manner? Select
*Do you have a meter on group well(s) or water supplies to measure water? Select
*Of the total volume of water applied per day, what is the maximum estimated percent runoff per day? Select
*Do you have seasonal variations in water use and runoff volume? Select
*What is the average annual rainfall for your location? Select
*What is the average irrigation frequency for your crops? Select
*On average, how do you select and manage irrigation frequency and amount? Select
*What percent of the production inventory is in 1 gallon containers? Select
Continue To Next Page
Done



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http://floriculture.tamu.edu:7998/riskassessment/part10.html

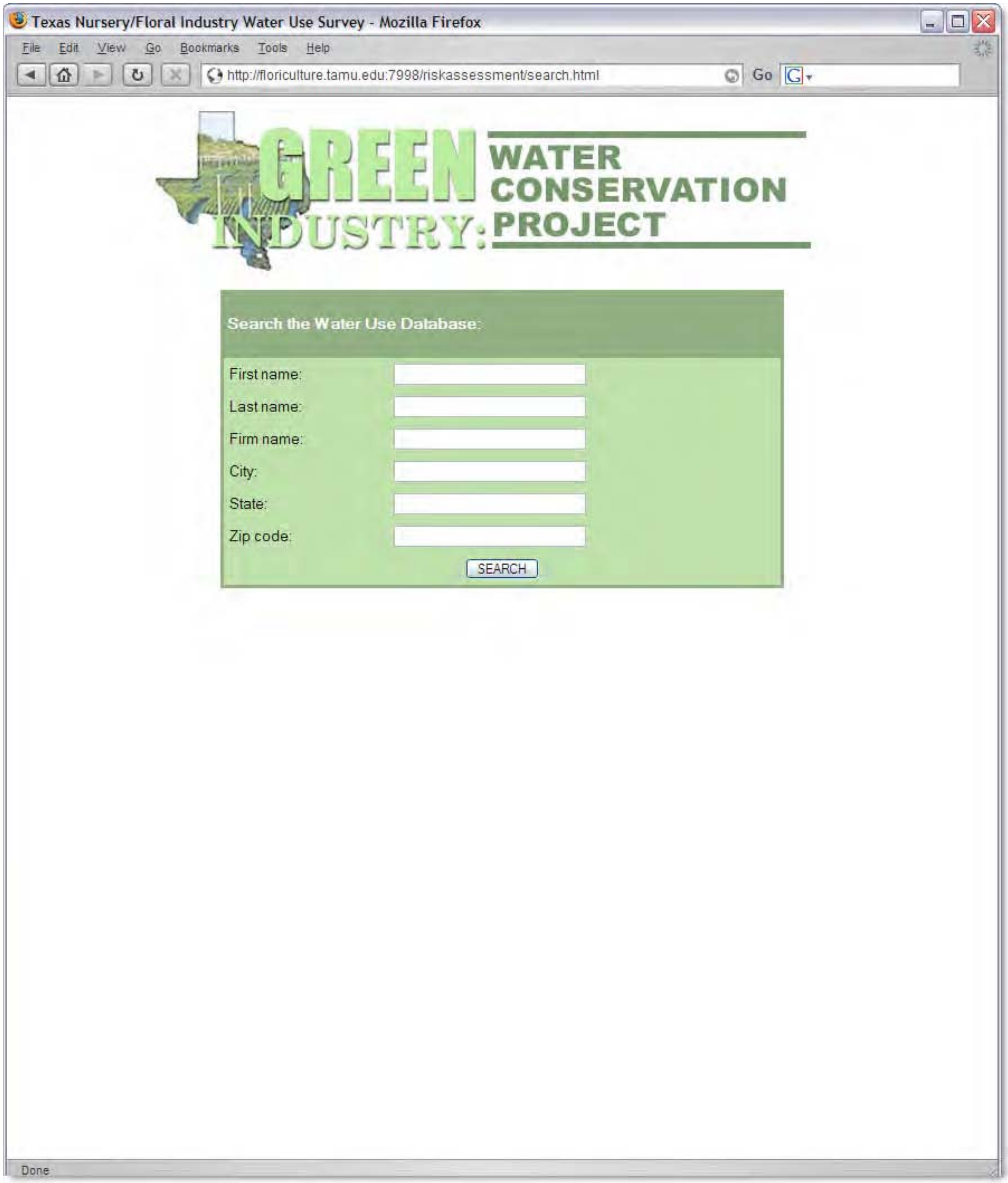
GREEN INDUSTRY: WATER CONSERVATION PROJECT

Site Related Considerations:

*What percent of the production inventory is in 3 gallon containers?	Select
*What percent of the production inventory is in 5 gallon containers?	Select
*What percent of the production inventory is in larger than 5 gallon containers?	Select
*How would you characterize the growing medium used for crop production?	Select
*Can you quantify the percent aeration, percent drainage and percent water holding capacity of the growing media(s) used for crop production?	Select
*Of all fertilizers used what percent is soluble fertilizer?	Select
*Of all fertilizers used what percent is granular fertilizer?	Select
*Of all fertilizers used what percent is controlled/slow release fertilizer?	Select
*Do you use water saver trays or other water saving devices?	Select
*Do you increase the water holding capacity of the growing media to conserve water?	Select

