

THE CONNECTION BETWEEN LANDSCAPE ARCHITECTURE
AND WATER QUALITY: A SURVEY OF LANDSCAPE
ARCHITECTS IN TEXAS

by

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ABSTRACT

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For local jurisdictions and consumers, water quality has become important as development pressures and expanding population have increased the strain on existing water supplies. Aging infrastructure, limited financial resources, and environmental regulations are forcing many users to seek alternatives to traditional water treatment and storm conveyance systems.

Landscape architects can utilize many environmentally sound methods and technology to protect water quality. The opportunity is there to incorporate measures such as buffers, low-impact development, open space design, rain gardens, basins, and native plantings in the design process.

A survey of practicing landscape architects in Texas demonstrated the trends of alternative measures application and perception to water quality. The responses indicate the use of these measures is not prevalent. The visibility of projects with the water quality solutions remains limited to a select audience. Educating the client in the need for these measures is still required of the landscape architects.

Dissemination of information media such as professional periodicals would increase the visibility of water quality projects. Another potential option is to establish demonstration exhibits with independent school districts, and municipal governments. More of the public would then be encouraged to consider the use of alternative measures in protecting water quality.

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CHAPTER 1

INTRODUCTION

1.1 Research Objective

A survey of the landscape architecture profession in Texas was taken to see what solutions are currently being applied to design that benefits water quality. The assessment utilized qualitative and quantitative methods of analysis. Analysis of the survey gave a snapshot of the profession's perception toward water quality.

1.2 Research Question

The research questions for this study are:

- How widespread is the use of alternative methods and technology for protecting water quality in the landscape architecture profession?
- How often are these methods and technology applied?

1.3 Definition of Terms

Aquifer – water held in underground rock strata.

A.S.L.A. – American Society of Landscape Architects is a national organization that serves the landscape architecture industry through accreditation, education, and policy making.

Wastewater – water used in cleaning, toiletry, heating and cooling, and manufacturing processes.

B.M.P. – Best Management Practices are environmentally sound practices for managing a specific use. For example: detention basins for controlling storm water or buffers for habitat protection.

Buffer Zone – strip of land between development and an environmentally sensitive site to limit damage and pollution to the environmentally sensitive site.

Detention Basin – medium or large constructed depression to catch water from rain for indefinite periods.

Low Impact Development – type of development that minimizes impervious footprint in the landscape and tries to maintain the original hydrology of the site.

Non-Point Source Pollution – pollution that is untraceable to its source such as from parking lots and streets.

Open Space – space protected from development for the benefit of the public and sometimes wildlife.

Point Source Pollution – pollution traced directly to the source.

Retention Basin – medium or large size designed depression that retains water for slow percolation into the ground after rainfall.

Swale – a small depression in ground that retains water for a time after rains.

Watershed – a broad network of streams, rivers, lakes, ponds, creeks, and groundwater.

Wetland – area that stays consistently wet for long periods.

1.4 Overview of the Topic

1.4.1 The Hydrologic Cycle and the Demands on Water

Water is a necessity for survival of man, plant communities and wildlife. It is constantly in motion from one physical state to another. The term for this cycle is the hydrologic cycle. The physical states are atmospheric, ground and surface waters. (USGS, 9/06)

Atmospheric water is water in a gaseous or vapor state suspended in the atmosphere. Clouds and fog are the more visible forms of atmospheric water. Ground water is water deep under the ground surface in aquifers or suspended water table. The recharge rate is dependent on the geologic characteristics of an area. Some places take hundreds of years to recharge. Surface waters are bodies of water above the ground surface. Lakes, oceans, ponds, reservoirs, rivers, and streams are examples of surface water. Surface and ground water do not behave independently of each other. If ground water levels go down, chances are that nearby surface water levels will go down also. (USGS, 9/06)

Water in its liquid state evaporates into a gaseous or vapor state when the temperature rises. This vapor or moisture will rise upwards to colder air. If there is enough moisture accumulated, the vapor will then condense back to either liquid rain or frozen snow and returns back to ground or surface water. Water will do one of two things after falling as precipitation; the first one is to run over the ground surface into the nearest water body such as a lake; the other is to percolate into the ground to an aquifer or suspended water table. (USGS, 9/06)

During this hydrologic process, plant communities, wildlife, and man divert water for survival. However, man or *Homo sapiens*, takes water diversions further for use in aesthetics, agriculture, drilling, drinking water, industry, landscape irrigation, manufacturing, ranching, recreation, and sanitation. With these uses, expanding population and development pressures, contamination of the water supply has and continues to occur frequently by leaching, chemical spills, and other non point sources. (USGS, 9/06)

1.4.2 Traditional Water Management

Traditionally, managing water has been by reservoir storage and large chemical treatment plants with domestic, sanitary and storm conveyance systems. The consequences of using a traditional system were high financial outlays, high labor and material resources, high maintenance and monitoring needs, and degradation of waterways.

The use of storm conveyances with curb and gutter systems, and piping to the nearest waterway, has been the traditional solution for controlling runoff and flooding. One of the problems with this process is that floods are just shifted further downstream in the watershed. In addition, non-point source pollution, water bank erosion from high velocity flows, destruction of habitat, and declining water quality are examples of other issues that arose with this system. Many municipal codes still use curb and gutter and storm sewers as their traditional best management practice for storm water management.

1.4.3 National Pollutant Discharge Elimination System

In recent years, the Environmental Protection Agency (EPA) put in place regulations to meet the Clean Water Act and its subsequent amendments. The National Pollutant Discharge Elimination System is one of the regulations with two phases that EPA has responsibility over. The first phase covers municipalities with populations of 100,000 or more with municipal separate storm sewer systems (MS4's) and the following listed eleven industrial activities. The categories are:

- Facilities with effluent limitations
- Manufacturing
- Mineral, metal, oil and gas
- Hazardous wastes, treatment, or disposal facilities
- Landfills
- Steam Electric plants
- Transportation facilities
- Treatment works
- Construction activity
- Light industrial activity

Construction activities under Phase I covers land disturbance of five or more acres. Phase II covers municipalities with populations of less than 100,000 with MS4's and construction activities with land disturbance of one to five acres. (EPA, 12/05) Municipalities and state governments implement measures to meet regulatory requirements to gain and keep permits to operate their stormwater and water treatment facilities. The Phase I and II minimum measures are:

- Public education and outreach
- Public participation and involvement
- Illicit discharge detection and elimination
- Construction site runoff control
- Post construction runoff control minimum control measure
- Pollution prevention/good housekeeping (EPA, 12/05)

1.4.4 Alternative Water Management

Alternative methods and technology are available for meeting water quality standard and Phase I and II regulatory requirements. Documentation of many studies shows trapping pollutants before entering the water supply protects the users from chemical toxicity, bacterial and viral infections. The EPA completed a study in Sacramento, California in 1987 about storm water sewer systems discharges. The agency found:

.....almost one-half of the water discharged from a local MS4 was not directly attributable to precipitation runoff. A significant portion of these dry weather flows were from illicit and/or inappropriate discharges and connections to the MS4. (EPA, 1987)

In a report submitted by The Council of Environmental Quality on the National Environmental Policy Act, it was noted that:

....evidence is increasing that the most devastating environmental effects may result not from direct effects of a particular action, but from the combination of individually minor effects of multiple actions over time. (Council of Environmental Quality Report, 1/97)

Alternative measures to traditional conveyance and chemical water treatment includes buffer zones, low impact development, native plantings, rainwater gardens, swales, and natural wastewater treatment wetlands.

Demand for ecological wastewater treatment will grow steadily as scientists and engineers find that landscape based root zone systems clean wastewater better than the conventional wastewater drainfield even in colder regions. (Steinfeld, 1/04)

Landscape architects can design using alternative methods of trapping runoff and pollutants, and use of native plantings to minimize water use. Education of both users and designers can increase the effectiveness of using these measures.

1.4.4.1 Buffer Zones, Rain Gardens, Swales, Basins, Trenches, and Roof Gardens

Designers can use a variety of techniques or a combination of them to manage water on a site. They offer flexibility in retrofitting or repairing existing infrastructure. In Portland, Oregon, the aging combined sewer system of both sanitary and storm water has motivated the city to seek alternatives. In a significant storm, this combined system backs up and bypasses water treatment facilities. The polluted water then discharges directly into Willamette River that runs through the city. Installation of infiltration basins in modified streets, a redesigned public parking lot with rain gardens, swales and native planting for an elementary school are examples of what Portland is doing. (Arvidson, 9/06)

Buffer zones refer to a strip of land or vegetation between development and watercourse. Its primary use is to help filter pollutants and sediments in runoff before it gets to the waterway. The elements that define buffers as listed in the Handbook of Water Sensitive Design and Planning are:

- The topography of the land adjacent to water or wetlands is natural
- An expectation of natural vegetation
- Inclusion of buffers for wetlands as well as surface waters
- Inclusion of upland areas beyond a stream bank, lake shore, or wetland edge
- Application to a variety of possible land uses beyond the buffer
- A minimum but flexible width based on site-specific conditions (Mitchell, 2002)

“Vegetation and accompanying fauna maintain soil aggregation, macropores, and infiltration rates. The highest infiltration rates in a given soil type are found in maturely vegetated areas free of clearing, grading, compaction, and disturbance.” (Ferguson,

1997) A study in Norway covered the effectiveness of buffers in trapping pollutants from runoff. The effectiveness shows that “pesticides showed moderate to high adsorption to soil particles” in a simulation runoff test. (Syversen, 5/04)

Rain gardens are designated areas to receive runoff from various sources such as parking lots, streets, or roofs. Excess water is stored until use by nearby vegetation or slowly infiltrates the soil. Vegetation and soil medium traps pollutants by adsorption. Portland Oregon constructed a major rain garden at the Oregon Convention Center. Runoff from the roof drains into a designed rain garden which mimics a rocky stream.

During a heavy rain, water that exceeds the holding capacity of the stone channels goes into a detention pond at the low point. The pond receives runoff from a truck loading area that has a 205 feet vegetated swale. (Thompson, 9/04)

Swales, basins, and trenches, are depressions of various sizes for retention and conveyance of runoff during a rainstorm. The water slowly percolates into the ground. The velocity of runoff decreases which gives pollutants a chance to adsorb to soil particles and vegetation. Soil characteristics, historical rain data, site topography and vegetation used will determine the effectiveness of these methods.

The advantages of these systems are the retrofit coverage for existing development, decreasing potential flooding, and stream bank erosion, and improved water quality. (EPA, 9/99)

A roof garden is a vegetated surface on the roof of a building. Types of roof gardens used today are intensive and extensive. Intensive roof gardens are suitable for roofs that can handle a minimum of one-foot of soil depth, with loads of 80 – 150 pounds per square foot. Types of vegetation typically used are large trees, shrubs and groundcovers. The public can access this type of roof garden. The extensive roof

gardens are shallow with soil depth between one to five inches. Roof loads for this type of garden ranges from 12 – 15 pounds per square foot. Vegetation is limited to groundcovers and grasses. For this garden, access is limited to maintenance only. The objectives are to trap runoff, reduce energy costs and reduce glare from reflective surfaces. (EPA-Heat Island, 6/06)

In the summer, depending on the plants and the depth of growing medium, green roofs retain 70 – 90% of the precipitates that falls on them; in winter they retain between 25 – 40%. (Greenroofs, 5/05)

Baltimore Montgomery Park Business Center has 30,000 square feet of green roof designed by Katrin Scholz-Barth as an experiment for trapping runoff. The expectation of the business center is to reduce runoff by 50 to 75 percent when fully vegetated. (Eisenman, 11/05)

1.4.4.2 LEED's Water Conservation Strategies

Green building is a building with environmentally sustainable technologies and materials. United States Green Building Council established a Leadership in Energy and Environmental Design's credit criteria system to certify green buildings. In a manual developed by the U. S. Green Building Council,

Green design makes a positive impact on public health and the environment; reduces operating costs, enhance building and organizational marketability, potentially increases occupant productivity, and helps create a sustainable community. (USGBC, 10/05)

To certify a building as sustainable or green, a rating system with six sections is used.

The sections are:

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere

4. Materials and Resources
5. Indoor Environmental Air Quality
6. Innovation and Design Process

In each section, the designer earns credits if the design and construction meet the detailed criteria listed. For example, swales, retention ponds, and other strategies for water quality could be used to meet some of the criteria. (Kinkade-Levario, 9/04) Pennsylvania State University recently built a replacement facility for their School of Architecture and Landscape Architecture Department using the LEED criteria. Part of the design utilized stormwater management, native plantings, and saving existing open space and buffers.

1.4.4.3 Low Impact Development, Open Space Design

Minimal impact on land to accommodate the natural hydrology of the site is referred to as low impact development (LID). Various ecological and design strategies are integrated to keep the site as close to predevelopment conditions as possible. The LID approach uses:

- Conservation
- Development minimization
- Predevelopment time of concentration
- Redevelopment curve number and runoff volume
- Pollution prevention (Coffman, 2002)

The open space design approach utilizes density concentration of buildings and minimizes the footprint of impervious surfaces. The characteristics of this approach are:

- Using narrower, shorter streets and rights-of-way
- Applying smaller lots and setbacks, and narrow frontages to preserve significant open space

- Reducing the amount of site area devoted to residential lawns
- Spreading stormwater runoff over pervious surfaces
- Using open channels rather than curb and gutters
- Protecting stream buffers
- Enhancing the performance of septic systems, when applicable (Zielinki, 2002)

Both approaches use less building materials in construction, thereby reducing impervious surface and the costs of building and maintenance.

1.4.4.4 Natural Wastewater Treatment, Constructed and Natural Wetlands, and Natural Pools

Natural wastewater treatment has mostly been used by small population centers and highly mechanized wastewater treatment by larger populations. Research shows that the use of natural systems can be effective for large populations as well and reduces maintenance needs and costs. There are three major categories of natural systems; aquatic, terrestrial, and wetland. (Reed, 1998) Constructed wetlands, overland flows, natural wetlands and other natural methods rely on the chemical and biological reactions found in the environment to treat wastewater. The wetlands treating wastewater destroys pathogens, decreases biological oxygen demand, filters out particles, reduces nitrogen and phosphorus, and disposes of toxins. (Steinfeld and Del Porto, 1/04) Wetlands do not behave equally and are site specific.

Created treatment wetlands typically costs about \$5,000 to \$6,000 per acre. An investment that is between 10 to 50 % of the costs of conventional chemical treatment with only about half the costs associated with long-term operation and maintenance. (France, 2003)

The best water purifier is the original wetland that has developed over time. Wetland design that mimics nature would be low maintenance, and self-regulating.