View Assessment Report

Done


Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox
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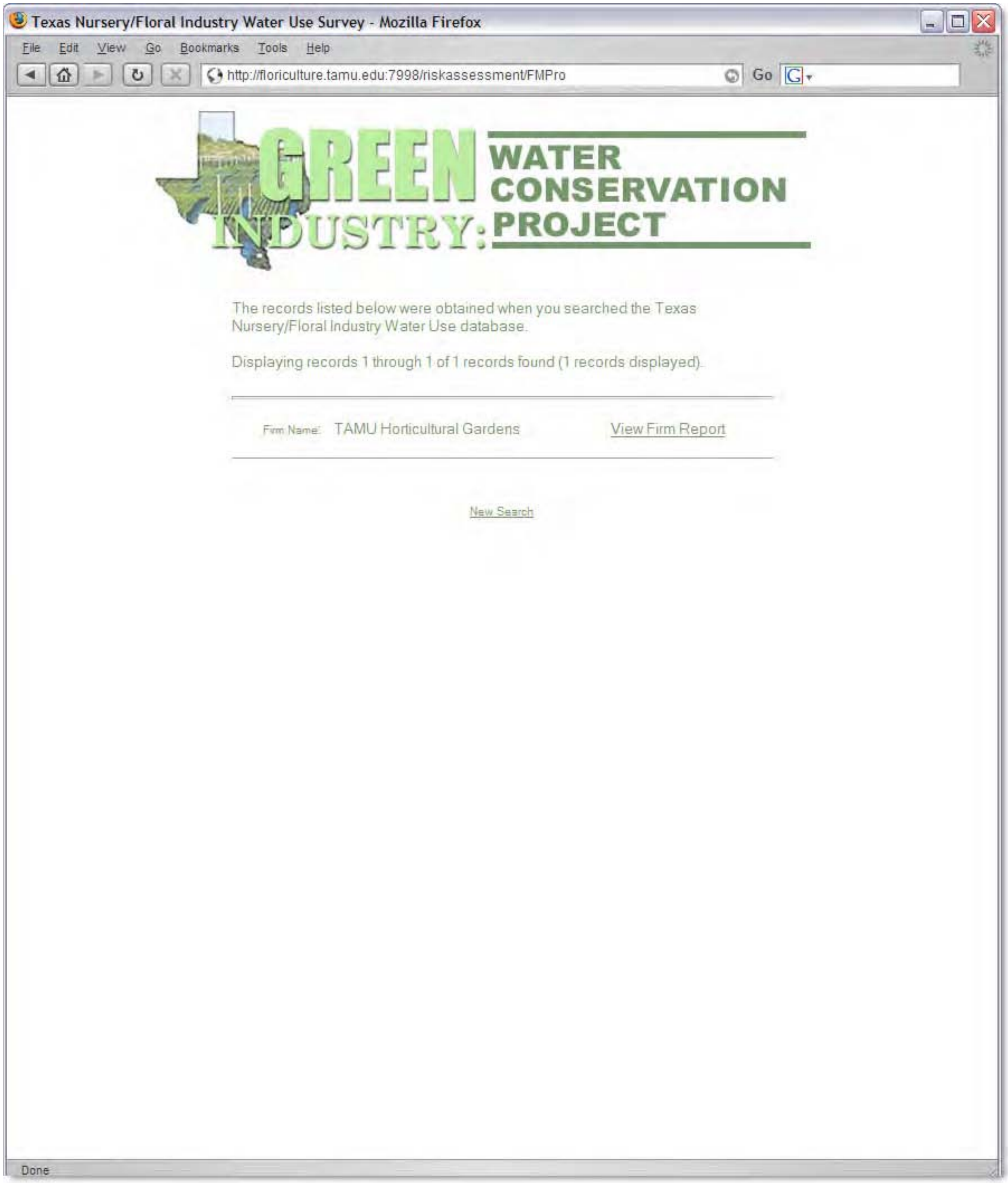
http://floriculture.tamu.edu:7998/riskassessment/search.html
Go
GREEN INDUSTRY:
WATER CONSERVATION PROJECT
Search the Water Use Database:
First name:
Last name:
Firm name:
City:
State:
Zip code:
SEARCH
Done


Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://floriculture.tamu.edu:7998/riskassessment/FMPro
Go
GREEN INDUSTRY: WATER CONSERVATION PROJECT
The records listed below were obtained when you searched the Texas Nursery/Floral Industry Water Use database.
Displaying records 1 through 1 of 1 records found (1 records displayed).
Firm Name: TAMU Horticultural Gardens
View Firm Report
New Search
Done

Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox

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http://floriculture.tamu.edu:7998/riskassessment/FMPro?-db=risk.fp5&-format=ris Go