Staten Island has “leveraged existing waterways, and wetlands to convey, store, and filter stormwater” instead of adding costly pipe conveyance and water treatment facilities. (Eisenman, 11/05) In addition, native plantings, swales, and detention basins contributed to the overall system.

Another type of natural system that helps in cleaning water is the natural swimming pool. Use of natural swimming pools instead of chlorinated swimming pools is garnering some interest in the United States. In Europe, three countries use the pools extensively. The natural pool systems meet the rigorous European Union water quality requirements. (Taute, 3/03) Most pools, ponds, and lakes clean and purify themselves by the combination of plants and microorganisms including beneficial bacteria. These microorganisms break down organic wastes into substances that plants can use directly as nutrients. Such pools are preferable because of lower maintenance needs and are healthier and environmentally sound than the chlorinated pools. Scientists suspect the chemicals used in the chlorinated pools are carcinogens that accumulate in the fatty tissues of the body and do not degrade easily. Documented cases have shown Chlorine is a skin irritant and can aggravate asthma. (Littlewood, 11/06) Construction costs can be as little as \$2,000 if done by the owner, where conventional chlorinated pools can run to tens of thousands of dollars. (Buege and Uhland, 2005) About fifty percent of the total surface area is dedicated to aquatic plants for filtering and is not limited to one side of the pool. A wall with two inches below the water surface helps keep the media and plants in place. The maximum planting depth is eighteen inches. The system can blend in easily with the natural landscape.

1.4.4.5 Native Plants

Use of native plants reduce dependency on water, and chemicals, and is adapted to local conditions. The need for less fertilizer means less chance of pollutants entering the water supply. The plants can also act as a filter to trap sediments and pollutants.

1.4.4.6 Summary

The methods discussed in this chapter, singly or in combination apply as an alternative to the standard stormwater and wastewater protocol in most metropolitan cities. Knowledge and skills in these innovations can advance the landscape architecture profession over other allied professionals who do not have extensive knowledge of the land. Areas of knowledge that seems to be consistent through these methods are plant biology, hydrology, and soils. Success of a project often depends on cooperation between different groups.

The planning and management of large landscapes usually involves a complex mixture of social and technical issues such as ecosystem diversity, removal of invasive species, air pollution caused by smoke from controlled burns, and the necessity for local public understanding and support. (Flocke, 2002)

A Michigan convent, The Sisters, Servants of Immaculate Heart of Mary, renovated their buildings and site using a combination of these methods. Their goal was to become sustainable and promote environmental justice to their community. Graywater treatment, geothermal heating and cooling, swales, wetlands, and native plantings are key elements of their site. The Sisters and the design team actively educated themselves and the community, and in doing so, garnered support to the success of the project. (McIntyre, 11/06).

CHAPTER 2

RESEARCH METHODS

2.1 Introduction

Review of literature regarding water quality management revealed what alternative methods and technology are currently applied by landscape architects. Landscape architects accessed a website-based survey with a short description and a link on the Texas Chapter of the American Society Landscape Architects' website. ZipSurvey.com software was the survey medium used. Approximate number of potential responses was 460 practicing landscape architects in Texas. The actual number of responses to the survey was 130. Not all questions received the exact same number of responses because the questions and answers were multifaceted.

2.1.1 Objectives

The objective of the research was to view the use of alternative measures and perceptions by landscape architects towards water quality. Landscape architecture can directly affect water quality by land use, site development, ecology, plant material, geology, soil science, hydrology, and hardscape design. A few projects with the involvement of a landscape architect have garnered some attention in professional magazines and newspapers using alternative methods and technology. For example, Mayer/Reed landscape architects in Portland, Oregon designed a stormwater garden for the Oregon Convention Center. (Thompson,11/04)

2.2 Research Design

2.2.1 Research Challenges

In doing literature review, an innumerable number of research papers, and project documentation was available. The value of the data determined their suitability to the study purpose. Development of survey questions and answers were based on the literature review. ZipSurvey.com software was used as a research medium to establish a web-site based survey. The choice of the survey distribution was determined by the ease and speed of use. The ability to protect the identity and confidentiality of the respondents effectively was also a plus of the software. The only identifier to tie the respondents to the responses was a computer internet protocol address, otherwise known as an I.P. address. Before participating in the survey the respondents were required to sign an electronic informed consent form by clicking the SUBMIT button. Samples of the web-site description with link, informed consent and survey questionnaire is in the appendixes.

2.2.2 Study Characteristics

The study has eight questions and multifaceted responses. The respondent was a practicing landscape architect in the state of Texas. Texas was chosen as the area of study for its broad range of water conditions. Such conditions that affect water are geology, topography, climate, and diversions. The study was applied through a web site based survey using ZipSurvey.com software.

2.2.3 Suppositions Prior to Research

Several suppositions were developed after reviewing literature. The first supposition was that a small niche of landscape architects appeared to be using alternative measures of protecting water quality on a regular basis. Second supposition was that water quality appeared to be a secondary consideration to a client's other needs. The last supposition was the publicity of projects using alternative measures appeared to be limited to professional periodicals and users.

2.2.4 Suppositions Change After Research

The change in suppositions made prior to research was small. Most landscape architects have used one or two alternative measures of protecting water quality on a regular basis. Application of alternative measures was not widespread. The second supposition -- that water quality was a secondary consideration -- held true. The last supposition was still partially true. Major publicity to projects with water quality solutions expanded from professional periodicals and users to internet and seminars.

2.3. Summary

The focus of the research was based on the use and perceptions of alternative measures of protecting water quality by landscape architects. Literature review was performed to frame questions and responses for a web-site based survey and to establish suppositions of the research. The survey was given to landscape architects in Texas through the Texas Chapter of American Society of Landscape Architects' website.

CHAPTER 3

DATA ANALYSIS

3.1 Introduction

Landscape architects from the state of Texas accessed a website-based survey of eight questions located on the website of the Texas Chapter of American Society of Landscape Architects. The survey covered the type of practice, client base, type of alternative measures used in water quality protection, and media used to publicize projects. Survey data were analyzed by using frequency distribution tables, data averaging and counting methods. The data analysis performed was used to establish trends in water quality measures being used by the respondents.

3.2 Preliminary Suppositions Prior to Data Analysis

The first supposition before data analysis was that a small niche of landscape architects extensively uses alternative measures of protecting water quality. The second supposition was that water quality appeared to be a secondary priority in relation to client's other needs. The last supposition was public visibility of projects with the alternative measures was limited to professional periodicals such as Landscape Architecture Magazine.

3.3 Data Analysis Process

The responses by landscape architects to the questions were tabulated using the frequency distribution method and data averaging. One question used a basic counting

analysis. The first two questions were designed to categorize respondents by practice and primary client base. The ensuing questions dealt with frequency of typical alternative water quality measures use, extent of use based on client base, receptivity of clients to alternative measures, personal preferences of use, publicity mediums, and client education of water quality measures.

3.4 Results from the Data

1. In what area do you primarily practice? (Please pick only one)

The first question covered areas of practice typically found in the profession. These areas were education, government, private practice, education and private practice combination, and government and education combination. Often, landscape architects change type of practice or participate in more than one practice at the same time. The majority of the respondents (76%) came from private practice; the second highest group of respondents was Government (15%).

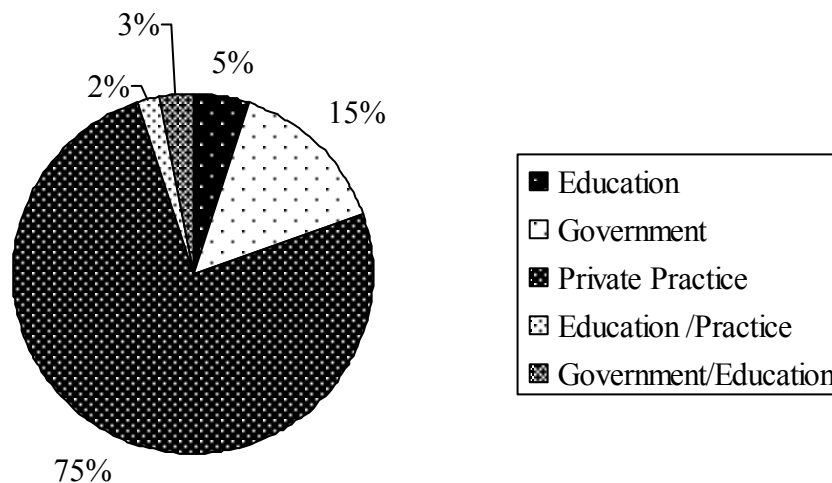


Figure 3.1 Area of Practice

2. *What is your primary client base?*

The second question referred to the clientele of the practice or services rendered. Services to more than one type of client are not unusual. The typical clients are commercial, government, institutions, non-profit organizations, and residential. Commercial clients can include developers, corporations, and small businesses. Government clients can include local municipalities, state and federal agencies, and international government. Institutions can be hospitals, churches, and education. Education covers K-12, community colleges, occupational training facilities, and universities. Government clients were the primary client base by 32% of the respondents and commercial clients followed closely at 30%. Residential clients garnered 21% of the respondents as being a primary client base.

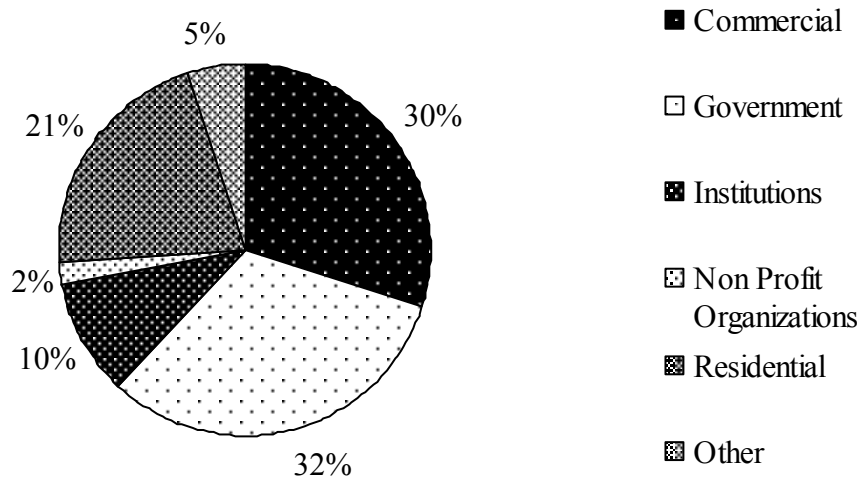


Figure 3.2 Primary Client Base

3. *Do you employ alternative solutions to protecting water quality in your projects?*

The third question covered the frequency of use of alternative measures for protecting water quality. The highest percentage by the respondents for an alternative measure being used all the time went to native plantings at 33%. Vegetated buffers came in second at 25%, followed by swales at 23%. In the category of frequently, the alternative measures of swales received the most responses at 50%. Native plantings and vegetative buffers followed closely with responses of 48%. In third place, bioretention systems received 34% of the responses.

Table 3.1 Alternative Water Quality Measures Frequency

| Alternative Measures Frequency of Use | All the Time | Frequently | Sometimes | Rarely | Never | Responses |
|--|-----------------|------------|-----------|--------|-------|-----------|
| Bioretention Systems | 14% | 34% | 33% | 15% | 5% | 124 |
| Cisterns | 2% | 2% | 31% | 25% | 40% | 123 |
| Green Roofs | 0% | 2% | 13% | 20% | 66% | 123 |
| Low Impact Development | 5% | 23% | 38% | 25% | 9% | 124 |
| Native Plantings | 33% | 48% | 14% | 2% | 2% | 126 |
| Natural Pools | 1% | 3% | 16% | 17% | 63% | 118 |
| Pervious Hardscape | 6% | 23% | 55% | 15% | 2% | 122 |
| Swales | 23% | 50% | 24% | 1% | 2% | 125 |
| Vegetated Buffers | 25% | 48% | 21% | 4% | 2% | 126 |

4. Please rate what percentage of your client base receives these alternative solutions to protecting water quality?

Question 4 covered how much of the client base actually receive the alternative measure of protecting water quality. Frequency distribution method was used to tabulate the responses for this question. In 75-100% of projects, government clients received alternative measures from 23% of the respondents; residential followed at 21%. For 50-75% of projects, thirty-two percent implemented these measures for government followed by non-profit organizations at 23%. Government was the primary user of alternative measures. For 25-50% of projects, the highest 32% applied measures for both institutions and residential, followed by commercial at 27%. In the lowest range of 0-25% of projects, 45% of the respondents implemented measures for non-profit organizations. Commercial clients came in second at 41%.

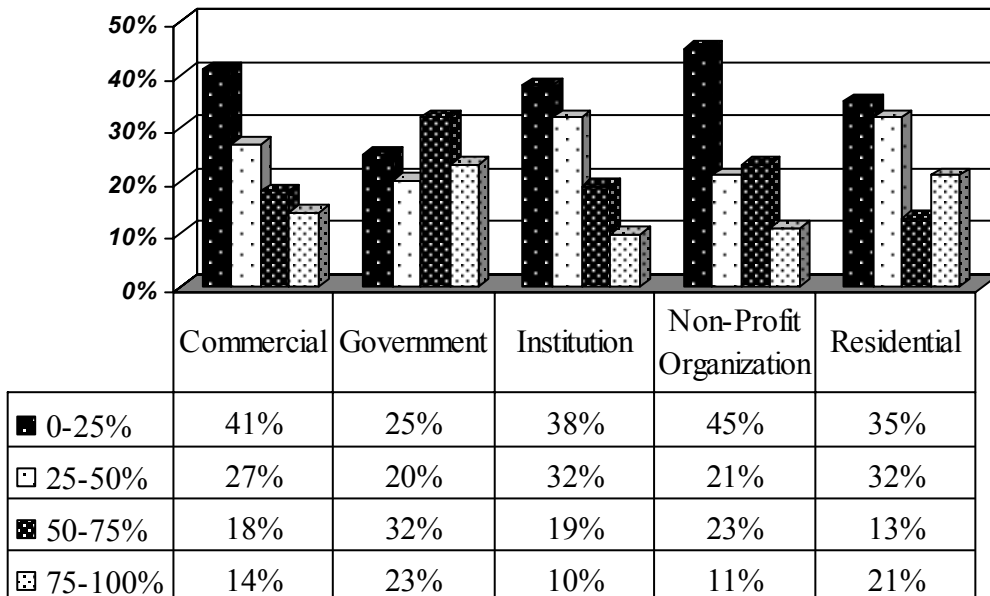


Figure 3.3 Alternative Measure Frequency by Client Base

5. Please rate your client base as those most receptive to alternative solutions to protecting water quality?

Question 5 referred to the clients’ openness to using alternative solutions to protecting the quality of water. Clients may not want to change from something known to them to something unfamiliar, or put in the effort or the resources to change. Frequency distribution and averaging was applied to analyze data for this question. An average of 23.6% of the practitioners had clients who were receptive from a range 0-25% of projects. In this range, the highest percentage went to commercial clients at 36%. For the 25-50% of projects range, the average was 30.6% with residential clients leading at 35%. Institutions led the group at 34% in the 50-75% of projects range, with a 29.4% average. The highest number of landscape architects that had received 75-100% receptivity was 27% for government clients. The average for this level was 16.2%.