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Water Conservation, Surface & Groundwater Contamination Risk Assessment for TAMU Horticultural Gardens

You are in a medium risk category. The responses listed below contributed to this asssessment:

- The depth to bedrock you reported (less than 80 feet) is problematic. A shallow bedrock increases the risk of groundwater contamination.
- Since the bedrock under your operation is fractured, the risk of groundwater contamination is increased.
- Urban areas are more sensitive to water quality issues.
- Practicing frequently for emergencies can help reduce the potential for surface and groundwater contamination.
- If you have no specific clean-up facility, it could increase the risk of surface and groundwater contamination.
- If you do not dispose of rinse water from pesticide application equipment, you increase the risk for surface and groundwater contamination.
- You should have a secondary containment for spills in storage, mixing, and application areas.
- If you are unable to recapture spilled materials, you can increase the risk for surface and groundwater contamination.
- You should have absorbent material for spills.
- You indicated that less than 50% of your growing area is under cover. This increases the risk of contamination.
- You reported that less than 50% of your growing operation is on concrete. Having your growing area on concrete can be useful in conserving irrigation water and decreasing the risk for surface and groundwater contamination.
- It is indicated that more than 50% of your growing operation is on gravel. Utilizing an appropriate surfacing area can assist in conserving irrigation water and decrease contamination.
- You reported that more than 50% of your growing operation is on some other surfacing material. You should use an appropriate surfacing area to help conserve irrigation water and decrease contamination.
- It is indicated that you do not have system to allow you to capture and recycle rainfall and/or irrigation runoff. A capture and recycle system can be the most effective management tool for water conservation and preventing surface and groundwater contamination.
- You reported that more than 50% of your growing operation is on some other surfacing material. You should use an appropriate surfacing area to help conserve irrigation water and decrease contamination.
- You indicated that more than 50% of your crops were overhead irrigated. By decreasing the percent of crops that are overhead irrigated, you increase the potential for water conservation and decrease the risk for surface and groundwater contamination.
- Since you indicated that less than 50% of your crops were on subirrigation, you should increase the amount on overhead irrigation in order to increase the potential for water conservation and decrease the risk of contamination.
- You reported that less than 50% of your crops were subirrigated, by increasing the amount on sub irrigation can increase the potential for water conservation and decrease the risk of surface and groundwater contamination.
- Careful management of irrigation frequency and amount can decrease the risk of surface and groundwaer contamination and increase the potential for water conservation.
- You reported that more than 50% of your production inventory was in 5 gallon containers. You need to carefully manage the amount of containers and space them accordingly to decrease the amount of contamination and increase the amount of water conservation.

End of report.

This assessment was conducted by the TCE-TWB-TNLA Green Industry Water Conservation database. Reliability of this analysis depends on the inputs entered by the user. This report is intended to guide nursery/floral operations in the wise use of our water resources.

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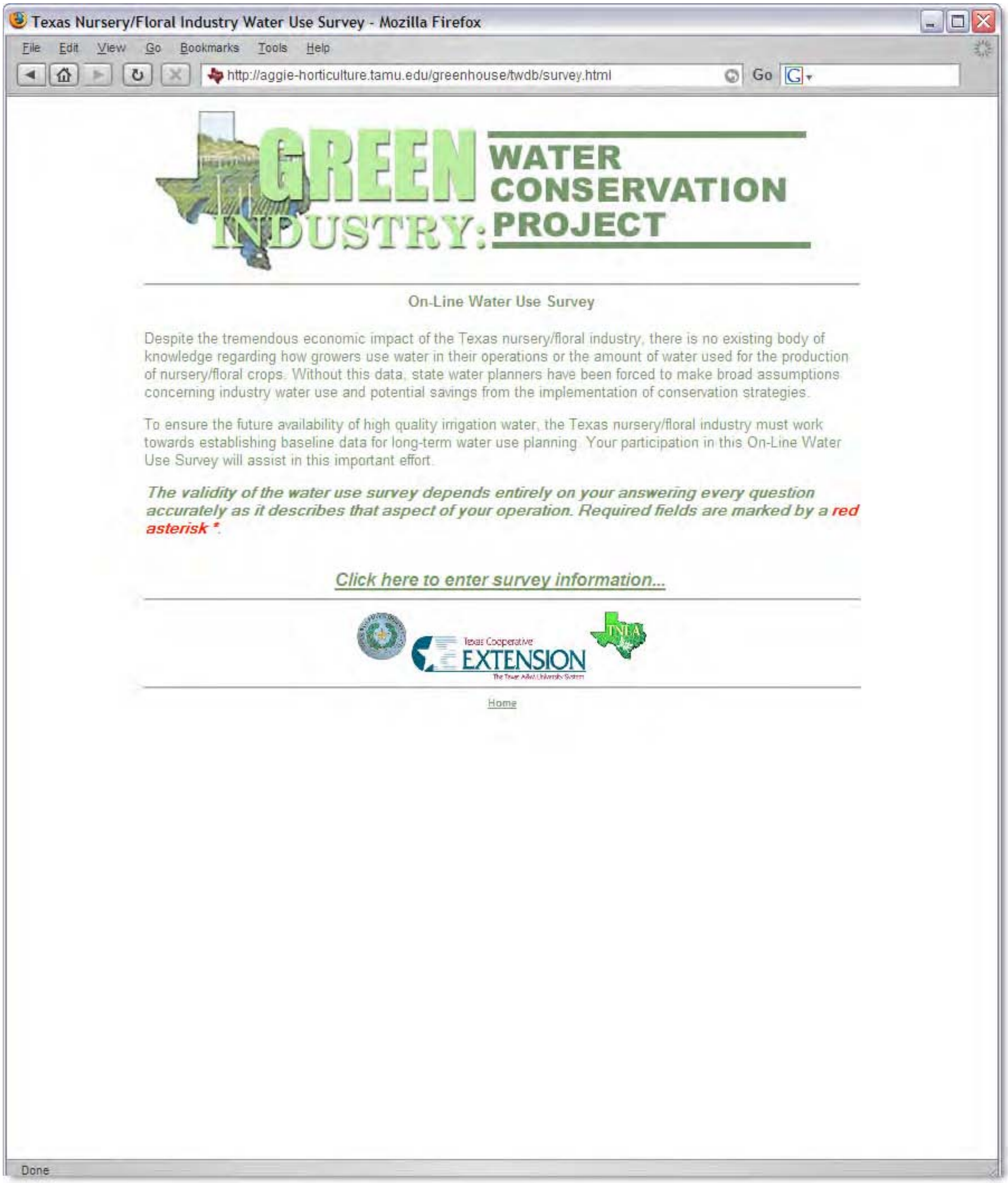
Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox

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http://aggie-horticulture.tamu.edu/greenhouse/twdb/survey.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

On-Line Water Use Survey

Despite the tremendous economic impact of the Texas nursery/floral industry, there is no existing body of knowledge regarding how growers use water in their operations or the amount of water used for the production of nursery/floral crops. Without this data, state water planners have been forced to make broad assumptions concerning industry water use and potential savings from the implementation of conservation strategies.

To ensure the future availability of high quality irrigation water, the Texas nursery/floral industry must work towards establishing baseline data for long-term water use planning. Your participation in this On-Line Water Use Survey will assist in this important effort.

The validity of the water use survey depends entirely on your answering every question accurately as it describes that aspect of your operation. Required fields are marked by a red asterisk *.

Click here to enter survey information...

Texas Cooperative EXTENSION

TNLA

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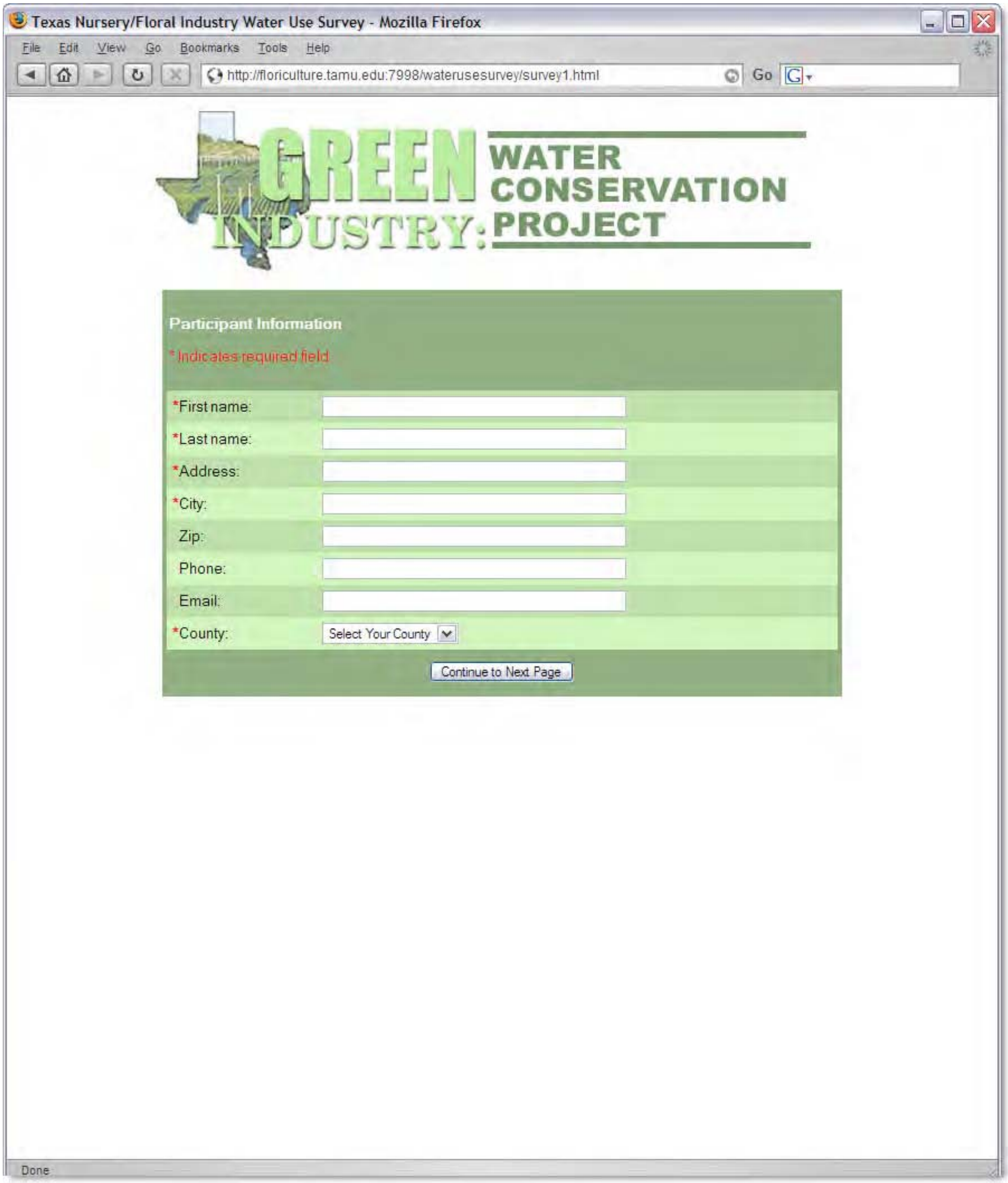
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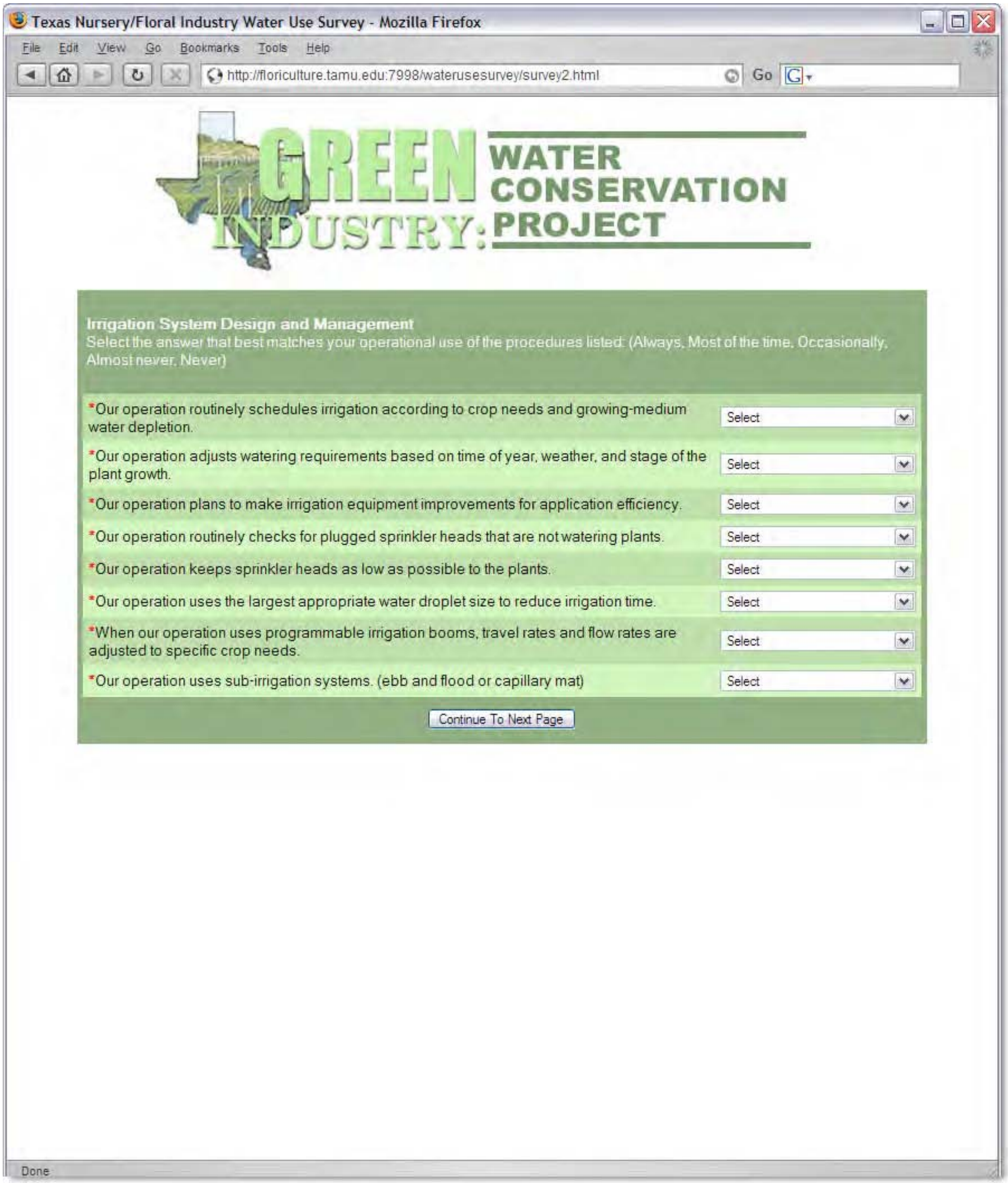
http://floriculture.tamu.edu:7998/waterusesurvey/survey1.html
Go
GREEN INDUSTRY: WATER CONSERVATION PROJECT
Participant Information
* Indicates required field
*First name:
*Last name:
*Address:
*City:
Zip:
Phone:
Email:
*County:
Select Your County
Continue to Next Page
Done