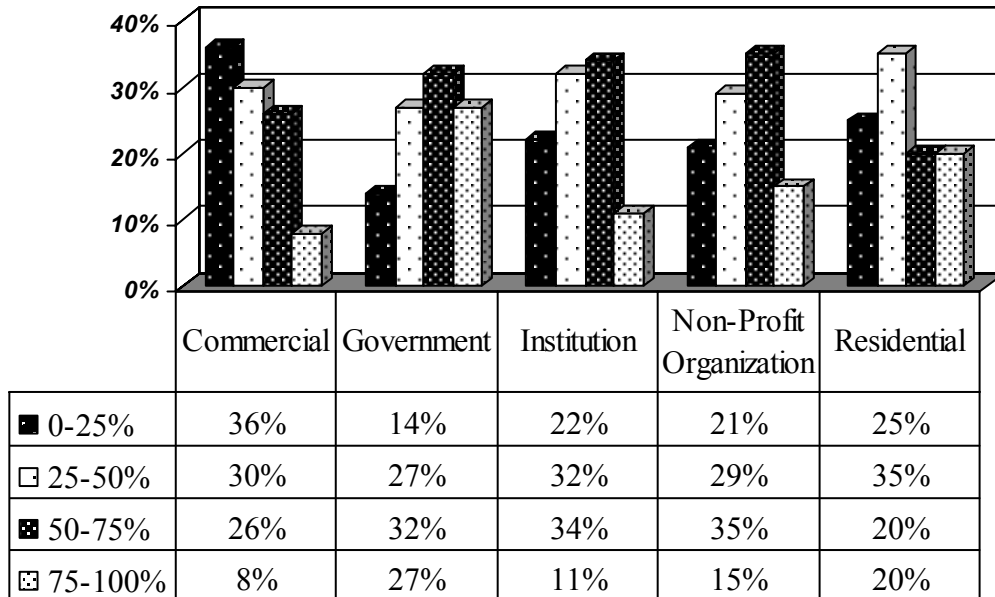


Figure 3.4 Client Receptivity to Water Quality Measures

6. Excluding site constraints, please rate your top five preferences of solutions to protecting water quality?

In question 6, landscape architects indicated their personal preferences in using alternative solutions to protecting water quality without any site constraints dictating the choice. Bioretention Systems garnered the most responses in the first and second choice category. Native Plantings took the second most responses in both the first and second choice category. In the third choice category, highest response was Pervious Hardscape. Second highest response in the third choice category was Vegetated Buffers at 20%. Bioretention Systems was the top choice, with Native Planting a close second in preferred water quality solutions. A simple counting method was used to analyze this question based on the number of responses for each alternative measure. The differences in the number of responses with each measure eliminated the use of percentages and averaging.

Table 3.2 Preferences of Alternative Water Quality Measures

| Preference of Measures | Top Choice | 2nd Choice | 3rd Choice | 4th Choice | 5th Choice | Responses |
|------------------------------|------------|------------|------------|------------|------------|-----------|
| Bioretention Systems | 47 | 27 | 16 | 7 | 7 | 104 |
| Cisterns | 2 | 8 | 9 | 9 | 17 | 45 |
| Green Roofs | 0 | 4 | 7 | 9 | 22 | 42 |
| Low Impact Development | 30 | 18 | 12 | 9 | 11 | 80 |
| Native Plantings | 44 | 24 | 10 | 9 | 9 | 96 |
| Natural Pools | 1 | 4 | 3 | 7 | 10 | 25 |
| Natural/Constructed Wetlands | 15 | 17 | 16 | 17 | 6 | 71 |
| Pervious Hardscape | 6 | 14 | 25 | 20 | 10 | 75 |
| Swales | 15 | 18 | 15 | 12 | 15 | 75 |
| Vegetated Buffers | 24 | 11 | 20 | 22 | 15 | 92 |

7. Please rate which medium most often publicizes projects with solutions to protecting water quality?

Question 7 covered the amount of visibility of projects with alternative measures of water quality protection and the medium used. Fifty-six percent of respondents indicated they receive 75-100% of exposure of projects with water quality measures through Professional Periodicals. Seminars followed second with 25% of respondents received 75-100% of project exposure. The average percentage for the range was 14.6%. For the 50-75% range, 44% of respondents received exposure to projects with Seminars. Professional Periodicals was the second highest of 34%. The average for the group was 21.3%. The standouts of the 25-50% range were two groups tied at 33%, which were General Periodicals and Internet. The average for that range was 22.1%. In

the 0-25% range, Radio took 90%, followed by Television at 69% and Newspaper at 61% with a 41.9% average. From this data, most of the publicity appeared to cater to the professionals with a limited amount to users outside of the profession.

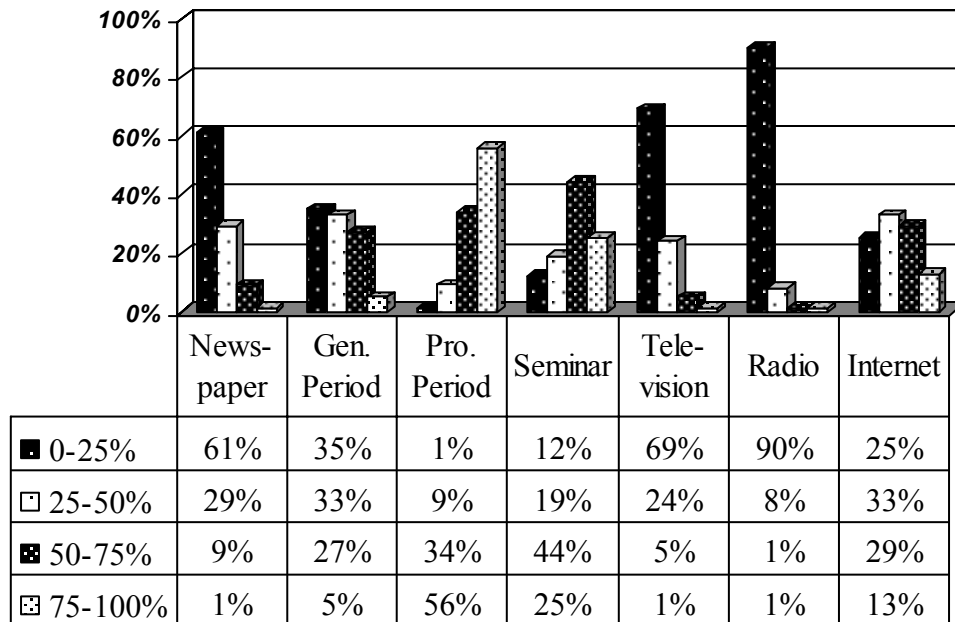


Figure 3.5 Publicity Media for Alternative Water Quality Measures

8. *Which of your client base requires additional education or awareness of those water quality measures?*

The final question referred to additional education of water quality solutions given to clients. Statistical methods used were frequency tables and averaging. Forty-two percent of landscape architects gave additional education in 75-100% of projects to commercial clients followed by 41% for residential clients. The average percentage for this range was 36.8%. In 50-75% of projects, institutions received 40% of the respondents followed by commercial at 35%. The average percentage for the group was 31.2%. Twenty-two percent of the respondents gave additional education to

government and non-profit organizations in 25-50% of the projects with an average of 17.4%. For the 0-25% range, non-profit organizations and government garnered 17% and 16% respectively. The range average was 14.4%.

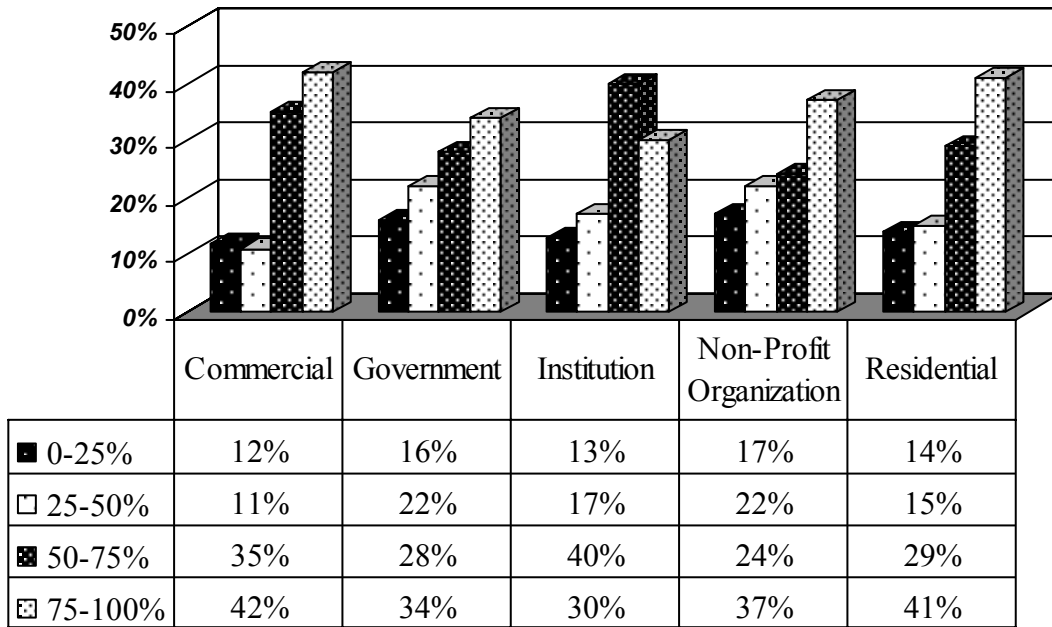


Figure 3.6 Additional Education/Awareness of Water Quality Measures by Client Base

3.5 Summary

In analyzing the data, descriptive statistics has two different tools that were used based on the question and standardized answers. The two primary tools used were frequency distribution tables, and averaging. This process gave a view of the use and perceptions of alternative water quality measures used by landscape architects in Texas. The data expanded prior suppositions made before the analysis process and gave direction in developing conclusions and recommendations.

CHAPTER 4

DISCUSSION

4.1 Introduction

Analysis of data was performed on responses given by landscape architects participating in a web based survey. The survey was accessed by a short description and link on the Texas Chapter of American Society of Landscape Architects' website. The survey was designed to gauge trends in the use and perceptions of alternative water quality measures by landscape architects. Frequency distribution and averaging were the two main tools of analysis. Some of the results confirmed some aspects of suppositions made before research and some broadened views about the connection between landscape architects and water quality.

4.2 Summary of Findings

The majority of landscape architect respondents were in private practice followed by this in government. The major clients requesting landscape architecture services were government, commercial, and residential in that order. Native plantings, swales, vegetative buffers were the alternative measures most used in protecting water quality followed by bioretention systems, low impact development, and pervious hardscape. The primary users of water quality services were government and residential. In the area of being most receptive of the measures, government again took the lead, with non-profit organizations being the second most receptive. The top three choices most preferred by landscape architects were: bioretention systems, native

plantings, and low impact development. Information about water quality projects being done by landscape architects has primarily been in professional periodicals and seminars and to a lesser extent, the internet. All client bases required additional education and awareness of water quality projects.

4.3 Relation of Findings to Research Objectives

The findings correlated some previous assumptions concerning water quality measures used by landscape architects. There were slight differences in regards to visibility of projects. The research objective was to view the profession in terms of their perceptions and their use of alternative measures to protect water quality. The literature review expanded on alternative measures that have been applied in the field with supporting evidence.

4.4 Relation of Findings to Research Questions

The findings answered the two research questions which are:

- How widespread is the use of alternative methods and technology for protecting water quality in the landscape architecture profession?
- How often are these methods and technology applied?

The major area of services rendered was found to be private practice at 75%, followed by government at 15%. The largest client base was government at 32%, followed closely by commercial at 30%. Use of alternative measures by landscape architects in Texas has a few standouts. Landscape architects use these three practices the most often, in this order: native planting; swales; and vegetated buffers. The following three are not as extensively used: bioretention systems, pervious hardscape, and low impact

development. Preferences did not line up with methods most used. The preferred top choices were bioretention systems, native plantings, and low impact development. Secondary choices were vegetated buffers, swales, and natural/constructed wetlands in that order. The highest user of services with water quality solutions was found to be government. Commercial clients followed second. Additional education and awareness were required by all client groups on 50-100% of projects by an average of 70% of landscape architects. Commercial clients required the most by 77% of landscape architects. Receptivity of water quality measures was low across the board with the exception of government. Fifty-nine percent of landscape architects chose government being as receptive in 50-100% of projects. Commercial and residential were found to be least receptive at 34% and 40% respectively. The media most often identified to publicize projects were professional periodicals, seminars, and internet. For less than 50% of projects, radio, newspapers, and television were the media used.

4.5 Importance of Findings

From these data, the findings can give direction for improvement or encouragement of the use of alternative measures of protecting water quality. A clearer picture of what is available, what is actually being used, and what is the perception toward water quality has now been documented.

4.6 Summary

Literature review and a web-site based survey provided views of the use of alternative measures and the perception of landscape architects in protecting water quality. Data collected from respondents were analyzed by the use of frequency

distribution, averaging, and simple counting. Certain trends emerged from the data, such as selective use of measures, limited publicity of projects, and low client receptivity to water quality measures. Landscape architects can utilize the information to encourage or to expand the use of alternative measures and alter negative perceptions.

CHAPTER 5

CONCLUSION

5.1 Introduction

Landscape architects responded to a web-site survey on the use and perceptions they hold regarding alternative water quality solutions. Based on analysis of the responses, certain trends became apparent. Specifically, it was found that landscape architects use alternative water quality measures, but not extensively. A lack of publicity geared to those outside the profession contributes to the inadequacy of public education and awareness regarding these measures. From these and other findings, the following generalizations can contribute to design solutions capable of improving water quality in the state.