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http://floriculture.tamu.edu:7998/waterusesurvey/survey2.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Irrigation System Design and Management

Select the answer that best matches your operational use of the procedures listed: (Always, Most of the time, Occasionally, Almost never, Never)

*Our operation routinely schedules irrigation according to crop needs and growing-medium water depletion.	Select
*Our operation adjusts watering requirements based on time of year, weather, and stage of the plant growth.	Select
*Our operation plans to make irrigation equipment improvements for application efficiency.	Select
*Our operation routinely checks for plugged sprinkler heads that are not watering plants.	Select
*Our operation keeps sprinkler heads as low as possible to the plants.	Select
*Our operation uses the largest appropriate water droplet size to reduce irrigation time.	Select
*When our operation uses programmable irrigation booms, travel rates and flow rates are adjusted to specific crop needs.	Select
*Our operation uses sub-irrigation systems. (ebb and flood or capillary mat)	Select

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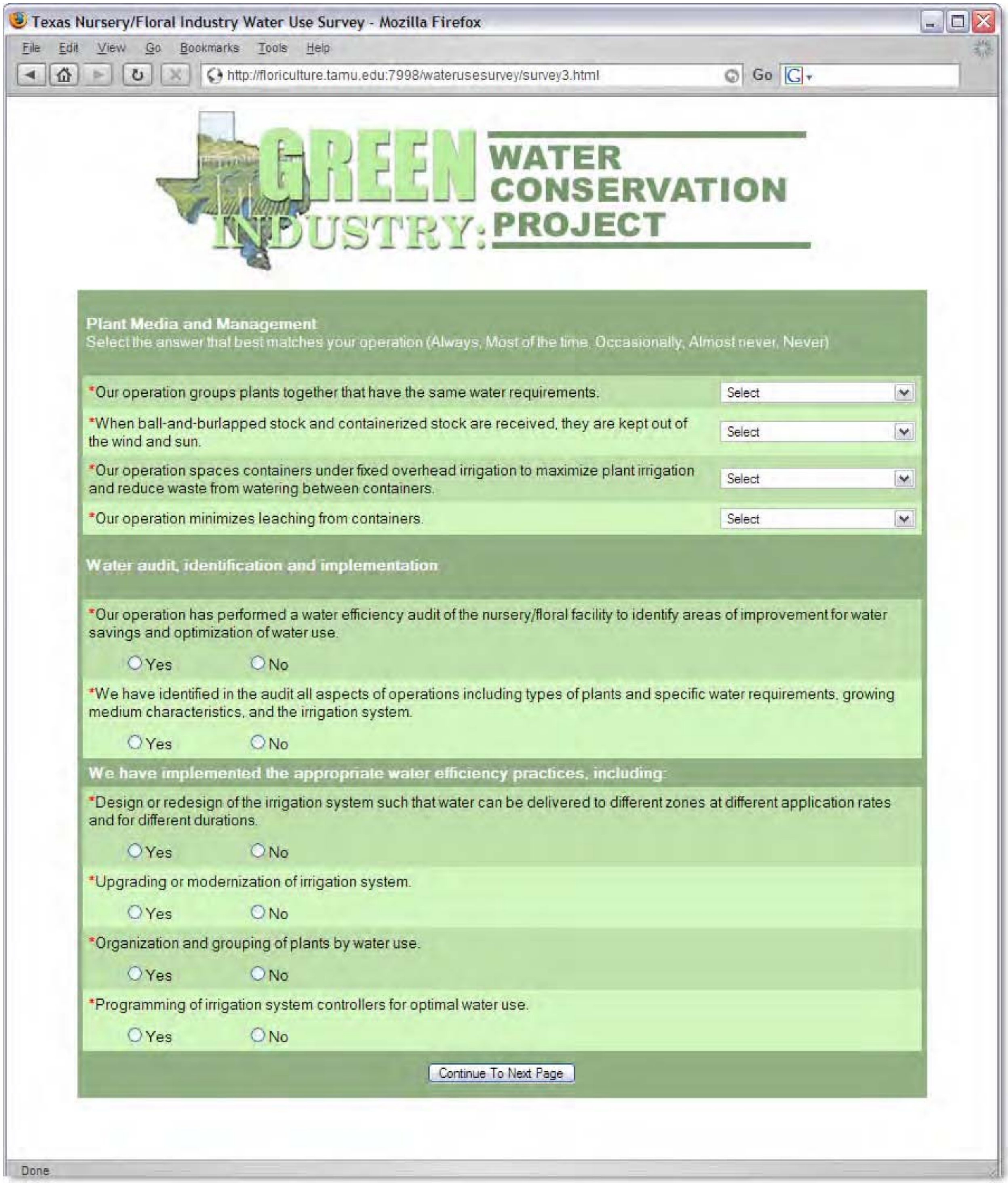
Done



Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox

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http://floriculture.tamu.edu:7998/waterusesurvey/survey3.html Go

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Plant Media and Management
Select the answer that best matches your operation (Always, Most of the time, Occasionally, Almost never, Never)

*Our operation groups plants together that have the same water requirements.	Select
*When ball-and-burlapped stock and containerized stock are received, they are kept out of the wind and sun.	Select
*Our operation spaces containers under fixed overhead irrigation to maximize plant irrigation and reduce waste from watering between containers.	Select
*Our operation minimizes leaching from containers.	Select

Water audit, identification and implementation

*Our operation has performed a water efficiency audit of the nursery/floral facility to identify areas of improvement for water savings and optimization of water use.

○ Yes ○ No

*We have identified in the audit all aspects of operations including types of plants and specific water requirements, growing medium characteristics, and the irrigation system.

○ Yes ○ No

We have implemented the appropriate water efficiency practices, including:

*Design or redesign of the irrigation system such that water can be delivered to different zones at different application rates and for different durations.

○ Yes ○ No

*Upgrading or modernization of irrigation system.

○ Yes ○ No

*Organization and grouping of plants by water use.

○ Yes ○ No

*Programming of irrigation system controllers for optimal water use.

○ Yes ○ No

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Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox

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http://floriculture.tamu.edu:7998/waterusesurvey/survey4.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Schedule

The time required to implement one or more of the above practices depends on the size and extent of the nursery operation and which conservation practices are to be implemented. Implementation of some of the above practices can be done in less than a week (programming of irrigation controllers, replacement of sprinkler nozzles, scheduling irrigations, etc.) to several months (installation of a new irrigation system or water recovery and reuse system).

*In our operation we have adopted the implementation of ____ percent of the practices identified in the water efficiency audit. Select

Scope

Nursery/floral production systems vary in extent from small (less than 1 acre) operations to multi-acre farms and greenhouses. The applicability of each of the above practices must be customized for the specific requirements of each Nursery Production System. Some of the above practices may be not be cost effective for smaller operations. Larger operations may select to implement all of the above practices.

*What size is your operation? Select

Documentation

*In our operation we have a description of irrigation techniques and water zones used.

○ Yes ○ No

*In our operation we have a description of the irrigation and water recovery and reuse systems in use.

○ Yes ○ No

*In our operation we have water use records for the periods both before and after implementation of water efficient practices.

○ Yes ○ No

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Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox

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http://floriculture.tamu.edu:7998/waterusesurvey/survey5.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Determination of Water Savings

Determination of the quantity of water saved by implementing this BMP must be determined specific to each nursery production system and is dependent on the amount of water used by the existing system and which conservation practices are currently implemented by the producer. Water use records prior to and after implementation of one or more of the above practices can be used to determine the amount of water saved.

Cost-Effectiveness Considerations

The cost-effectiveness of implementing one or more of the above practices must be analyzed for each nursery production system. The cost ranges from minimal (for reprogramming irrigation controllers, changing sprinkler heads, etc.) to significant (installation of water recovery and reuse system, upgrading or replacement of irrigation system, etc.). Some basic operational practices should be corrected without a cost-effectiveness analysis.

*Our operation conducted a cost-effectiveness analysis prior to undertaking any new management practices.

○ Yes ○ No

Our operation adopted new management practices without conducted a cost-effectiveness analysis.

○ Yes ○ No

Water Supply Information

*Do you purchase the water used in your operation?

○ Yes ○ No

If yes, the supplier is a: Select

Please specify the water provider:

Example: City of Sequin, Gonzales Utility District, McMahan WSC

What percent of your total water use came from this source?

If you do not purchase water, or purchase only a portion of the water used then your operation is SELF SUPPLIED (including well(s), ponds, tanks and state-issued surface water rights. Please complete these questions.

If your operation uses well water (groundwater), which aquifer does it come from?

Examples: Carrizo aquifer, Trinity aquifer.

What percent of your total water use came from this source?

If your operation uses surface water, please provide the name of the source.

Examples: Colorado River, Water Right Number 12345-B, Lake Fork Reservoir, contract with Lake Fork River Authority, Pond on property.

What percent of your total water use came from this source?

*Do you use recycled water?