5.2 Generalizations

5.2.1 Landscape architects' preferences of alternative quality measures is superseded by client's needs and site restrictions.

The measures that landscape architects used most frequently are native plantings, swales, and vegetative buffers. To a lesser extent, bioretention systems, pervious hardscape, and low impact development are not used as frequently. Respondents' personal preferences for alternative measures are those that require more site modification, planning and changes in existing building codes. Bioretention systems, native plantings, and low-impact development are the most preferred choices.

5.2.2 Landscape architects provide a broader range of alternative water quality solutions to government clients than to other clients.

Government agencies are responsible for most water treatment and public works operations. The implementation of the National Pollutant Discharge Elimination System with Phase I and II and other environmental regulations have forced many government agencies to adapt their traditional methods of water management. In order to meet these regulations, they have become very receptive to alternative methods of protecting water quality.

5.2.3 Landscape architects receive most resistance to the use of alternative water quality measures from commercial clients.

Commercial clients came in second in requesting water quality solutions, but were found to be the least receptive of these alternative solutions, arguably because their focus is profit margin. Environmental elements such as air, water and vegetation have traditionally been considered by commercial clients not to have an economic value. Such clients may use water quality measures only to the extent necessary to comply with environmental regulations.

5.2.4 Landscape architects give additional education and awareness to all client groups.

The use of these alternative measures for protecting water quality has been limited by the lack of public education and awareness to those outside the profession. The publicity surrounding these measures is only available through professional periodicals, seminars, and to a lesser extent, the internet.

5.3 Recommendations

To promote acceptance of alternative water quality solutions, landscape architects can undertake the following:

- Establish demonstration projects in prominent locations such as government facilities, school site, shopping areas, and recreation areas
- Develop relationships with K-12 schools, churches, and government
- Develop workshops or events for public participation
- Expand media base beyond the use of professional periodicals, seminars, and internet.

5.4 Summary

While the Texas landscape architects who responded to the survey indicate that they use alternative measures to protect water quality, the use of these measures was found not to be prevalent in their practices. Visibility of projects with the alternative measures was being limited to professional periodicals and seminars. In addition, clients needed additional education and awareness from landscape architects. To improve the acceptance and expand the use of these measures, landscape architects can build relationships with different groups such as K-12 schools and churches, develop demonstration projects, public workshops or events, and expand visibility of water quality projects to those outside the profession.

APPENDIX A

TEXAS ASLA CHAPTER PERMISSION LETTER BY EMAIL

October 23, 2006

Ms. Jean Kavanagh, FASLA
Texas Chapter President
Texas Tech University
4111 17 th Street, #108
Lubbock, Texas 79416

Dear Ms. Kavanagh:

My name is Andrea L. Davis and I am a graduate student in the Program of Landscape Architecture at The University of Texas at Arlington. I would like to conduct a website based survey of landscape architects in the Texas ASLA Chapter for a thesis entitled "The Connection Between Landscape Architecture and Water Quality". Professor Gary Robinette is my thesis committee chairperson.

With your permission, I would place a short survey description and a link to the survey on your website.

This study gauges the methodologies used by and perceptions of landscape architects on projects related to water quality. The responses will be placed in a database without any personal identifying information of the participants in order to protect their privacy and confidentiality. Before volunteering to participate in the survey, there will an informed consent page that will need to be signed electronically and returned by a Submit button.

Please feel free to contact me by email if you have any questions concerning the study. I appreciate your attention to this.

Thank you.

Sincerely,

Andrea L. Davis
LARC Graduate Student
The University of Texas at Arlington
P.O. Box 19108
Arlington, Texas 76019-0108
ald6170@exchange.uta.edu

APPENDIX B

SURVEY INFORMED CONSENT

A SURVEY ON THE CONNECTION BETWEEN LANDSCAPE

ARCHITECTURE AND WATER QUALITY

INFORMED CONSENT

This “The Connection Between Landscape Architecture and Water Quality Survey is a thesis research project to gauge the use and types of alternative methods used in the landscape architecture field to protect water quality and the perception of the field toward water quality issues. This project was reviewed and approved by the University of Texas at Arlington Office of Research Compliance on 10-21-06

PURPOSE: You are being asked to participate in an on-line survey of Texas ASLA members and their relationship with water quality issues. The purpose of the research is to learn:

- What is the general consensus of the profession in using measures to protect water quality?
- The methods and technology used to protect water quality.

PROCEDURES: This is an online survey. After reading this informed consent text, you can proceed directly to the online questionnaire. Clicking on the “submit” button below will be understood to represent your consent to participate in the survey. If you click the “submit” button you will be taken to a Web page and will be able to complete the survey.

It will take about 10 minutes to complete the survey.

Your responses to the survey questions will be stored in a database, but will not be linked to your name or any other unique identifier. Your answers will be anonymized.

RISKS: Completion of the survey carries no known or foreseeable risks. Because your responses to the survey are not linked to your name or other unique identifier, no one will be able to discover your answers, or even whether you took the survey.

BENEFITS: You will not benefit from completion of this survey. It may only increase the awareness of the importance of protecting water with alternative methods.

ALTERNATIVES: You have the alternative not to participate in this study.

COSTS: There are no costs associated with completing this survey.

PAYMENT TO PARTICIPANT: You will not be paid for completing the survey.

CONFIDENTIALITY: Your participation in this study will generate no personally identifiable record, data, or document. Upon submission of your survey answers, the data will be unlinked from your name and other unique identifiers. It is possible that online hackers, spyware filters, or other Web impediments to secure online communications will be able to eavesdrop on your submission. It is difficult to assess the risks or consequences of this, but they are based in part on the security of your network connections and, in any case, are believed to be small.

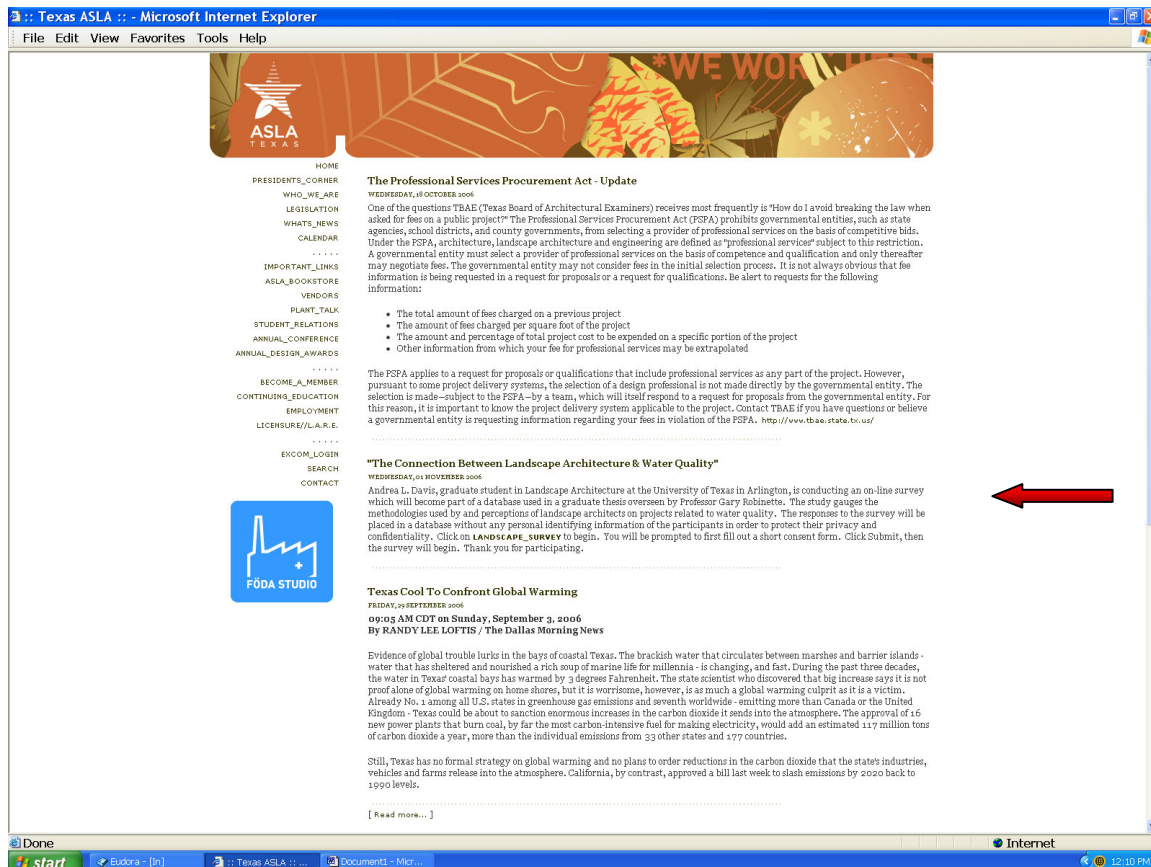
RIGHT TO WITHDRAW: Your participation in the survey is voluntary; you have the right to withdraw at any point or to skip any questions you want.