○ Yes ○ No

Please describe the source of this water:

Examples: Treated city effluent, On-site retention and reuse.

What percent of your total water use came from this source?

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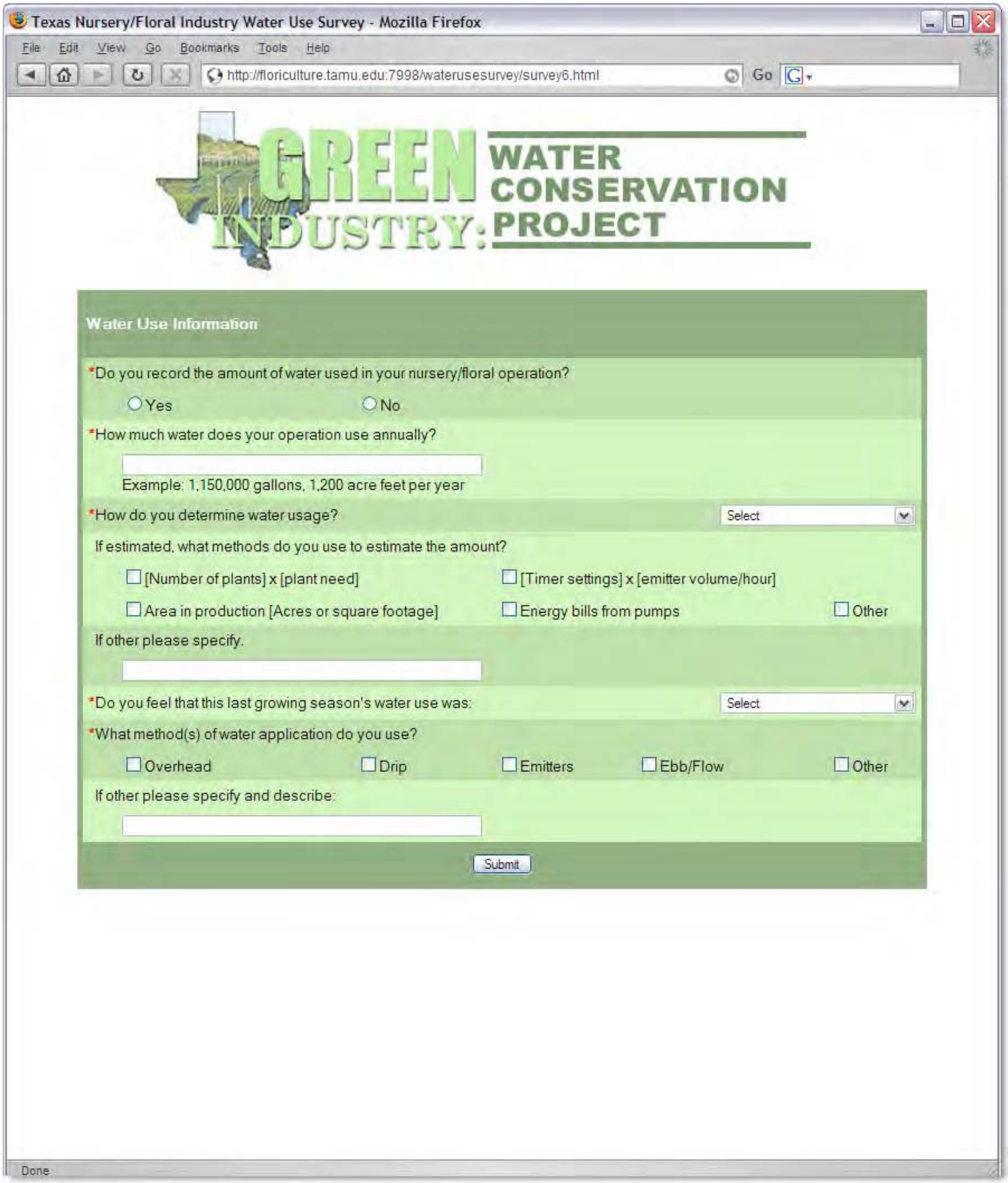

Texas Nursery/Floral Industry Water Use Survey - Mozilla Firefox

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http://floriculture.tamu.edu:7998/waterusesurvey/survey6.html

GREEN INDUSTRY: WATER CONSERVATION PROJECT

Water Use Information

*Do you record the amount of water used in your nursery/floral operation?

○ Yes ○ No

*How much water does your operation use annually?

Example: 1,150,000 gallons, 1,200 acre feet per year

*How do you determine water usage? Select

If estimated, what methods do you use to estimate the amount?

☐ [Number of plants] x [plant need] ☐ [Timer settings] x [emitter volume/hour]

☐ Area in production [Acres or square footage] ☐ Energy bills from pumps ☐ Other

If other please specify.

*Do you feel that this last growing season's water use was: Select

*What method(s) of water application do you use?

☐ Overhead ☐ Drip ☐ Emitters ☐ Ebb/Flow ☐ Other

If other please specify and describe:

Submit

Done