OTHER PERTINENT INFORMATION: You may print a copy of this consent form. The principal investigator – Andrea L. Davis, will answer any questions you may have about the study; her phone number is (817)557-4158 and email is ald6170@exchange.uta.edu. If you have questions about your rights as a research participant, you should contact the University of Texas at Arlington Office of Research Compliance at (817)272-3723 as well as the UTA -School of Architecture Landscape Program Office at (817)272-2801.

Submit

APPENDIX C

TEXAS ASLA CHAPTER WEBSITE – INVITATION TO SURVEY



Highlighted Portion of the website:

"The Connection Between Landscape Architecture & Water Quality"

WEDNESDAY, 01 NOVEMBER 2006

Andrea L. Davis, graduate student in Landscape Architecture at the University of Texas in Arlington, is conducting an on-line survey which will become part of a database used in a graduate thesis overseen by Professor Gary Robinette. The study gauges the methodologies used by and perceptions of landscape architects on projects related to water quality. The responses to the survey will be placed in a database without any personal identifying information of the participants in order to protect their privacy and confidentiality. Click on **LANDSCAPE_SURVEY** to begin. You will be prompted to first fill out a short consent form. Click Submit, then the survey will begin. Thank you for participating.

APPENDIX D

SURVEY

**A SURVEY OF THE CONNECTION BETWEEN LANDSCAPE
ARCHITECTURE AND WATER QUALITY**

The purpose of the survey is to gauge the methods used by and perceptions of landscape architects on projects related to water quality. The methods included in the survey are bioretention systems; low impact development; native plantings; swales; vegetative buffer zones; vegetated roofs; and wetlands.

Deadline for participating in the survey November 24, 2006

1. In what area do you primarily practice? (Please pick only one)
 - a. Education
 - b. Government
 - c. Private practice
 - d. Education and private practice
 - e. Government and education
 - f. Other (please identify)

2. What is your primary client base?
 - a. Commercial
 - b. Government
 - c. Institutions such as hospitals, churches, and education
 - d. Non-profit Organizations such as neighborhood associations
 - e. Residential
 - f. Other (please specify)

| | | | | |
|---------------------|-------------------|------------------|---------------|--------------|
| <i>All the time</i> | <i>Frequently</i> | <i>Sometimes</i> | <i>Rarely</i> | <i>Never</i> |
|---------------------|-------------------|------------------|---------------|--------------|

3. Do you employ alternative solutions to protecting water quality in your projects?

- a. Bioretention Systems such as detention, retention ponds, and rain gardens
- b. Cisterns or Rain Barrels
- c. Green or Vegetated Roof
- a. Low Impact Development
- b. Native Plantings
- c. Non chemical or Natural Swimming Pools
- d. Natural and/or Constructed Wetlands
- e. Pervious Hardscape
- f. Swales
- g. Vegetative Buffers
- h. Other (please identify)

| | | | |
|--------------|---------------|---------------|----------------|
| <i>0-25%</i> | <i>25-50%</i> | <i>50-75%</i> | <i>75-100%</i> |
|--------------|---------------|---------------|----------------|

4. Please rate what percentage of your client base receives these alternative solutions to protecting water quality.

- a. Commercial
- b. Government
- c. Institutions such as hospitals, churches, and education
- d. Non-profit Organizations such as neighborhood associations

- e. Residential
- f. Other (please specify)

| | | | |
|-------|--------|--------|---------|
| 0-25% | 25-50% | 50-75% | 75-100% |
|-------|--------|--------|---------|

5. Please rate your client base as those most receptive to alternative solutions to protecting water quality.

- a. Commercial
- b. Government
- c. Institutions such as hospitals, churches, and education
- d. Non-profit Organizations such as neighborhood associations
- e. Residential
- f. Other (please specify)

| | | | | |
|-------------------|----------------------|---------------------|-------------------|-------------------|
| <i>Top Choice</i> | <i>Second Choice</i> | <i>Third Choice</i> | <i>4th Choice</i> | <i>5th Choice</i> |
|-------------------|----------------------|---------------------|-------------------|-------------------|

6. Excluding site constraints, please rate your top five preferences of solutions to protecting water quality?

- a. Bioretention Systems such as detention, retention ponds, and rain gardens
- b. Cisterns or Rain Barrels
- c. Green or Vegetated Roof
- d. Low Impact Development
- e. Native Plantings
- f. Non chemical or Natural Swimming Pools
- g. Natural and/or Constructed Wetlands
- h. Pervious Hardscape

- i. Swales
- j. Vegetative Buffers
- k. Other (please identify)

| | | | |
|-------|--------|--------|---------|
| 0-25% | 25-50% | 50-75% | 75-100% |
|-------|--------|--------|---------|

7. Please rate which medium most often publicizes projects with solutions to protecting water quality.

- a. Newspapers
- b. General Periodicals such as Home and Garden
- c. Professional Periodicals such as Landscape Architecture Magazine
- d. Seminars
- e. Television
- f. Other (Please specify)

| | | | |
|-------|--------|--------|---------|
| 0-25% | 25-50% | 50-75% | 75-100% |
|-------|--------|--------|---------|

8. Which of your client base requires additional education or awareness of those water quality solutions?

- a. Commercial
- b. Government
- c. Institutions such as hospitals, churches, and education
- d. Non-profit Organizations such as neighborhood associations
- e. Residential
- f. Other (please specify)

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BIOGRAPHICAL INFORMATION

Andrea Lora Davis received her Master's of Landscape Architecture from The University of Texas at Arlington in December 2006. She received her Bachelor of Business Administration with a concentration in General Business from Texas Woman's University in December 1993 and an Associate in Applied Science in Horticulture from Tarrant County College in December 1996. Her career direction is to improve the connection between the public and the environment through education design, and active participation.